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CULTIVATE  
THE FUTURE.



# CULTIVATING THE FUTURE BASED ON SCIENCE

Proceedings of the Second Scientific Conference of the International Society of Organic Agriculture Research (ISOFAR), held - at the 16<sup>th</sup> IFOAM Organic World Congress - in Cooperation with the International Federation of Organic Agriculture Movements (IFOAM) and the Consorzio ModenaBio 2008.

18-20 June 2008 in Modena, Italy.



## VOLUME 2 LIVESTOCK, SOCIO-ECONOMY AND CROSS DISCIPLINARY RESEARCH IN ORGANIC AGRICULTURE

Edited by Daniel Neuhoff, Niels Halberg, Thomas Alfordi, William Lockeretz, Andreas Thommen, Ilse A. Rasmussen, John Hermansen, Mette Vaarst, Lorna Lueck, Fabio Caporali, Henning Høgh Jensen, Paola Migliorini, Helga Willer.



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**Volume 2**

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Daniel Neuhoff, Niels Halberg, Thomas Alföldi, William Lockeretz, Andreas Thommen, Ilse. A. Rasmussen, John Hermansen, Mette Vaarst, Lorna Lueck, Fabio Caporali, Henning Hogh Jensen, Paola Migliorini, Helga Willer (Editors)

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## Preface

To carry home these heavy two volumes of ISOFAR's 2nd Scientific Conference Proceedings might give rise to the question whether these books represent more mass than class and if they are still topical.

After all the author must wonder whether a contribution in a peer-reviewed proceedings volume is worthwhile when there is the alternative of publishing it in a highly ranked scientific journal with the same effort. Moreover, the editors as well as the numerous referees might have felt desperate at times due to the enormous amount of time and strength they invested to compile about 400 selected papers.

I would like to thank all of you for your effort. It was worthwhile since the reader now obtains a valuable overview of the current state of knowledge and research aims of the scientifically based Organic Agriculture which might be important not only for the scientist but also for all other stakeholders interested in the further development of Organic Agriculture.

I owe gratitude to all who contributed to coping with this laborious task. You have all done a tremendous job in contributing to foreseen successful scientific modules held under ISOFAR's and IFOAM's joined conference/congress umbrella. Our collective hope is that these proceedings will represent a significant milestone on the road towards a better understanding of the potentials and effects capabilities of a scientifically based Organic Agriculture can have.

Prof Dr Ulrich Köpke

President ISOFAR



## Dear Reader,

The two volumes of the Proceedings of the Second Scientific Conference of the International Society of Organic Agriculture Research, 'Cultivating the Future Based on Science', represent a considerable part of the worldwide increase in research activities in Organic Agriculture (OA). This observation is in accordance with the overall trend, at least in much of the western world, of increased production and consumption of certified organic products.

In all, 495 four-page papers were submitted to the conference, and all went through a sophisticated review process resulting in 380 papers being selected for presentation at the ISOFAR Conference. Evaluating papers is a difficult task, requiring a sure scientific instinct. It also requires a reasonable judgement of the quality of the language of each paper; since a paper's language is part of what determines its overall quality, even though this gives an unjustified advantage to native speakers of English. Supported by a review form that checked various aspects of the paper's quality, the reviewers tried their best to ensure maximum transparency of the evaluation, which basically reflected the objective of improving the paper's quality.

The first volume deals mainly with various aspects of organic crop production, which traditionally represent the largest share of all papers submitted to conferences on OA. We hope that you will find it interesting to discover the diverse research approaches regarding the management of organic crops. While a tendency to a more problem-oriented approach realized by specialists is evident, as perhaps is to be expected, there is still a strong foundation of papers on traditional agronomy with a systemic approach, which remains a key discipline in OA research. Attentive readers will realize that the diversity of papers also reflects the global differences with respect to an understanding of what OA is.

This second volume gives insights into the increasing research activities on animal husbandry, socio-economics, interdisciplinary research projects, and QLIF workshops, all related to OA. We gratefully acknowledge in particular the increasing interest in organic animal husbandry, which in the past was a poor cousin in OA research. Some topical issues such as global warming and energy supply are discussed in the interdisciplinary sessions.

The scientific committee agreed at the start that cross-disciplinary papers should be given high priority because of the very nature of organic farming and food systems. For many years we have claimed there was a need for a holistic understanding of OA, both because of the interdependencies among sub-systems on the farm (soil-crops-livestock-people) and because of the multiple objectives behind OA (producing wholesome food, conserving soil fertility, maintaining biodiversity, supporting animal welfare, reducing pollution, etc.). However, most often researchers end up meeting and discussing these matters in largely discipline-oriented sessions, even at most organic conferences. Therefore, we wanted to encourage a more cross-disciplinary approach at this ISOFAR event, and we were happy to receive a large number of papers for the cross-disciplinary topics. We hope this tendency will be strengthened in future organic conferences.

Moreover, the great number of papers submitted for the scientific part of the OWC clearly demonstrates the interest in sharing research-based knowledge within the organic sector. To achieve this, it was important to have a section of the OWC where strict methodological approaches are required for participation.

On the other hand, it is a pleasure and an advantage for a scientific conference to be part of a global event that attracts the whole sector and thus allows the researchers to disseminate their findings widely and gain inspiration from other stakeholders in the organic movement.

First and foremost many thanks to all authors who contributed to our joint conference. We also are greatly indebted to the numerous reviewers listed on the next page, who did a first-class job in evaluating hundreds of papers. It was a great pleasure to cooperate with Paola Bonfreschi from the OWC – Organizing Committee, who is the embodiment of reliability and politeness. Last but not least, many thanks to Anja Schneider, of the ISOFAR Head Office, who was mainly in charge of overall communication with the authors and substantially supported the editing of the proceedings.

Managing the review process and editing the proceedings for an international conference is a challenging task in which language difficulties and technical problems may sometimes result in confusion. We kindly ask you to accept our apologies for any problems you may encounter.

We sincerely hope that the Proceedings of the Second Scientific Conference of ISOFAR 'Cultivating the Future Based on Science' will be an important and worthwhile source of information and inspiration for you.

On behalf of the Editors,

Daniel Neuhoff, Niels Halberg, Thomas Alföldi & William Lockeretz

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## **Welfare indicators and welfare promotion of organic animals**



# Assessment of skin damages in dairy cows

Smolders, G.<sup>1</sup>

Key words: skin damage, location, housing, assessment period, benchmarking

## Abstract

*Skin damages were assessed at 48 conventional and organic farms with mainly cubicle houses. Scores from 1 – 9 were given depending on type and size of the damaged skin at 9 locations of the cow: outer hock, inner hock, knee and body all left and right hand side and the neck. Only the highest score per location is recorded and remarks of unusual findings are made separately. The most frequent and most severe affected location is the outer hock followed by the knee. Only 14 percent of all cows did not have any damage, 34 percent had only hairless patches and 24 percent of the cows did have at least one swelling. Correlations of the mean farm score for the left and right hand side are high for the outer hock and low for the body. To have the most impact in advising farmers, assessment should preferably be made at the end of the housing period, the most threatening period in animal welfare in the Netherlands. This system allows benchmarking within and between farms.*

## Introduction

In animal assessment of welfare, beside lameness, one of the important issues are skin damages of the cows. Hairlessness, wounds, bruises and swelling demonstrate that the animal does not fit in the housing or that the housing system does not fit to the animal (Whay et al; 2003, Klocke and Ivmeyer; 2004; Rousing et al, 2000). In the new EU health strategy (European Commission, 2007) is acknowledge that suitable performance indicators will allow the assessment of progress. In the Netherlands a assessment system for skin damages has been developed in witch it was important to have a link between the location of the damage on the cow and the cubicle housing system. Farmers understand performance parameters as a practical system for assessing skin damages of diary cows and are able and wiling to react with improvements in the housing conditions.

## Material and methods

In the period 2005 -2007 in total 2419 cows are assessed for skin damages at 34 conventional farms (con), 11 organic farms (eco) and 3 biodynamic farms (bd). The majority of the herds were Holstein Frisian. At nine farms Meuse Rhine Ijssel was the main breed, at one farm Brown Swiss, one farm Montbeliarde and at one farm Jersey. At 11 farms cows were scored twice (at the end of the stabling period and at the end of the grazing period), at 37 farms cows were scored once during the stabling period. All assessments were carried out by the same person. The scoring system for skin damages is as given in table 1. Scores are recorded separately for outer hock, inner hock, front knee, neck and body. Except for the neck, all locations are score on the left- and on the right-hand side of the cow. If more cows do have comparable

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damages on the body or damages on the same place, it is recorded as an extra remark.

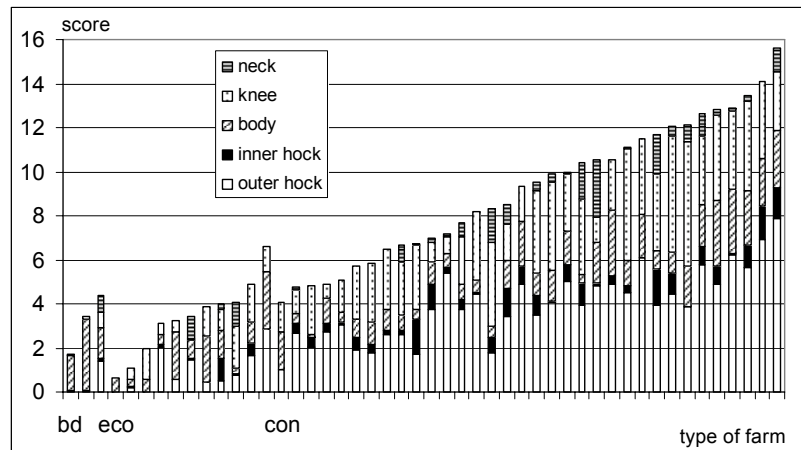
Only the worst damage per location is recorded: a cow with a swollen hairless outer hock with an open wound, will get a score for that place of at least 7 (depending on the size of the swelling). Cows are assessed while standing at the feeding rack. At farms over 30 cows a random sample of about 25 cows is assessed. To ensure a random selection of 1<sup>st</sup> and 2<sup>nd</sup> calvers and older cows, instead of selecting particular cows, some more cows than strictly necessary for a good sample are assessed. Selecting particular cows disturbs the cows and takes much time. Assessing cows for skin damages takes about 2 minutes per animal. Together with skin damages body condition and locomotion are assessed and sometimes also teat end callosity.

**Tab. 1: Scoring skin damages in assessment system for dairy cattle**

Patch (Ø in cm)	Hairless			Lesions (open or curing)			Swollen		
	<3	3-6	>6	<3	3-6	>6	<3	3-6	>6
Score	1	2	3	4	5	6	7	8	9

## Results

All farms except three with deep litter housing, kept the cows in winter in cubicle housing. The bedding in the cubicles consisted of deep straw or sawdust or of different types of mattresses, waterbeds or rubber mats with sawdust or grinded straw on top. The average score per location and farm is presented in figure 1 as the mean of the left and the right-hand side of the cow and ranked by the sum of sores by farm type (bd, eco, con). The best possible score is 0 (no skin damage at all), the worst possible score is 45 (max swelling at the 5 assessed locations of the cow).



**Figure 1: Mean skin damage score per location and total score per farm**

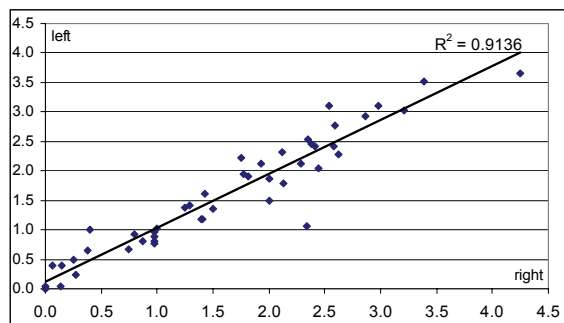
The organic farms, even with horned cows at the biodynamic farms, reach good scores compared with conventional farms. The average overall score is 7.4 (table 2).

The absolute score shows that the outer hock is the most affected location of the cow and the inner hock the least affected area. For all assessed parameters there are farms with no damaged cows, but on 15 of the farms there were no cows without skin damages. From the total score, 41% is caused by the outer hock and 30% by damages of the front knee. The maximum percentage of total score shows that up to 100% of skin damages could be caused by one parameter.

**Tab. 2: Absolute and relative mean score for skin damages of cows (48 farms)**

Location	Outer hock	Inner hock	Body	Knee	Neck	Total score
Absolute score						
Mean	3.1	0.5	1.30	2.2	0.4	7.4
Maximum	7.9	1.7	3.3	5.7	2.6	15.6
Percentage of total score						
Mean	41	6	17	30	5	100
Maximum	76	26	100	73	29	
Percentage of cows						
No skin damage	45	92	77	67	89	14
Hairless	34	5	16	20	8	34
Infected	15	3	6	5	1	28
Swollen	6	0	1	8	2	24

Fourteen percent of all assessed cows did not have any skin damage at all. For the different parameters the percentage of not damaged cows ranged from 45% for the outer hock to 92 percent of the inner hock. In 34 percent of the cows, the damages were only hairless patches while 24 percent of the cows did have at least one swelling somewhere. The outer hock is not only the most severe affected part of the cow, with 55% of cows it is also the most frequent damaged location.



**Figure 2: Correlation between mean farm score for left- and right outer hock of the cow**

### **Assessing left and right hand side**

Correlation between the left-hand and right-hand side of the outer hock are given in figure 2. The mean scores per farm for the right- and left-hand side of the outer hock are comparable ( $r^2=0.91$ ). Correlations between the left-hand side and the right-hand side for inner hock, body and knee respectively are. 0.67; 0.39 and 0.74. The skin damages on the body are sometimes typically for the stable on one side of the body especially if they are caused by obstacles in the walking area or at the feeding rack.

### **Discussion**

The assessment system is used to help farmers finding inadequacies in the housing of the cows. To be able to show the farmers the weak points of their housing, at farms where cows are grazing during summer, assessments should be preferably made at the end of the stabling season. Under grazing conditions skin damages are less frequent and less severe than under stabling conditions. Especially for assessing the front knee, it helps if cows can be closed in the feeding rack. Although assessing only one side of the cow would save time, large part of the skin damages at the "body" are missed. Assessing the different locations of the cow makes the system acceptable by farmers for it is easier to link the damaged locations of the cow to specific housing conditions. So there will be a greater chance of improving the situation for the animal (Aerts et al, 2006). As Whay et al (2003) reported, we found that even farms with a low level of animal welfare usually do have one strong point. In assessing more separate locations of the cow the chances of having some positive results on certain locations compared with colleagues are higher and in a positive mood, farmers are more susceptible to improve the weak points in their housing system. For reliable results in various housing systems, between different breeds, between horned and dehorned cows and between farm types more assessments are being made.

### **Conclusions**

The most affected places with skin damages are the outer hocks of the cows. Assessing only one side of the cow gives a good idea of the damages of the outer hock but not of skin damages of the body. Farmers understand the system while there is a link between assessed locations of the cow and the housing system and are able to improve housing based on the assessment.

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# Evaluation of Laying Hen Strains for biodynamic Farms

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Poultry, Animal nutrition, Animal health, Animal husbandry and breeding, Performance

## Abstract

*In biodynamic and organic agriculture mostly the same strains of laying hens as in conventional agriculture are used. These strains require feed with a high nutrition level to tap the full potential of their genetic. When this feed is not available it may lead to health problems and ethological interferences as well as to a deficiency of performance. In this study, four potential adequate strains are evaluated and compared with a commercial strain using health and ethological parameters as well as characteristics of performance under biodynamic conditions. After one laying period the laying performance of Amberlik, Hylina, Sperber and Sussex was high but only the plumage condition of Sussex was acceptable. Therefore this strain will be used for further investigations.*

## Introduction

In laying hen husbandry normally the same strains are used as well in organic as in conventional agriculture. These strains generally have a high genetic performance potential.

In conventional agriculture, feed supplements are added as for instance chemically synthesized vitamins. These supplements guarantee a high production performance. In guidelines of the Demeter-association (2007) these supplements are not allowed. Therefore it is difficult to meet the needs of the hybrids with a very high performance potential. A lower performance and health and ethological problems as for instance feather pecking may occur when the supply with certain nutrients is insufficient.

In winter 2005/2006 free range husbandry was forbidden in Switzerland because of avian influenza risk. During this time, biodynamic farms had increasing problems with feather pecking, possibly because the hens had not the opportunity to complement their feed with grass and invertebrates in the hen runs. Likewise, Nicol et al. (2003) found a reduced risk of feather pecking with an even use of the hen run. Due to these problems a special approval allowed the use of chemically synthesized vitamins in DEMETER-feed. With this procedure the problems with feather pecking could be reduced. However, the discussion of special breeds for free range and especially organic laying hen husbandry was resumed. Since years the demand for alternative breeds is discussed among experts. Field checking of different breeds under organic conditions has been performed in the studies of Ökoring Schleswig-Holstein e.V. (2003) and Glawatz et al. (2007). However these field studies were only evaluating the laying period and it was not possible to control the rearing conditions. Therefore we decided to evaluate different strains of laying hens, which were reared together.

The aim of the study was to find a laying hen which is suitable for the conditions on biodynamic farms feeding 100% organic feed and no artificial vitamins. The evaluation

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was divided into two phases. The first phase included a comparison of five laying hen strains on a farm. In the second phase the most suitable strain should be chosen to verify the results on several biodynamic farms.

### **Methods of the first phase**

Before starting the experiment we discussed with several experts which strains we should use for the evaluation to be potentially good for biodynamic farms.

In a descriptive study, four strains were tested with a commercial hybrid as control. The brown hen Hyline which is often used on organic laying hen farms in Switzerland was used as control strain. The other chosen lines were Dekalb Amberlink, Sussex D-104, Sperber and a cross of Welsumer (the cock was Welsumer and the hen Hyline) which was recommended by a farmer.

For the rearing period about 125 hens from all five strains were housed together on an organic farm. The commercial organic rearing feed contained the components wheat and maize in Demeter-quality. With 19 weeks the young hens were moved to the laying hen house on the same farm where all strains were kept in separate flocks (5 hens/m<sup>2</sup> in the house and a hen run of 5m<sup>2</sup>/hen). The hens were fed with biodynamic laying hen pellets and grains. During the whole laying cycle, feed consumption, laying performance and mortality of all hens were recorded. At the age of 28, 38 and 67 weeks we recorded plumage condition, weight, feather pecking frequency and general activity of the hens on one day. The plumage condition of 10 randomly chosen hens per strain was scored on five parts of the body (head, back, wings, chest and abdomen) from score 1 (plumage without damages) to score 4 (bare parts). The mean scores of the 10 hens per strain were compared. From the same 10 hens per strain the weight was measured. Feather pecking was recorded with all-occurrences-sampling observing 30 hens for 15 minutes per strain. The activity (active behaviour: pecking, preening, moving, scratching, dustbathing or passive behaviour: resting, standing) of all hens was recorded with scan-sampling (five scans with an interval of 30 min per day).

### **Results of the first phase**

The laying performance increased as usual in all five strains. However, Welsumer soon had a decline in their laying curve and never reached the performance of the other strains. Therefore they had about 20% eggs less than the normally expected laying performance of commercial hybrids. The laying performance of Sussex decreased faster than the expected performance and this resulted in about 5% eggs less (Table 1). The other strains all performed according to the expected laying performance of commercial hybrids. Only the mortality of Hyline was higher than the normally accepted 10% (Table 1). The feed consumption did not differ between the strains.

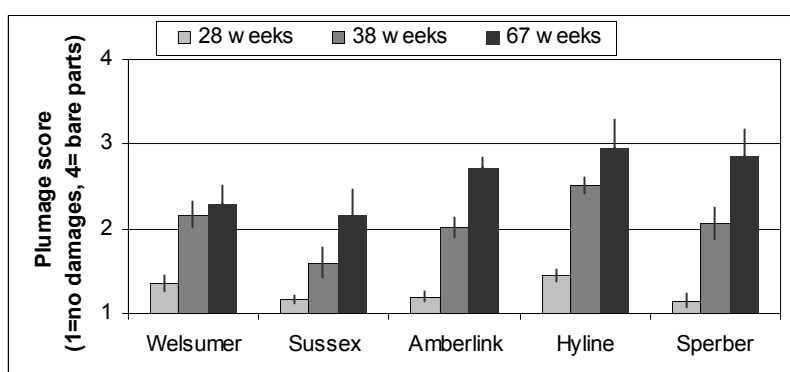
At the beginning of the rearing period, all strains had almost the same weight. However, at the end of the rearing period, Sperber were the heaviest hens. At the age of 38 weeks, Welsumer and Sussex had the highest weight and at the age of 67 weeks, again Sperber together with Welsumer were the heavier ones. Sussex seemed to have lost weight.

**Tab. 1: Performance Characters of the five strains (in percent)**

	Sperber	Hyline	Amberlink	Sussex	Welsumer
Laying Performance	83.27	81.15	83.96	77.26	61.05
Mortality	8.59	11.72	3.91	6.25	4.69

As expected, the plumage condition deteriorated with increasing age (Figure 1). The differences in the plumage condition were small at the beginning of the laying cycle in week 28. Hyline was the strain with the worst plumage throughout the laying cycle. On the other hand, Sussex had the best plumage condition up to the end of the laying cycle. Remarkably, Welsumer had almost the same plumage condition at weeks 38 and 67. Therefore it did not change a lot over this long time.

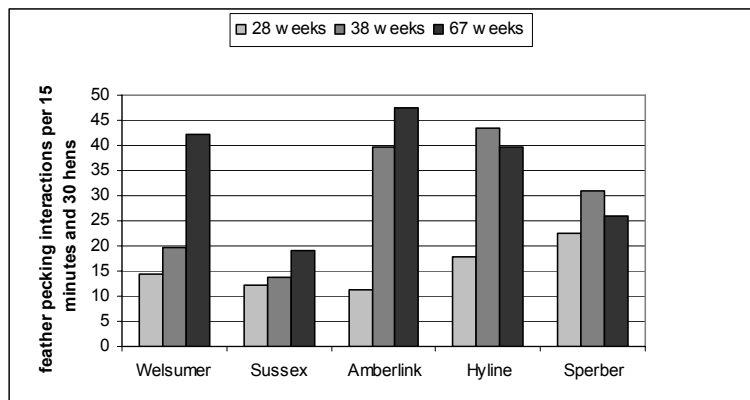
In the frequency of feather pecking, Sussex had the lowest number of feather pecking interactions (Figure 2). All other strains had a much higher frequency of feather pecking at least at one age of observation. There was no remarkable difference in the activity of the strains.



**Figure 1: Plumage condition; given is the mean score of 10 hens per strain.**

### **Discussion and Conclusions**

The laying performance of all evaluated strains except of Welsumer was acceptable. However, a lower laying performance than usual would be acceptable as it might help to put up reserves for fluctuating nutritional value of the feed and therefore improve health of the animals. As Hyline had the highest mortality, this strain seems to be overstrained in its adaptability to the biodynamic conditions.



**Figure 2: Number of feather pecking interactions per strain at three ages.**

In a discussion group with Demeter-farmers it was decided to proceed with Sussex in the second phase of the project. This strain had the best plumage quality up to the end of the laying cycle and the lowest frequency of feather pecking. It seems that for this strain it is possible to adapt to the conditions on biodynamic farms while having an acceptable performance. Therefore this strain should further on be tested on biodynamic farms

### Acknowledgments

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# Risk factors for feather pecking in organic laying hens –starting points for prevention in the housing environment

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Key words: poultry, laying hens, pullet rearing, feather pecking, housing

## Abstract

*Feather pecking still presents a major problem in organic laying hen farming. In order to identify important risk factors during the laying period as well as during the rearing period in an exploratory epidemiological approach, we followed birds from 23 organic rearing units in Austria and Germany to 46 laying units. Management and housing conditions were recorded during one day visits in the 16<sup>th</sup> to 18<sup>th</sup> and 30<sup>th</sup> to 40<sup>th</sup> week of age, respectively. As an indicator of feather pecking, feather conditions of random samples of 30 hens per laying farm were assessed. Average feather scores from 0 (best) to 3 (worst) were calculated. The average score of 0.73 ( $\pm 0.44$ ) was not significantly different from the score of 0.77 ( $\pm 0.33$ ) from 54 conventional farms assessed in the same way ( $p=0.247$ ). 73 % of the total variance in feather score between the different organic farms could be explained by 6 variables. About 79 % of the explained variation was due to rearing conditions. The major risk factors for poor plumage were little elevated perch space, few drinking places and no regular scattering of grain during the rearing period, as well as poor litter quality during the laying period. It is concluded that these are feasible starting points for improved prevention strategies against feather pecking.*

## Introduction

Feather pecking still represents a major problem in organic systems. However, the reliable prevention of feather pecking is a challenge, because it is a typical multifactorial disorder. Genetics of the hens, nutritional aspects, as well as housing and management both during the rearing and laying period contribute to risk or prevention of feather pecking. Although there is broad scientific evidence regarding single factors involved, little is known about their relative importance, especially when taking into account both the rearing and consequent laying period. It was therefore the aim of this study, in an epidemiological design to find indications for especially influential risk factors that should be addressed when trying to devise a better prevention of feather pecking. It was our underlying hypothesis that factors affecting the hens early in life are of particular importance.

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## Animals, farms and methods

Based on literature, own experience and expert advice, a list of 33 potential risk factors for feather pecking both during the rearing and laying period was compiled. Following expert opinion and the literature it was not possible to formulate a well-based hypothesis comprising only a limited number of risk factors of major importance. Therefore, we decided for an explorative approach considering the whole factor list.

Respective data recording was carried out on 23 organic pullet rearing units and 46 laying hen units (each rearing farm provided pullets to 2 laying hen farms) in Austria and Germany during one day visits in the 16<sup>th</sup> to 18<sup>th</sup> and 30<sup>th</sup> to 40<sup>th</sup> week of age of the birds, respectively. A standardised questionnaire on management practices and recording sheet were used. Housing details were measured, counted or scored, and a random sample of 30 hens per unit was weighed and their plumage condition scored using the system of Gunnarsson et al. (2000), but slightly modified. Bodies of the birds were divided into 6 regions which were each allocated a score from 0 (at maximum 2 damaged feathers) to 3 (naked area  $\geq 25$  cm<sup>2</sup>). Mean scores per bird and afterwards per farm were then calculated and, additionally, the prevalence of birds with naked areas or at least single missing feathers. In the same way data from 27 conventional non-cage rearing units and 54 laying units were collected, but not reported here, except for a comparison of overall results with the organic farms using the Mann-Whitney-U test. All birds were brown egg layer hybrids from in total 8 different lines. Potential risk factors were expressed as either continuous or dichotomous variables. Their explanatory value regarding the total variation in feather score or quality between units was analysed using a regression tree (Breimann et al. 1984) in Jump 5.1.2. The contribution of risk factors during the rearing period relative to those during the laying period was calculated as proportion of the total explained variation on the basis of the respective sums of squares (Table 1).

## Results

On average 47.1 % ( $\pm 36.4$ ) of the assessed organic laying hens were lacking one or more feathers (n=46 farms). This was not significantly different from the 54 conventional farms with 46.7 % ( $\pm 35.3$ ) of birds (p=0.948). The average feather score was 0.73 ( $\pm 0.44$ ) on organic compared to 0.77 ( $\pm 0.33$ ) on conventional farms (p=0.247). Of the total variance in plumage condition (feather score) between the different organic farms, 73 % could be explained by 6 variables (Table 1). One of the variables ('age at feather scoring of laying hens in days') was only introduced to control for possible confounding due to the fact that it was not feasible to score all herds at exactly the same age. Excluding this variable from the further calculation, about 79 % of the explained variation was due to factors affecting birds during the rearing period. These factors were: (i) provision of sufficient elevated perches and (ii) drinkers, and (iii) regular scattering of grain onto the litter (Table 1).

## Discussion

Published data comparing organic and conventional herds are to date not available. However, earlier reports from practice indicated that problems with feather pecking were greater on organic farms. Therefore, matters might have slightly improved, as the condition of organic and conventional hens was similar. However, it should be mentioned that in Austria (= 26 laying units) also the conventional hens had intact

beaks. Otherwise, organic rearing differed in many aspects from conventional rearing, e.g. in terms of day light provision, smaller herds or lower stocking densities, to name only a few.

Despite the similar average feather condition in organic and conventional hens, results were far from satisfactory. Improvements in organic farms are necessary, and our results provide some feasible starting points. For an epidemiological study we could explain a relatively large proportion of the total variance between farms, additionally considering that it was not possible to take genetic background and nutritional imbalances into account. We only found one ambiguous result with regard to the weight of the laying hens. Regression tree analysis successively subdivides the dataset into sub-datasets using those independent variables that generate the greatest decrease in variation regarding the dependent variable. In one of these sub-datasets of farms a mean weight of more than 105 % of the target weight was associated with a deteriorated plumage, in another subset, however, it was the opposite, with better plumage on farms with higher weights of 108 % or more of the target weight. This issue needs further investigation. However, the other identified risk factors match existing knowledge. This is true for the most influential factor, elevated perch space for pullets (Huber-Eicher & Audigé 1999), for the scattering of grain (Blokhuis & Van der Haar 1992), as well as the importance of friable litter in the laying period (e.g. Green et al. 2000). The significance of sufficient drinkers for pullets that we found is very interesting and not otherwise investigated, yet. However, water provision is especially important for birds. Therefore, stress may result from lack of water or competition around drinkers, with stress being known to contribute to feather pecking in general (El-Lethey et al. 2000).

**Tab. 1: Risk factors for feather pecking (indicated by feather score) as identified by regression tree analysis; limits and sums of squares calculated in the regression tree procedure, and status quo at the farms**

Risk factor	Feather score higher (= quality worse) if:	Sum of squares	Status quo on farms (n=46) <sup>1</sup>			
			Mean	Median	Min	Max
Elevated perches <sup>2</sup> in cm/pullet	< 5.6	2.7556	7.8	8.9	0.8	13.7
Weight of laying hens in % in relation to target	< 108; ≥ 105	1.1218	106	105	89	120
Drinking place/pullet ratio <sup>3</sup>	< 0.9	1.1179	1.0	0.9	0.2	2.5
Age at feather scoring of laying hens in days <sup>4</sup>	≥ 238	0.8698	237	233	208	272
			% of farms with risk factor present			
No regular scattering of grain for pullets <sup>5</sup>	No scattering	0.4743	65.2			
Poor litter quality in laying unit <sup>6</sup>	Poor quality	0.0563	28.3			

<sup>1</sup> rearing farms = 23, but each rearing farm provided pullets to 2 laying farms; <sup>1</sup> laying farm was conventional, but received organic pullets; <sup>2</sup> at least 20 cm distance downwards, 30 cm to next perch, 20 cm to wall and 45 cm upwards; <sup>3</sup> 1 drinking place/bird = 1 cm round drinker/bird or 0.1 nipple drinker/bird or combination of both in

cases where both drinker types were provided; **4** only included as confounder (see also text above); **5** at least every second day; **6** wet and caked or litter being absent; fields in grey relate to the laying period

Particular attention should be paid to the relatively high importance of rearing factors on the later feather condition of the laying hens. The EC-regulation currently does not contain any provisions regarding the rearing of laying hens. Some organic associations such as Bioland, Demeter, Naturland and others have set own private standards for the rearing period. Probably, the slight improvement discussed above is already a consequence of these activities. However, in the private standards there is no provision on drinkers, and only a minimum of 4 cm elevated perches is required.

## Conclusions

Our epidemiological analysis of possible risk factors for feather pecking was of exploratory nature. Therefore, conclusions should be drawn with caution. However, the way how pullets are reared appears to play an important role with respect to the later risk of feather pecking in layers. Although the factors identified deserve further investigation, it appears advisable for laying hen farmers to pay attention that pullets during rearing had sufficient elevated perches and drinkers available, and were regularly stimulated to forage on grain in the litter. Maintaining the litter in good conditions during the laying period is another potentially effective measure that contributes to the prevention of feather pecking.

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# Monitoring the welfare of sheep in conventional and organic farms using an ANI 35 L derived method

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Key words: sheep, welfare monitoring, organic farming, reliability

## Abstract

*The present study was undertaken to evaluate the inter-observer reliability of a welfare monitoring scheme to be applied to sheep, and compare the welfare state of the animals between 10 organic and 10 conventional sheep farms. No significant differences were observed between organic and conventional farms in terms of housing characteristics and animal based parameters ( $P>0.10$ ). This result may be due to the fact that most of the farms, both conventional and organic, based their farming systems on an extensive use of the land by grazing animals. The monitoring protocol proved to be feasible (the mean time needed to perform the assessment of welfare was 45 min per farm) and reliable: a significant correlation between observers was observed for total score and all sheets ( $P<0.001$ ), while the correlation was significant for all animal based parameters (integument alterations, animal dirtiness, hoof overgrowth and lameness;  $P<0.001$ ), apart from lesions ( $P>0.10$ ).*

## Introduction

Organic farming promotes high standards of animal welfare as a means to increase health and longevity of the animals and fulfill consumer ethical needs. However, the general belief that organic systems always provide the best conditions to the animals has been recently challenged (Athanasidou et al., 2002). Therefore, in organic systems the need of reliable tools for monitoring the welfare state of the animals at farm level is urgent (Knierim et al., 2004). Due to a lack of welfare monitoring schemes for small ruminants a protocol scientifically validate for cattle, the ANI 35L 2000, was fitted to sheep. The Animal Needs Index proposed by Bartussek *et al.*, (2000) relies on a graded point system that allows assessing five aspects of the housing relevant to animal welfare. These aspects are scored through 5 corresponding assessment sheets, namely: Locomotion, Social interaction, Flooring, Environment, and Stockmanship. Two main problems are associated with the ANI protocol: (a) it mostly relies on design criteria with a lack of animal based variables, therefore, it may not sufficiently indicate the actual welfare state of the animals; (b) it allows compensation between poor and good conditions. However, this index, at least in cattle, has proven to be valid (Ofner *et al.*, 2003), reliable (Amon *et al.*, 2001) and to have some common criteria with consumer perception of animal welfare (Napolitano *et al.*, 2007). The

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present study was undertaken to evaluate the inter-observer reliability of the scheme when applied to sheep and compare the welfare state of the animals in organic and conventional sheep farms.

## Materials and methods

Recordings were performed in 10 organic and 10 conventional sheep farms located in Basilicata (southern Italy) at an average altitude of 844 m above sea level. The mean number of heads per farm was 350 and Merinizzata Italiana the most common breed. The average milk yield was 80 kg, including the amount ingested by the lambs. Observations were conducted on lactating animals from January to March 2007. Two trained observers performed assessments. Four preliminary sessions, conducted in different non-experimental farms, were used to standardize assessments: observers thoroughly discussed the score attributed to each parameter and, if different scores had been attributed, further discussion allowed to reach an agreement. No additional discussion was conducted between assessors before, during and after the experimental recordings. The protocol used in the present study relies on five sheets derived by the Animal Needs Index (ANI 35 L), mainly based on resource-based parameters (Bartussek et al., 2000), and a sixth sheet where animal-based parameters, deemed relevant to animal welfare, are taken into account. In particular, in Sheet 6 were included the following animal-based variables recorded on at least 20% of lactating animals: integument alterations, animal dirtiness, hoof overgrowth, lameness and lesions, which were scored on the basis of their prevalence (number of affected animals/numbers of observed animals), longevity (years) and mutilations (de-horning, caudotomy, etc.). The final score can range from 81 to -9.5, the higher the score the better the sheep welfare. Data on housing characteristics and animal based parameters were analysed using ANOVA with one factor. Data on the presence of the outdoor paddock and hospital pen were analysed using the  $\chi^2$  test. For each sheet and each qualitative parameter inter-observer reliability was computed using the Spearman coefficient of correlation ( $r_s$ ).

## Results and Discussion

The mean time needed to perform the assessment of welfare was 45 min per farm. No sophisticated equipment was necessary in both time consuming and economical terms. The main housing characteristics of the sheep farms are depicted in Table 1, whereas in Table 2 the animal related variables monitored in this study are shown. The mean total scores of the sheep farms ( $48.4 \pm 1.7$  and  $47.7 \pm 1.8$  for organic and conventional farms, respectively) were well above the central point of the scale ( $(81 - 9.5)/2 = 35.75$ ), which indicated an overall satisfactory level of welfare. The application of the scheme showed that the most critical aspects of sheep farms were the low indoor and outdoor space allowance and the lack of an outdoor paddock in several farms (67 and 55% in conventional and organic farms, respectively). However, these aspects were compensated by the frequent access to the pasture, which was not allowed only in very bad weather conditions. In addition, pasture was steep in most of the cases, thus allowing a good physical exercise to the animals. As to animal based parameters, the prominent aspect to be improved was dirtiness, as it affected the highest percentage of animals. This aspect is obviously dependent on the low space allowance offered to the ewes in the barn and also related to the fact that the animals were observed in the early morning, before access to pasture. No significant differences were observed between organic and conventional farms in terms of housing characteristics and animal based parameters ( $P > 0.10$ ). Accordingly, no

marked differences in terms of welfare were observed between organic and conventional sheep by Braghieri et al. (2007), whereas in Germany organic dairy cattle farms showed higher welfare conditions than conventional farms (Hörning, 2000). The results obtained in this study may be attributed to the fact that farms, both conventional and organic, based their farming systems on an extensive use of the land by grazing animals. Therefore, the decision to certify their products as organic was dependent on market constraints (lack of distribution channels for organic products, which are often sold in local markets as undifferentiated) rather than on obstacles to the conversion dependent on the farming system (most of the conventional farms could become organic with little or no changes).

**Tab. 1: Mean ( $\pm$  SE) of the main housing characteristics of the sheep farms**

	Indoor space allowance (m <sup>2</sup> /head)	Outdoor space allowance (m <sup>2</sup> /head)	Space at manger (m/head)	Presence of outdoor paddock (% of farms)	Presence of hospital pen (% of farms)
Organic	1.2 $\pm$ 0.15	1.7 $\pm$ 0.4	0.28 $\pm$ 0.03	45	27.3
Conventional	1.0 $\pm$ 0.17	1.2 $\pm$ 0.5	0.26 $\pm$ 0.03	33	44.4

**Tab. 2: Mean ( $\pm$  SE) of some animal related variables**

	Longevity (years)	Integument alterations (%)*	Hoof overgrowth (%)*	Lameness (%)*	Lesions (%)*	Dirtyness (%)*
Organic	8.0 $\pm$ 0.56	19.2 $\pm$ 7.0	1.0 $\pm$ 0.55	6.6 $\pm$ 2.4	1.35 $\pm$ 0.93	28.3 $\pm$ 8.9
Conventional	8.5 $\pm$ 0.61	17.0 $\pm$ 6.9	0.40 $\pm$ 0.52	3.5 $\pm$ 2.0	1.79 $\pm$ 0.93	35.3 $\pm$ 8.9

\*(Number of affected animals / number of observed animals) x 100

Spearman correlation coefficients were significant for total score and all sheets ( $P < 0.001$ ). Inter-observer reliability of animal based parameters is displayed in Table 3. A significant correlation between observers was observed for all parameters ( $P < 0.001$ ), apart from lesions ( $P > 0.10$ ). However, the level of statistical significance of the correlation says little about the degree of reliability, as significance also depends on the sample size, whereas the value of the correlation coefficients is much more informative on the strength of the association. Martin and Bateson (2007) suggest that, although acceptability of coefficients depends on several factors, a satisfactory threshold can be considered 0.7. In this study the  $r_s$  of total score and all sheets exceeded this value, whereas only 4 (integument alterations, hoof overgrowth, lameness and dirtiness) out of 5 animal based parameters showed coefficients higher than 0.7. This latter result may be due to the fact that lesions were often small and hidden by the fleece. The problem could be approached by monitoring only wide and evident lesions, while observers should also perform more training.

**Tab. 3: Inter-observer reliability ( $r_s$ ) for each qualitative animal-based parameter**

	Integument alterations	Hoof overgrowth	Lameness	Dirtiness	Lesions
$r_s$	0.85	0.82	0.81	0.84	0.22
P<	0.001	0.001	0.001	0.001	NS

### Conclusions

No marked differences were detected between organic and conventional sheep farms, using the ANI 35 L derived protocol possibly because most of the farms, both conventional and organic, based their farming systems on an extensive use of the land by grazing animals. The present monitoring protocol proved to be feasible and reliable, although more studies are needed to test the scheme on a larger sample size and assess its validity.

### Acknowledgments

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## Development of animal health and welfare planning in organic dairy farming in Europe

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### Abstract

*Good animal health and welfare is an explicit goal of organic livestock farming, and will need continuous development and adjustment on the farms. Furthermore, the very different conditions in different regions of Europe calls for models that can be integrated into local practice and be relevant for each type of farming context. A European project with participants from seven countries have been established with the aim of developing principles for animal health and welfare planning in organic dairy farming, based on a process where knowledge about the status within a given herd will be included as background for taking decisions and planning future improvements. An important part of the planning process is communication with other farmers as well as animal health and welfare professionals (veterinarians and advisors). Other principles such as systematic evaluation of how the improvements work in the farm ensure the continuity of the planning process. This presentation gives an overview over the current animal health and welfare planning initiatives in the participating countries and lines up the principles which are being gradually implemented in partner countries in collaboration with groups of organic farmers and organisations.*

### Introduction

Livestock farming is an important part of organic farming systems, and it is an explicit goal of organic farming to ensure high levels of animal health and welfare (AHW) through proactive and appropriate management of breeding, feeding, housing and species specific husbandry. A goal in organic livestock farming is to minimise the use of veterinary medicines to improve food quality and protect the environment, and to do this by improving livestock living conditions rather than using alternative medical treatments. Key values influencing organic livestock production are naturalness, harmony at all levels of production, use and recirculation of local resources and the precautionary principle. The concepts of "positive health and welfare" are incorporated in EU Regulation 2092/91 on organic production. The farmer must ensure that farm animals as much as possible can perform natural behaviours and live natural lives, but at the same time he/she must intervene when necessary and at first signs of disharmony in the herd.

High levels of AHW are not guaranteed merely by farming to organic standards. This is a conclusion from two EU network projects, "Network for Animal Health and Welfare in Organic Agriculture (NAHWOA)", and "Sustaining Animal Health and Welfare in Organic Farming" (SAFO). Therefore, both networks recommended implementation of farm individual animal health plans to make organic farmers work towards AHW

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promotion and disease prevention. A good planning process of animal health and welfare should be built on an identification of the current state of the art in the particular herd and farm, and the farmer's own prioritisation of what issues should be worked with at the farm. One very relevant way of gaining insight into the herd's current state is to carry through an animal health and welfare assessment. Systems aiming at assessing animal health and welfare have been developed and used in organic dairy herds in the UK, Austria, Germany, Switzerland, Norway and Denmark, e.g., in research and development projects or in relation to certification.

If animal health plans are to gain widespread use among organic farmers, communication with the farmer community is crucial. A creative dialogue with the individual farmer is also necessary when identifying goals and planning how to reach them. Communication regarding the role and benefits of benchmarking or AHW assessment systems may be the catalyst needed to get farmers thinking about health and welfare planning. It can take place within health advisory systems or in farmer groups. Current research and development activities in Denmark, Norway, Switzerland, and the Netherlands show the benefits of such a dialogue.

Based on these various project experiences and results and research questions from different European countries, a research project titled 'Minimising medicine use in organic dairy herds through animal health and welfare planning', with the acronym ANIPLAN, was initiated in mid-2007 with the aim as indicated in the title. The aim of this presentation is to present the project and the first results of the work towards an identification of what is an animal health and welfare plan, and a development of common principles for animal health and welfare planning in a diverse, European context.

### **Presentation of the project**

The main aim of the project is to minimise medicine use in organic dairy herds through active and well planned animal health and welfare promotion and disease prevention. This objective is met through the following intermediate objectives:

Develop animal health and welfare planning principles for organic dairy farms under diverse conditions based on an evaluation of current experiences.

Application of animal health and welfare assessment based on the WelfareQuality parameters in different types of organic dairy herds across Europe. This will result in an overview of the herds and allow for potential adaptations for the organic situation (e.g. pasture systems, longer cow/calf contact). For calves, a special system will be developed by the Norwegian partners, and combined and tested together with the WelfareQuality assessment system.

Develop guidelines for communication about animal health and welfare promotion in different settings. This can be part of existing animal health advisory services or farmer groups such as the Danish Stable School system and the Dutch network program.

The ANIPLAN project aims at minimising medicine use in organic dairy farming through animal health and welfare promotion in ways which meet the common organic goals and at the same time is adjusted to the individual farm context. This calls for an on-farm approach, and a strong collaboration with the end-user environment. The participating institutions in this project come from Austria, Switzerland, UK, Norway, The Netherlands, Germany and Denmark, and they all have a strong on-farm research

and development experience and focus, and our common research facilities are the private farms. We aim to combine epidemiological research based on farm-data, different qualitative research approaches and systemic thinking seem to be well implemented in all institutions, and we all seem to work with topics which are related to the ANIPLAN project. The research approach will basically be action research oriented.

### **Animal health and welfare plans and planning**

#### The starting point: what is the current state of art in Europe regarding animal health and welfare plans?

Perspectives on animal health plans and animal health planning in the UK form a starting point for this project, since animal health plans are mandatory in UK. In no other participating countries than the UK, formalised animal health planning is taking place. This does not mean that organic dairy farmers do not work with animal health and welfare in a more or less systematic way. Various approaches to the assessment of animal health and welfare specifically for organic animals have also been taken in Norway, The Netherlands, Denmark, Germany, Austria and Switzerland. Likewise, initiatives to farmer group formation and animal health advice through veterinary practices have been taken in many places. Much of the ANIPLAN project is based on national on-going activities, and is designed to transfer, jointly analyse and discuss the results of this work.

#### A clear difference between animal health plans and planning

One key point that became strongly apparent based on experiences from UK is that there is a big difference between the on-farm presence of an animal health and welfare plan versus animal health and welfare planning. The first is viewed by many farmers solely as a 'document', where the latter is the process involving the farmer in making a plan for improvements in the herd and implementation of this plan. In this project, we focus on the animal health and welfare process.

#### Dealing with diversity

In this project, very different farming conditions are represented – e.g. from monocultural intensive and high yield production in Danish, Dutch, German and British farms to alpine farming in Austria and Switzerland, as well as mountain farming in Norway. We aim at developing concepts which refer to the organic principles and ideas and at the same time possible to adjust to national conditions. This is a part of the working conditions for research and for daily practice in the farming systems – since we are partners from so many different countries – and as such a challenge. Clearly, each project participant is responsible for create the connection between the national organic dairy farming environment and judge what is possible there, and the project group, so that no principles are included in the common platform, if they are not approved and thought into the national conditions. This should be seen as a great advantage for the project outcome, since the common developed principles are then tested possible to use under many different conditions.

#### Animal welfare assessment as a part of animal health planning

The various elements of the project all form parts of an animal health and welfare planning process. A plan necessarily has to be based on knowledge of the animal health and welfare status on the farm, and therefore tools for assessing animal health and welfare on-farm have to be well developed and trained. In this project, a number

of parameters from the European project WelfareQuality will be applied, including management information, assessment of the housing system, clinical conditions of the cows and behavioural observations both on individual level (e.g. flight distance to humans) and flock level (social behaviour and interactions). It also has to be evaluated, in order to find out whether the planned and implemented improvements on the farm work in the way they were expected, and in order to ensure continuous improvements.

#### Communication about animal health and welfare a part of a planning process

Communication is considered a necessary part of making an animal health and welfare plan; the farmer needs to direct the process him- or herself, but will also need to be challenged, have the right questions at the right time and to be stimulated and guided at times. Therefore, one of the work packages in this project aims at identifying appropriate ways of communicating in relation to the animal health and welfare plan.

#### Development of common principles

It is a vision of this project to develop a process of animal health and welfare planning which can be implemented in all different types of farming environments, e.g. large scale dairy farming as well as alpine, smallholder and diverse farming systems. By developing a method of analysing the context of the farming environment, and include this in the process of animal health and welfare planning, we hope and expect that other research groups and countries outside the partnership in this project also can benefit from research results. The national teams feed the acquired knowledge back to their national partners, and the European (and international) community benefit from the joint effort to develop practices, which meet core areas of organic livestock production (animal health and welfare through non-medical approaches). In the project, the development of common principles for the animal health and welfare planning process have started and will be further developed and adjusted along the project, based on practical experience from the dialogue with farmer groups in different parts of Europe. Furthermore, an active process will build on the establishment of a dialogue with external partners, and this could be advisors, veterinarians or other fellow farmers. Based on experience, farmer ownership is identified as another crucial principle of any on-farm planning process.

#### In conclusion

Whilst the necessity for a form of health planning on organic farms is recognised, the means by which this is best achieved is still under development and discussion. Formal health plans provide a framework, but these require a sense of farmer ownership and need to reflect actual farm and regional variation. Further, there is a requirement for dialogue in order to achieve a balance between farmer needs, animal needs and the wider societal perception of health and welfare whilst also satisfying the multiple objectives of organic farming. During the course of the collaborative project it is envisaged that practical and research experiences from a range of European settings will contribute to this process of development and discussion with the aim of providing clear guidelines for the use of animal health and welfare plans on organic farms.

# Knowledge Transfer in the Animal Health Planning Process: Putting Research into Practice

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Key words: Animal health plan, knowledge transfer

## Abstract

*Animal health plans are now widely accepted as a tool that can provide a structured approach to health promotion and positive welfare. This requires a partnership between farmer and veterinary advisor as well as a good knowledge of organic farming practice by animal health professionals.*

*This paper describes an electronic compendium of information relevant to animal health and welfare in organic farming, the main aim of which is to provide resource material and a training tool for those working with organic livestock farmers. The approach involved an extensive and detailed literature search, synthesis to provide advisory material and the development of a website. The compendium is divided into species specific sub-sections covering Disease Management, Veterinary Management and Health and Welfare and includes over 2500 references and web-site links. The compendium covers 45 cattle, 44 sheep, 32 poultry and 27 pig diseases and conditions as well as extensive sections pertaining to each species' behavioural requirements. Throughout there are links to relevant elements of organic farming legislation.*

*By providing information on new research and practical solutions to treating and avoiding disease it is expected that the compendium will contribute to improved knowledge amongst farmers, veterinarians and advisors and thereby enabling the development of animal health plans that promote high standards of animal health and welfare in organic farming.*

## Introduction

Organic farming places strong emphasis on the achievement of high standards of animal health and welfare and EC Regulation 1804/99 outlines the key principles and practices that are designed to meet these aims. However, in practice, achievement of these aims is not guaranteed and in many cases the health and welfare of organic animals is similar to that found on non-organic farms (Sundrum *et al.*, 2006).

Animal health plans are now widely accepted as a tool that can provide a structured approach to health promotion and positive welfare although the most effective means by which these are defined and implemented have not yet been developed. The UK organic standards emphasises the desirability of a partnership between farmer and

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veterinarian as a key element in the development of a health plan on an organic farm (Defra, 2006). However, the limited exposure to organic farming experienced by many veterinarians (Hovi *et al.*, 2002), and the commonly expressed concern over the welfare benefits of organic farming by the veterinary profession (Hovi, 2003), may be a factor influencing the success of such a partnership and the ensuing health plan. To this end, a requirement for the improved dissemination of knowledge about organic farming to veterinarians has been recognised (Vaarst *et al.*, 2006).

This paper describes an electronic compendium of information relevant to animal health and welfare in organic farming, the main aim of which is to provide resource material and a training tool for advisors, inspectors and veterinarians who work with organic or converting farmers. The compendium succeeds a version first produced in 2000. The original was based on knowledge available at the time. Since its completion there have been considerable changes in organic farming practice, research and legislation.

## **Materials and methods**

The approach to the development of the compendium involved five distinct processes: a literature search; a review of the original compendium; synthesis of the literature; development of a website and an expert review of the material.

### **a) Literature search**

Key word literature searches were conducted drawn from a number of sources, including scientific publications, conference and workshop proceedings and the dedicated organic farming database OrgEprints. Internet searches were used to supplement these literature sources. The overarching criteria applied to the literature search was a) relevance to organic cattle, sheep, pig and poultry production and b) potential application as practical advisory material.

### **b) Review of the original compendium**

A review of the original compendium was conducted so as to identify any existing technical and legislative inaccuracies, inconsistencies and omissions. The review process also included the presentation of the technical information and recommendations for improvement.

### **c) Synthesis and incorporation of literature**

A synthesis of the scientific literature involved the transformation of key scientific conclusions and recommendation into a format relevant and appropriate to organic farmers, advisors and veterinarians.

### **d) Development of a web-site**

Using the basic design of the original web-site, a new site was created with additional features and sections. The web-site design included introductory sections for each species covered and links to all referenced material and web-sites.

### **e) Expert review of the material**

Expert reviewers were selected to represent knowledge of organic cattle, sheep, pig and poultry production, organic farming expertise, advisory experience and legislative knowledge. The review process included an evaluation of the comprehensiveness of the literature review, the quality of the synthesis and the presentation of the material.

The review also included expert opinion on the relative risk to organic systems of all of the diseases covered.

## **Results**

The compendium is divided into species specific sub-sections covering Disease Management, Veterinary Management and Health and Welfare. For each of the common diseases, the material is presented into appropriate parts covering The Condition (describing causes, symptoms and risks), Treatment, Control and Prevention, Welfare implications and Good Practice. The compendium covers 45 cattle, 44 sheep, 32 poultry and 27 pig diseases and conditions respectively.

Literature pertaining to animal welfare is presented in sections appropriate to each species, all aimed at the promotion of the organic approach to health and welfare. For example, the poultry Health and Welfare section covers positive welfare, welfare pros and cons of free-range production, a comparison of organic welfare standards, The Organic Standards, features of organic poultry systems, understanding behaviour, the Five Freedoms, promoting outdoor access, health, housing, breeds and breeding, nutrition and feeding and rearing replacements. In turn, these are divided into appropriate pages with more detailed information. For example, the poultry housing section includes pages on types of housing, building design, litter management, perches, injury, ventilation, lighting and nest boxes.

Literature pertaining to Veterinary Management is summarised as sections covering the organic standards, health promotion, animal health plans and biosecurity, vaccine usage, the responsible use of veterinary medicines, homoeopathy and other alternative treatments.

Throughout the compendium there are links to relevant elements of organic farming legislation. The compendium includes over 2500 scientific and other literature references and web-site links. A full list of all references is provided.

## **Discussion**

The inclusion of the requirement for animal health plans within the UK organic standards, coupled with the emphasis on preventive health care and the promotion of positive health heralds a significant opportunity for the veterinary profession and the organic farming community to work together. The content of the compendium described in this paper provides an important resource for farmers and veterinarians in their attempts to meet the high health and welfare standards aspirations of organic farming and to aid in the health planning process. By providing information on new research and practical solutions to treating and avoiding disease the compendium should aid in the aim to use health planning as a positive disease prevention tool rather than simply a list of issues present on any particular farm.

The increasing interest in organic farming has stimulated more research into, and provided more information on, the impact of organic management on the health and welfare of livestock. Much of this information points to a requirement for greater support for organic farmers in health management and planning. In addition, animal health management, associated food safety and food quality issues in organic and conventional farming have increased the demand for specific advice (Hovi and Vaarst, 2004). Animal health plans have been proposed as a means by which organic farmers

can work in partnership with veterinarians to create a tool for meeting the aspirations set out in the legislative framework for organic farming and the perceptions of society.

Health planning needs to be more than a treatment strategy. Reducing dependence on veterinary medicines, whether for legislative reasons, for philosophical reasons or because of the development of drug-resistant disease agents, requires a greater understanding of disease patterns and the interaction between the various elements that make up livestock farming systems, whether that be management, choice of breed, choice of system or preventative measures. Epidemiological knowledge needs to be combined with ethological understanding within the context of a complex ecological system (Vaarst *et al.*, 2004). By bringing together scientific results from a wide range of perspectives, and presenting them in a practical format, giving, amongst other information, methods of control and prevention and good practice based on current knowledge, the compendium contributes to the achievement of this goal.

## Conclusions

It is expected that the compendium will contribute to improved knowledge amongst farmers, veterinarians and advisors and therefore the evolution of systems that encourage the responsible use of veterinary medicines, utilise herd/flock health plans, enable effective biosecurity, promote high standards of animal welfare and operate through agri-environmental principles.

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# Effects of different stocking rates with dairy cows on herbage quality and milk production in organic farming

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Key words: stocking rate, milk production, organic farming, herbage quality, dairy cow

## Abstract

*In order to identify the optimum stocking rate for grazing dairy cows in organic farming, grazing experiments were conducted from 2004 to 2006. Cows of one herd were divided into two groups during vegetation periods. The paddocks of the rotational pasture were split in a way that the low stocking rate group (SR<sub>L</sub>) had 15% more pasture area than the high stocking rate group (SR<sub>H</sub>). Post grazing sward height for SR<sub>H</sub> was decisive for the simultaneous change of the sub-paddocks. Annual stocking rates for SR<sub>H</sub> were 2.0, 2.3 and 2.3 cows per hectare (ha). In the offered herbage mass for SR<sub>L</sub> significant lower ash-, CP-, APDE- and APDN values as well as higher NDF values were detected. Sugar- and NEL values were unaffected. No significant differences were found for milk production per cow, but milk production per ha was significantly higher for SR<sub>H</sub>. Apart from two exceptions (lactose 2005 and urea 2006), no significant differences were identified for milk composition. The attribution of more pasture area without topping leads to a lower pasture quality. Increasing the stocking rate, within limits, slightly reduces the milk yield per cow, but clearly improves the utilization of grown herbage.*

## Introduction

In Switzerland, pasture based milk production systems offer an optimal possibility to take advantage of the climate providing ample and regular grass growth as well as minimizing the impact of topographic disadvantages. It is also well established that grazed grass is a low cost forage with a high nutrient density. The directives of Swiss organic farming prescribe, during the vegetation period, to keep ruminants on pasture to ensure a natural feeding system as well as animal welfare. The efficiency of pasture use under organic farming which in most cases implies restricted nitrogen supply still can be improved.

The objective of this research was to study the effects of two different stocking rates with dairy cows on herbage quality and milk production as well as milk composition in organic farming.

## Materials and methods

The investigations were conducted in the years 2004, 2005 and 2006 on the farm "l'Abbaye" in Sorens (Switzerland, 46°39.767' N, 7°3.143' E). In 2003 the conversion of this farm to organic farming started and was officially finished in 2005. During the three vegetation periods (April to November) means of temperature (Payerne, 490 m asl (MeteoSwiss), approximately 2° C higher than around the farm) and sums of

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precipitation were: 13.2° C, 819 mm; 13.3° C, 748 mm and 14.2° C, 991 mm. All lactating dairy cows were divided into two groups during the three vegetation periods. The paddocks of the rotational pasture system (800 to 900 m asl) were split such that the SR<sub>L</sub> had 15% more pasture area available than the SR<sub>H</sub>. The post grazing sward height (SH<sub>POG</sub>) for SR<sub>H</sub>, measured with a rising plate meter (Filip's folding plate pasture meter, Jenquip) was decisive for the simultaneous change of the sub-paddocks for both groups.

Every two weeks in 2004 and once per week in 2005 and 2006, respectively, two grass strips per stocking rate were cut (average cutting level 8.7 Units, 1 unit correspond to a compressed sward height of 0.5 cm) and sampled in the paddock to be grazed next to evaluate the pre-grazing herbage mass and herbage quality. Ash, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and total sugar were analyzed. Net energy for lactation (NEL) and absorbable protein at the duodenum based on energy (APDE) or nitrogen (APDN) available in the rumen were calculated according to RAP (1999).

Each year 14 pairs of Holstein dairy cows, whereof 6 primiparous pairs, were selected for the comparison of milk production (Flo master pro, Delaval) and milk composition data (CombiFoss, Foss). The criteria for pair building were the calving date, the milk production, the milk composition, the number of lactations and the live weight. At the beginning of the experiment respectively at turnout to pasture dairy cows were 178 ± 104 (2004), 116 ± 75 (2005) and 97 ± 86 (2006) days in milk. The milk data recording started at turnout to pasture and finished at the end of August. Concentrate distribution (7.0 MJ NEL kg<sup>-1</sup>, 115 g CP kg<sup>-1</sup> in fresh matter) on pasture for multiparous cows started at 22 kg (2004, 2005) and 24 kg milk production (2006). For primiparous cows concentrate distribution began 2 kg earlier. The distribution frequency was 1 kg concentrate for 2.2 kg (2004, 2005) or 2.5 kg additional milk production (2006). During the months of June, July and August the cows received in principle no forage supplements in the barn. Exceptions were made when pasture herbage mass was not sufficient.

The signs test for paired samples was applied to compare pre-grazing herbage mass (HM<sub>PrG</sub>) and herbage quality data. Milk production and composition data per cow were submitted to a variance analysis with repeated measurements. The milk production per ha results were compared with a paired T-test.

## Results

From 2004 to 2006 the average stocking rates during the vegetation periods were for SR<sub>H</sub> 2.0, 2.3 and 2.3 and for SR<sub>L</sub> 1.7, 2.0 and 1.9 cows per ha. The average SH<sub>POG</sub> for the SR<sub>H</sub> were 10.7 (2004), 9.7 (2005) and 9.0 Units (2006). Proportions of grasses (71% versus 72%) legumes (12% versus 15%) and herbs (5% versus 6%) in the sward were and remained similar in both treatments. The strongly varying HM<sub>PrG</sub> and the herbage quality data are shown in Table 1. No differences were revealed concerning the HM<sub>PrG</sub>. In SR<sub>L</sub> pasture significantly lower ash-, CP-, APDE- and APDN values as well as higher NDF values in the offered herbage were detected. Sugar- and NEL values were unaffected by the different stocking rates.

The milk production and composition data are presented in Table 2. Although no significant differences were found for effective and energy-corrected milk (ECM) yield per cow, in every year the milk yield for the SR<sub>H</sub> was numerically lower. The energy-corrected milk yield per ha per day was significantly higher in the SR<sub>H</sub>. Concerning the

milk composition no significant differences between the two stocking rates were found. Two exceptions were significant differences for lactose in 2005 and urea in 2006. Both differences are not explainable and, for lactose in 2005, may be accidental. The SCC showed no significant differences.

**Tab. 1: Pre-grazing herbage mass and herbage quality 2004 - 2006**

	High stocking rate (SR <sub>H</sub> )			Low stocking rate (SR <sub>L</sub> )			
	Median	Min.	Max.	Median	Min.	Max.	
HM <sub>PrG</sub> (kg DM <sup>a</sup> ha <sup>-1</sup> )	1235	317	2774	1165	382	3234	
Ash (g kg <sup>-1</sup> DM <sup>a</sup> )	106	81	197	101	84	167	**
NDF (g kg <sup>-1</sup> DM <sup>a</sup> )	459	352	534	475	325	592	*
CP (g kg <sup>-1</sup> DM <sup>a</sup> )	174	132	229	161	113	224	*
Sugar (g kg <sup>-1</sup> DM <sup>a</sup> )	68	42	146	66	41	134	
APDE (g kg <sup>-1</sup> DM <sup>a</sup> )	103	91	120	100	86	116	*
APDN (g kg <sup>-1</sup> DM <sup>a</sup> )	115	87	152	107	74	149	*
NEL (MJ kg <sup>-1</sup> DM <sup>a</sup> )	6.0	5.4	7.1	6.0	5.0	6.8	

\* significant at P<0.05 and \*\* significant at P<0.01

<sup>a</sup> DM: dry matter

**Tab. 2: Means of milk production and composition**

	2004			2005			2006			
	X <sub>SRH</sub>	X <sub>SRL</sub>	se <sup>f</sup>	X <sub>SRH</sub>	X <sub>SRL</sub>	se <sup>f</sup>	X <sub>SRH</sub>	X <sub>SRL</sub>	se <sup>f</sup>	
Milk <sup>a</sup>	19.7	20.2	0.6	23.0	23.5	0.4	23.5	23.8	0.5	
ECM <sup>a</sup>	18.8	19.2	0.5	22.2	22.2	0.4	21.0	22.0	0.5	
ECMha <sup>b</sup>	37.5	32.7	1.4	51.0	44.3	1.9	47.6	42.4	2.3	**
Fat <sup>c</sup>	3.74	3.64	0.12	3.76	3.68	0.06	3.59	3.76	0.10	
Protein <sup>c</sup>	3.29	3.26	0.05	3.21	3.19	0.02	3.13	3.17	0.03	
Lactose <sup>c</sup>	4.80	4.88	0.04	4.88	4.80	0.02	4.73	4.79	0.06	*
Urea <sup>d</sup>	24	24	0.6	22	22	0.5	21	25	0.9	*
SCC <sup>e</sup>	4.9	4.8	0.07	5.0	4.8	0.05	5.0	4.9	0.08	

\* significant at P<0.05, \*\* significant at P<0.01, \*\*\* significant at P<0.001

<sup>a</sup> average yields in kg day<sup>-1</sup> cow<sup>-1</sup>; <sup>b</sup> average yields in kg day<sup>-1</sup> ha<sup>-1</sup>; <sup>c</sup> mean in %; <sup>d</sup> mean in mg dl<sup>-1</sup>; <sup>e</sup> mean of somatic cell counts in log ml<sup>-1</sup>; <sup>f</sup> standard error of the mean

## Discussion

As concentrate feeding is limited in organic farming, forage respectively herbage quality is extremely important for covering the requirements of dairy cows for milk

production. The average nutritive value of herbage for SR<sub>H</sub> was, with 174 g CP kg<sup>-1</sup> DM, 459 g NDF kg<sup>-1</sup> DM and 6.0 MJ NEL kg<sup>-1</sup> DM, relatively high, but considerable seasonal variations appeared. The CP- and NDF- values were comparable with the data from Kuusela *et al.* 2002 and Kuusela 2004. Lower CP-, APDE- and APDN-values as well as higher NDF- values of offered herbage in the SR<sub>L</sub> show a decreasing herbage quality with too lax grazing without topping respectively too low stocking rates. Lax grazing during spring produces, according to Hoogendoorn *et al.* 1992, swards in early summer with lower proportions of grass leaf and higher proportions of grass stem and senescent material. Increasing the annual stocking rate by 1 cow per ha in conventional farming, reduces average milk production per cow and day by 1 kg (Peyraud *et al.* 2005). Although in the present study no significant differences concerning milk production per cow were found, the effective and energy-corrected milk yield was slightly lower for SR<sub>H</sub> as described by Peyraud *et al.* (2005). With the higher stocking rate the efficiency of herbage mass utilization was improved, as it was confirmed by the milk yield per ha (Leaver *et al.* 1985, Hoden *et al.* 1991). As it would be expected (Houssin *et al.* 2005) the milk composition was unaffected or only slightly affected by the different stocking rates.

## Conclusions

Higher pasture area allowance without topping leads to a lower herbage quality. Increasing the stocking rate, within limits, slightly reduces the milk yield per cow, but clearly improves the utilization of herbage mass. Milk composition remains unaffected by the different stocking rates.

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# Broilers welfare, health and production in organic and conventional systems

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Key words: organic poultry, broilers, behaviour production, reactivity.

## Abstract

*Animal welfare, product quality and organic or niche production system rise to more and more interest. Organic farming has grown rapidly in European and Italian agriculture during the last decade. The aim of the trial was to compare five organic and five conventional broiler farms from the productive, health and behavioural point of view. The productive performance showed that conventional broilers (CB) consumed significantly less feed than organic broilers (OB) and the first got a better FCR (Feed Conversion Ratio). These different figures could be due to the different environment and life style. OB are more exposed to natural climate, they can move much more and then they increase feed consumption and FCR become worsen.*

*The different age at slaughter determined the significant difference observed for the final body weight of g 2943±441 CB vs g 4486±346 of OB (P=0.0003). The same trend was observed for carcass and chest weight using the slaughtering age as covariate. The first weighed g 3530±581 for CB vs g 4410±219 for OB (P=0.01) and the second g 2450±432 for CB and g 3150±206 for OB (P= 0.01).*

*The mortality was similar and the main cause was SDS (Sudden Death Syndrome) related to genetic factors.*

*From the behavioural point of view the result might indicate that less intensive farming and the presence of an enriched environment, as in organic farming, seems to promote a better adaptation of animals, both to the environment and to man presence, ensuring better welfare conditions.*

## Introduction

The topic of animal welfare, product quality and organic or niche production system rise to more and more interest. Organic farming has grown rapidly in European and Italian agriculture during the last decade. The establishment of organic farming next to conventional intensive farming has been made possible by the willingness of increasing number of consumers to pay premium prices for organic food and by government subsidies for more sustainable production systems (Bennet R.M., 1996). In organic farming, animal welfare is viewed with regards to naturalness and animals should be able to express their species-specific natural behaviour. Poultry welfare can be considered in relation to the housing and management conditions to which it is subjected (Puppe 1996, Rushen and de Passillé, 1992). Welfare is good when all

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needs associated with the maintenance of good health and needs to show that certain behaviours are met. Health is an important part of welfare and behaviour is important in many regulatory systems. It is also clear that many needs involve the necessity for the animal to express different behaviours (Jensen & Toates 1993).

Although genetic factors play a major role in behaviour, the specific behaviour patterns shown by an individual animal result from the interaction of those factors with the environment experienced by that animal during its lifetime. Fearfulness which many birds display towards humans provides a good example of this interaction. The level of this fear is very high in jungle fowl, but selection during the course of domestication has considerably reduced it in modern strains. It can be reduced still further by environmental factors, such as human handling (Jones, 1987) and evaluated by behavioural tests, such as immobility test, open field test and emergency (Ferrante et al, 2005).

The research aim was to investigate the difference between organic and conventional broiler production in terms of productive, health and behavioural traits.

### **Materials and methods**

For this trial five organic farms (flock size from 4.800 to 5.100) and five conventional broiler farms (flock size from 11.600 to 62.000) have been compared.

The poultry houses were located in the same geographic area and rearing the same commercial hybrid (ROSS 508®).

Birds density was different between organic poultry house (OPH) and conventional poultry house (CPH): organic farms, respecting as established by law, did not exceed 10 birds/m<sup>2</sup>, while conventional were about 15.4-17.6 birds/m<sup>2</sup>.

Concerning the management, the five organic farms were characterised by natural ventilation and natural lighting, while conventional farms used forced ventilation and combined lighting program: natural light with artificial illumination. About temperature in OPH there was a mean value of 20°C (19.2°C min and 21°C max) lower than in CPH characterised by a mean of 23.2°C (22°C min and 25°C max). Feeders and drinkers availability were homogeneous: OPH had 2.36 feeders/100 birds and CPH had 2.23 feeders/100 birds. All the drinkers were nipples and they were available to birds with a mean density of 11.5 nipples/100 birds in CPH and 11.3 nipples/100birds in OPH.

Concerning the open run of OPH the area available to birds was 4 m<sup>2</sup>/birds respecting such established by the law. The grass recycle and the presence of shade area were generally sufficient.

Two check list have been prepared to collect information. The first concerning birds during the rearing period and data related to the characteristics of poultry houses and management (microclimate, light programme, drinkers, feeders and density). Organic poultry houses were also evaluated for the open run available to birds.

The second list concerned birds number and age, feed consumption, feed conversion ratio (FCR), diseases, therapy and mortality. Birds reactivity was scored from 0 (birds escaping the observer) to 2 (birds approaching the observer with curiosity). Birds plumage condition was also scored on neck, back and vent, from 0 (very damaged, lesions and total absence/lack of feathers) to 4 (any lesions or damages). A random sample of 100 broilers for each experimental farm was observed at the

slaughterhouse to evaluate rate of breast blisters, foot-pad dermatitis, haematomas related to the rearing period or handling and transport. Footpad lesions, mortality during transport e body weight were also recorded. Univariate analysis was conducted on feed consumption, FCR and carcass weight using system (conventional vs organic) as factor and the age at slaughter as covariate. Reactivity, plumage condition and carcass lesions were analysed using the Kruskal-Wallis test. The results of approaching test, the plumage condition in different body locations and the weight at slaughtering were also analysed using multivariate analysis (PCA; Jackson, 1991).

## Results

The productive performance showed that daily feed consumption and FCR were significantly ( $P=0.0003$ ) different between OPH and CPH. Conventional broilers (CB) consumed significantly less feed then organic broilers (OB) (Fig. n. 1) and the first got a better FCR (Fig. n. 2).

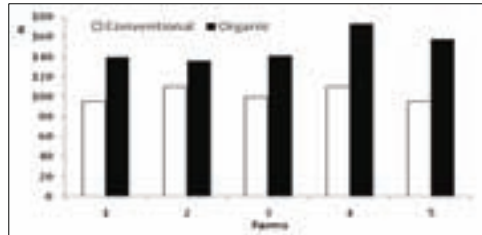


Figure1: Feed Consumption

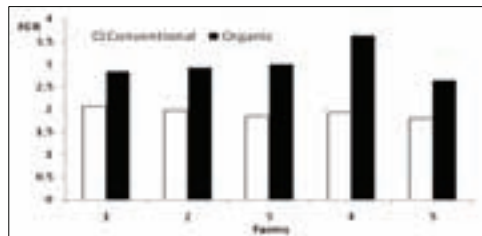


Figure 2: FCR

The different age at slaughter (56 d for CB vs 91 d for OB) determined the significant difference observed for the final body weight of g  $2943\pm441$  CB vs g  $4486\pm346$  of OB ( $P=0.0003$ ). The same trend was observed for carcass weight and chest weight even using slaughtering age as covariate. The first weighed g  $3530\pm581$  for CB vs g  $4410\pm219$  for OB ( $P=0.01$ ) and the second g  $2450\pm432$  for CB and g  $3150\pm206$  for OB ( $P=0.01$ ). The mortality was similar ( $5.8\%\pm1.03$  conventional vs  $6.1\%\pm1.67$ ) and the main cause was Sudden Death Syndrome (SDS) related to genetic factors ( $28.9\%$  conventional vs  $30.8\%$  organic). From the PCA analysis poultry in conventional farms seems to be characterized by good plumage conditions on the back and by higher reactivity approaching man. On the contrary the organic farms, are located on the floor projection of Loadings in a position that corresponds to low reactivity towards man.

## Discussion

Results related to broiler performance such as final weight, carcass weight and chest weight confirm that organic broilers being characterised by a longer rearing period reach higher value also considering the slaughter age as covariate. Feed consumption and FCR are higher in organic broilers probably due to the possibility to move more and to the exposure to natural climate (Castellini *et al.*, 2006). The good plumage condition showed by organic poultry (Hermansen, 2004) and the absence of fear in the approaching test seems to indicate that less intensive farming and the presence of an enriched environment promote a better adaptation of animals, both to the environment and to man presence, ensuring better welfare conditions. Similar SDS incidence both in organic and conventional farms seems to confirm the importance of genetic factors for this pathology (Druyan, 2007); most likely the slower growth in OB is not enough to delete genetic effects. The alternative could be to rear for organic farms only rural chicken characterised by a slow growth rate during all the 120d rearing period. It could be interesting to investigate the effects of a longer rearing period for conventional birds and to compare performance and meat quality (nutritive value, fat depth and tenderness) with organic broilers.

## Conclusions

The research showed interesting results concerning the observed behavioural traits: organic broilers were characterised by a lower reactivity towards human. It seems to indicate a better adaptation to environment and to humans and can be translated in a higher broilers welfare.

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## Veterinary treatment in organic husbandry

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Key words: animal health, animal husbandry and breeding, animal treatment

### Abstract

*The organic farming regulations put emphasis on the preservation of animal health by prophylaxis in the agriculture. The No 5 of the regulation EC 1804/99 (EC organic regulation) Appendix I B defines the veterinary treatments in organic animal husbandry. The veterinarian can use any medicine, which is effective for the indication and the animal species. If possible, effective homeopathics, phytotherapeutics or the like should have priority. Problems of implementing the EC organic regulation into the daily farm practice arise mostly from the doubling of the withdrawal period and the restriction of the numbers of treatments. The strict ban on prophylactic treatments is not mentioned any longer in the new regulation 834/2007, which shall apply as from 1st January 2009. Clarification of the guidelines for animal treatments in organic farming seems to be useful for farmers, veterinarians and boards of control.*

### Introduction

Recommendations regarding a husbandry, appropriate to the animal species, consider causal connections between health and husbandry. For organic farming the objectives for animal husbandry were aligned in the year 2000, when the EC regulations [Council Regulation (EC) No 1804/1999 of 19 July 1999 supplementing Regulation (EEC) No 2092/91] concerning livestock production came into force. The appendix I B No 5: "Disease prevention and veterinary treatment" defines that the animal health shall be based on principles like the choice of appropriate breeds and of animal-fair husbandry practices, high-quality feeds, regular use of outdoor-run and pasturage. The new regulation (EC) No 834/2007 mentions additionally "hygienic conditions". The principles should limit animal-health problems so that they can be controlled mainly by prevention.

This is possibly until today an unrealistic perception. No constant better flock health in organic farming could be shown so far in the reality. Apart from other problems, the outdoor husbandry arises the risk of the occurrence of endoparasites, livestock infections and even zoonotic infections (Conraths et al., 2005, Hovi et al., 2003). Problems in animal health are usually various. A larger variation in the status of animal health is found in between individual organic farms than in between the conventional and the organic system (Sundrum, 2004). Presumably good animal health depends very much on the personal priority and skills of the farmer and it overlaps with other farm options like labour capacity, personal interest, surface area indoors and outdoors, and equipment supply.

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Other causes for insufficient animal health in organic farming may be e.g. the restrictions of the number of treatments and the lack of medical prevention. In some cases there is to be a substantial deficit in knowledge of the veterinarians concerning strategic problem-solutions in organic systems. There is a certain scepticism in some veterinarians concerning the organic farming. Others are unassure about restrictions of therapy. Unsatisfactory interaction between farmer and veterinarian is described as well (Hertzberg et al., 2003, Hammarberg, 2001, Leeb and Baumgartner, 2000, Sundrum, 2004, Vaarst et al., 2003). The presentation of some problems, -information gaps and misunderstandings is the aim of the following paper, as well as the promotion of the scientific discussion.

## Regulations and problems

Most important current EC organic regulations for the animal treatment are:

- First of all there is a treatment requirement. Sick animals must "*immediately*" get treated. Thus, a farmer acts adversely to the regulation, if he does not give treatment to his ill livestock.

- Secondly, the organic farming favours complementary medicine, because these are to support the defence mechanism of the organism, without leaving chemical residues in dung and food. Homeopathic and phytotherapeutic products are to be preferred provided that they actually have a therapeutic effect on the animal species and the illness. But: "*chemically-synthesised allopathic veterinary medicinal products or antibiotics may be used under the responsibility of a veterinarian*" if the alternative treatment "*is unlikely to be effective*".

Particularly the effectiveness is pointed out. If the efficacy is not given free of doubts, the familiar remedies are to be used. E.g. the vets in Sweden are not allowed to use homoeopathics (Hammarberg, 2001).

The opinion that the treatment of organic livestock is permitted exclusively with "alternative remedies" is far common. This cannot be deduced from the EC regulation. Otherwise the organic husbandry gets a reputation of not treating sick animals in an appropriate way (Hammarberg, 2001). The use of chemotherapeutics is currently inevitable to prevent animals from suffering or distress in organic farming.

However the use of chemical medicine is to be limited to the indispensable minimum. The principles of "good veterinary practice" contain a similar passage. The demanded effectiveness of alternative medical treatments may also depend on the experience of the therapist. Advanced training in complementary medicine for veterinarians is possible, but in each regard costly and time-consuming.

The farmers already broadly apply various forms of the complementary medicine. Although the scientific proof for the effectiveness could not be offered so far, in the perception of the farmers many different remedies and concepts "proved" its efficacy (Leon et al., 2006). If farmers prefer to use unlicensed "alternative remedies" rather than treating their animals with licensed chemical drugs this is not acceptable in food producing animals.

- Thirdly, the "preventive administration of chemically synthesised allopathic veterinary medical products or from antibiotics" is clearly forbidden in the current regulation. The drying-off of cows with antimicrobial mastitis-syringes is not regarded as a preventive measure, if a high risk of mastitis infection is documented. It is a

therapeutic treatment in cases of subclinical chronic mastitis. More new infections at calving were found in untreated cows. The "prophylactic treatment" of newly bought calves with antibiotics may also be therapeutic if the probability of already being in incubation of illness is high. The new EC-rules do not mention any longer a ban of prophylactic treatment.

Certainly by the organic farmer a particularly intensive awareness is demanded, because if a chemical-synthetic treatment begins too late the objective of reduced use of medicine is missed. Since then often treatment has to be longer and more intensively and in many cases no complete restitution is possible. This is conscious to most organic livestock farmers.

- Fourthly, hormones may be given only in the context of a therapeutic veterinary treatment of single animals. Induction or synchronisation of oestrus or shots of Oxytocin without prescription are prohibited. Vaccines and e.g. paramunity inducer (also genetically manufactured) are permitted. Farmers must document batch-specifically or animal-individually all applied "*veterinary medicinal products*". 30% of organic layer-farms had missing drug-reports.

- Fifthly, the doubling of the legal withdrawal period for chemical drugs in the organic farming is to improve the desired consumer protection: "*The withdrawal period... is to be twice the legal withdrawal period or, in a case in which this period is not specified, 48 hours.*"

The duplication of the withdrawal period and the 48-hours rule only concerns the *allopathic veterinary* remedies, thus everything that is not ranked among the homoeopathics. This would concern also the phytotherapeutics. The registered 70 plants were intensively examined and possible residues were classified as without risk for humans. The 48-hours rule concerns as well medicinal products with a legal withdrawal period of 0 days. This affects e.g. the use of physiological NaCl infusion solutions. This is considered as "absolutely useless" (Tiergesundheit im Ökolandbau: Rechtliche Grundlagen,2007).

The constant documentation of this kind of animal treatments and reliable adherence to the withdrawal period of at least 48 hours may be doubted.

The duplication of the withdrawal period is problematic also for the owners of "minor species" e.g. goats. The withdrawal time is at least 2 x 28 days on meat and 2 x 7 days on milk, if the used medicine is not registered for the species which is treated. The double withdrawal period is particularly difficult also in connection with mastitis treatment. 85% of the mastitis treatments in organic farms were allopathic and at least 14 % of organic farmers usually treat with intramammary syringe at drying-off. Milk of treated cows has to be withdrawn for 10 days; but if the birth takes place too early, the withdrawal period is for e.g. 94 days, depending on the remedy. In reality the withdrawal of milk for more than 4 to 6 weeks after parturition has to be questioned.

- And finally, the number of "chemically-synthesised allopathic veterinary" treatment courses is restricted. This means: Two treatment courses in fattening pigs and fowl inhibits the marketing as an organic product. A cow and its milk only get disqualified with the fourth treatment course per year. This regulation does not apply to vaccinations and treatments against parasites. A "treatment course" covers the period of the first application of chemical-synthetic medicine within a therapy up to the recovery of the animal. In case of a relapse of the same illness a second treatment may be summarized with the first treatment to one "treatment course". A daily practice'

problem is e.g. the treatment of farrows which completely utilize the number of legal treatments, without the knowledge of the following fattening farm.

The current regulation could perhaps prevent a reasonable early, chemical-synthetic treatment. It may lead possibly to delayed, animal-protection-relevant disease pictures and accumulated mortality, if the farmer underestimate the problem in view of his financial loss. This section is discussed increasingly critically (Tiergesundheit im Ökolandbau: Rechtliche Grundlagen, 2007), because such conditions would run diametrically against the intentions of organic livestock production.

## Conclusion

Clarification of the guidelines for animal treatments seems to be useful for farmers, veterinarians and boards of control. The problems of the use of chemical-synthetic animal drugs in the daily practice of organic farming have to be discussed critically. The new Council regulation (EC) No 834/2007 defines only goals. The detailed rules for application will get fixed later by a "Committee on Organic Production". Feasibility of the rules and their impact on animal welfare is to be considered carefully. The organic farming is in danger to lose the reliability in the consumer's perception, if the facts about outdoor keeping, animal health and medical treatment are left ignored. The correlation between costly labour and animal health and welfare should be proved scientifically and communicated to the consumer. He would achieve a better perception of the organic process of production and the required prices may become more reasonable to him. Doubtless the objective of "less drugs" in organic animal farming could be reached in the future by long-term adaptation of hygiene, feed and husbandry-methods rather than by drugs. But denying today the necessity of chemical veterinary treatments will not help. Animal welfare has to be the major goal in organic farming.

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# Principles and practicality of organic dairy cattle breeding: different options and implications

Nauta, W.J.<sup>1</sup> & Roep, D.<sup>2</sup>

Key words: organic breeding, dairy cattle, organic principles, strategies of development

## Abstract

*As yet there is no set of generally acknowledged rules for organic animal breeding. Most organic farmers depend on conventional breeding programmes, which conflict with organic principles. Do we need a separate, distinct organic breeding system? And how can we support the development of organic breeding? These questions were explored in a PhD study. In general organic farmers and other interest groups express the need for a separate, fully organic breeding system, particularly in view of the modern reproduction technologies used in conventional breeding. Also the difference in the magnitude of GxE between organic and conventional milk production indicates that a separate breeding program might be needed. In practice, however, organic farmers respond to different, and sometimes opposing, strategic and practical considerations. In this situation three options are identified in the development of organic breeding: adaptation of conventional breeding, an organic breeding program and improved natural breeding. Each path has its own implications and demands. Organic breeding is the subject of experimentation and learning on the one hand and of social debate on organic principles on the other. This process needs to be enhanced and interconnected, before well-founded decisions can be taken on further development of organic breeding.*

## Introduction

At the majority of organic farms animal breeding is not organic since most farmers depend on bulls from conventional breeding programmes. This is because there is no official organic supply of breeding bulls. Does organic production need a (selective) organic breeding system distinct from conventional breeding? If this is the goal, what kind of organisation and structure should this selective breeding be based on, and how can the development of such a breeding system be supported?

To answer these questions, three aspects of breeding were explored in a PhD study: farmers views on organic breeding (Nauta et al., 2005); differences and the magnitude of GxE between conventional and organic milk production (Nauta et al., 2006a + 2006b), and the demand for breeding among organic dairy farmers (Nauta et al., 2007). In general farmers favoured the development of a breeding system based on the principles of organic farming, which they see as an obvious extension of their own preference for organic production (Nauta et al, 2005). Interest groups also see a need for organic animal breeding to improve the image of organic farming. This is mainly a

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reaction to the artificial reproduction technologies used in conventional breeding, such as embryo transfer (ET) and IVF.

Breeding bulls from conventional breeding schemes are selected based on estimated breeding values. The reliability of these breeding values is different for organic farmers due to the difference in GxE between conventional and organic production. A first exploration of the magnitude of this GxE showed a genetic correlation of 0.80 between organic and conventional milk production. This means that this magnitude is of “considerable” importance (Mathur & Horst, 1998) and that conventional breeding values are less reliable for organic farmers.

The demand for breeding among Dutch organic dairy farmers is very diverse. Farmers are experimenting and searching for a suitable type of cow (Nauta et al., 2007). This may be due to the lack of suitable information and the more multi-purpose use of animals, including their cultural and historical values. Cross-breeding with robust breeds is also popular among organic dairy farmers (Nauta et al., 2006a).

The question is how to support the development of organic breeding. In this paper we will focus on three possible options for the development of organic breeding and describe considerations affecting the decisions farmers make concerning cattle breeding. We further describe how to deal with and support this process of development of organic breeding.

## **Material and Methods**

The results of these three studies were used to develop three possible options for further development of dairy cattle breeding in organic farming and to describe how to deal with and support this process.

### **Results: Different options for organic breeding.**

From those three studies, three main options for dairy cattle breeding can be identified:

1. Adaptation of conventional breeding and service based on insights into G x E and specific organic needs.
2. Additional organic breeding program based on the organic population (selection of animals within organic herds).
3. Improved natural breeding (farm or regionally based).

The first option is still close to conventional breeding since it uses the same breeding programs and animals. For this option the breeding values of bulls can, when needed, be adapted to the organic production system based on information on GxE, as Interbull does when adapting breeding values for different countries (Interbull, 2007). Female reproduction with super ovulation, oocyte pick up, in vitro fertilisation, embryo culture and ET will be restricted by using ET-free bulls.

For the second option, the entire breeding program should be organic using animals exclusively from organic farms. Bulls will be tested and selected based on the performance of daughters on organic farms. There will be no use of multiple ovulation, ovum pick up and IVF and/or ET. However, the use of AI must be used to estimate breeding values in a testing scheme.

The third option is based on natural mating and selection of animals at the farm level. This system needs a totally different structure compared to the AI structure. The bulls can, for example, be selected from a kin-breeding scheme on a farm or group of farms (Nauta and Cazemier, 2005). Other farms can purchase bulls from breeding farms. Such 'user farms' will make use of the breeding progress on the breeding farms, and also have the option of crossbreeding. These three options for breeding can be seen as a stepwise development towards a natural breeding system.

### **Discussion: Considerations concerning organic breeding**

Between the three options, there are barriers which prevent farmers and other stakeholders from taking steps towards breeding that is more in line with the organic principles (Nauta et al, 2003). However, other farmers just make the transition towards 'organic' breeding. An important barrier is the keeping of bulls at the farm. Bulls are dangerous and special housing is needed but space is limited at many farms. It is the ease of ordering an AI from a bull by phone that keeps farmers to using conventional breeding (Nauta et al., 2005). At the same time more and more organic farmers are taking the opposite view and starting natural service (Nauta et al., 2007). Many farmers see benefits to keeping bulls on the farm: it is good for the image of their farm, often economically rewarding and increasing the fertility of the cows.

All three options raise questions about genetic progress. Due to effects of GxE (Nauta et al. 2006b, Bapst and Stricker, 2007) a separate breeding program might be justified (Mulder and Bijma, 2005). However, in a closed organic breeding program, with far fewer animals than the national population (in the Netherlands about 20,000 dairy cows), less genetic progress can be made (Harder 2002). But the indirect use of modern reproduction technologies might just force the sector towards a distinct organic based breeding program. If also AI might become limited or forbidden, breeding must be based on natural mating and will become based at farm level. Selection within the organic population or farm herd will however, result in less effect of GxE and genetic progress may not be as fast as in a (world-wide) testing scheme, but will still be possible (Rendel and Robertson, 1950).

For the whole sector, the main issue is whether the organic sector should continue to depend on conventional breeding, or whether it will opt for a separate, distinct organic breeding system, either at farm level or in a structure similar to conventional breeding. The objectives are clear; generally it is proposed that organic production should be based on natural integrated processes of animal and crop production using local resources and closed cycles. Animal health and welfare are also important issues for the organic sector, and animals should be able to adapt to the local environment (EU, 1999; IFOAM, 2006). However, current animal breeding practices in conventional breeding programs are in conflict with the rules and objectives.

### **Conclusion: Development and support of organic breeding**

There is still a lack of information for farmers about all the different activities farmers are in to with their own breeding activities: information on GxE, suitability of (cross)breeds, excluding ET, breeding at the farm. In our opinion, all these activities should be supported by providing information to farmers to enable them to make their decisions on breeding. Also further discussions are needed with farmers, researchers and breeding organizations to determine what the organic sector needs in the future .

A start has been made with this PhD, but more information and support are needed. Also new technologies for selection (marker assisted selection and genome wide selection) and reproduction (sperm sexing) are being introduced in conventional breeding programs. These developments may take the use of conventional breeding to a whole new level. The organic sector still has to develop a view on the use of these technologies. World-wide they might lead to a further erosion of genetic variation and harm the integrity of the animals. However, at farm level, in a family breeding scheme, the new tools like marker assisted selection and sperm sexing may help farmers to select and breed animals more efficiently.

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# Livestock Production Practices of Registered Organic Farmers in Uttarakhand State of India

Subrahmanyeswari, B.<sup>1</sup> & Chander, M.<sup>2</sup>

Key words: Organic standards, animals, organic farmers, Uttarakhand, India

## Abstract

*The authors studied 180 organic farmers, randomly selected out of 4459 organic farmers registered with Uttarakhand Organic Commodity Board (UOCB), in the North Indian state of Uttarakhand (77° 34' and 81° 02' E longitude and 28° 43' to 31° 27' latitude). These farmers were interviewed during 2006-07, using semi-structured Interview schedule, so as to know their Knowledge, Attitude and Practices (KAP) in context of their livestock production activities in particular. All the farmers had maintained some animals under crop livestock subsistence mixed farming system, mainly to meet household requirements of milk and more importantly cow dung for use in crop field. These farmers were mostly focussed on organic crop production activities, with active technical and marketing support from UOCB. The animal husbandry practices were mostly traditional but very close to organic livestock production systems when contrasted with the organic livestock standards. It was concluded in the study that conversions to organic livestock production systems would be much easier for these organic farmers, if technical and marketing support is extended beyond crops to cover livestock.*

## Introduction

The organic land in India is 1,50790 hectares spread over 1,547 farms constituting 0.1% of total agricultural land (Willer and Yussefi, 2007). India exported 35 organic products worth US\$ 21 Million during 2004- 05 (Gouri, 2006), but these products did not have any item of animal origin except honey. The Indian authorities managed to acquire both, United State Department of Agriculture (USDA) equivalence for the National Organic Programme (NOP) and the European Union (EU) third country listing in 2006, indicating significant progress India has made regarding organic farming (Wai, 2007). Indian agriculture is characterized by small scale (<2ha), subsistence farming operations under low input low output production systems, where, livestock are essentially integrated with crop farming. Thus, alongside organic crop production, the prospects for organic livestock production are bright though yet to be explored (Chander & Mukherjee 2005, Chander et al 2007).

In India, Uttarakhand is the pioneering state in organic agriculture, since it is the first state declared as organic. Here, the state government has identified "organic farming" as a thrust area for agriculture development and promoting organic farming through establishment of an institutional mechanism named as Uttarakhand Organic Commodity Board (UOCB). The UOCB was created on 19 May 2003, to promote, co-

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ordinate, centralize and decentralize the dispersed organic activity in the state. Achievement of sustainable rural development through organic farming and also to make 'Uttarakhand the Organic capital of India' are the mission and strong visions of UOCB, for which it acts as a nodal agency to enhance organic activities in agriculture and allied sectors like horticulture, medicinal and aromatic plants & herbs, milk production and animal husbandry throughout the state. The technical and marketing support for different activities of UOCB is provided by the Center for Organic Farming (COF). Thus, UOCB is working to promote organic farming in the Uttarakhand by bringing all the organic initiatives under one umbrella; to provide a single window access to market, industry and other stakeholders, by working as a bridge between farmers and government, as well as to access funds, grants and other finances for the different organic activities. As such, the Uttarakhand state is moving systematically towards organic farming development with full government support. UOCB could facilitate sale of certified organic products worth Indian Rupees (INR) 198.3 Lakhs (4,63,746 US\$) during 2003-06 (Shah, 2006). The registered farmers are currently motivated mainly due to the expectation of price premiums followed by other reasons. The state targets for certification of more than one hundred thousand farmers over similar number of hectares by the year 2010 (Subrahmanyeswari & Chander, 2007). Though the activities at the moment mainly focus on organic crop production but the interest in organic livestock production is also increasing (Subrahmanyeswari, 2007).

### **Materials and methods**

In north Indian state of Uttarakhand, 4459 organic farmers were registered with Uttarakhand Organic Commodity Board (UOCB), by the time of the study. Out of the 4459 registered farmers, 180 registered organic farmers were selected randomly at the rate of 10 farmers from each purposively selected village (total 18 villages, 2 from each block), 9 randomly selected blocks (3 from each district) and 3 purposively selected districts from the purposively selected state of Uttarakhand. As such, the total sample consisted of 110 registered organic farmers from hill region and 70 farmers from plain parts. The sample also represented both male (111) and female (69) groups. An interview schedule was developed consisting questions relating to general profile of farmers, their knowledge, attitude and production activities, with special emphasis on their animal husbandry practices. While designing the interview instrument, the organic standards developed by Government of India were considered so as to contrast their practices with the standards, for which a knowledge test was developed based on the standards. To measure their attitude towards organic livestock farming, an attitude scale was also developed. The selected farmers were personally visited by the researcher during 2006-07 to interview and observe their production activities.

### **Results**

Agriculture land in Uttarakhand is scattered, fragmented and land distribution is inequitable. Individual holdings are very small; more than 50 per cent of the holdings are sub-marginal (< 0.5 ha), the average holding size being only 0.93 ha, compared to the national average of 1.34 ha. Net sown area was 7,84,117 ha, of which, nearly 3,42,283 ha (44%) were irrigated crops and the rest rain-fed. Mixed-crop livestock farming is the predominant farming system in Uttarakhand with wide variation in the species of livestock held like cattle, buffalo, goat, sheep, pigs, horses, pony, mules and poultry. Large population and low productivity are the hallmark of livestock in the state, yet agriculture along with livestock is the single largest employer in the state and

80 per cent of the rural households in the state earn over a third of their income from livestock. Contribution of livestock sector accounts for over 9.5 per cent to the gross domestic product of the state. The major resources of feed and fodder in the state are crop residues, cultivated green fodder and edible herbage and permanent pastures. Collection of fodder leaves and local grasses is a normal practice in the hilly areas, whereas, the proportion of livestock maintained on grazing is very small in the agriculturally developed and irrigated areas of the state.

The General profile of the organic farmers of the study has been discussed by the authors elsewhere (Subrahmanyeswari & Chander 2007). More than three fourth of the respondents were having 3-6 years of experience in organic farming, followed by 15 per cent of farmers having 6-8 years of experience in organic farming. Total land holding with 180 organic farmers was 176.62 ha, with 34.97 per cent of land under organic cultivation. Of the total land, 87.14 per cent of land was rain-fed. Most of the farmers (48.33%) were with low level of awareness followed by 41.33 per cent of respondents with medium level of awareness about the organic animal husbandry standards, whereas, very few farmers (10.56%) were found to have high level of awareness. Majority of the farmers (76.67%) were with low level of knowledge, followed by 23.33 per cent of the respondents with medium level of knowledge regarding organic livestock standards. More than 60 per cent of organic farmers were having favorable attitude towards standards of organic livestock farming.

Organic farmers' livestock farming practices were in consonance with some of the organic production standards viz. diversity of farms, local breeds and traditional practices, which are given due importance in organic production systems. Farmers treat livestock as part of their family and were paying due care to their welfare. Animals' physiological and ethological needs were being fulfilled in the present rearing systems of organic farmers. Organic farmers who were in conversion to organic livestock farming were in the requirement of certain resources both at community and individual level like technical, infrastructural and financial resources. The majority of the farmers felt need of training in different areas of organic animal husbandry. UOCB effectively rendered training to organic farmers through Master Trainers in aspects like compost making, crop rotation, Integrated Pest Management (IPM), Internal Control System (ICS) measures, certification etc. Currently, organic farmers were marketing organic agricultural produce through UOCB, but in conversion to organic livestock farming, they perceived risks like uncertain product demand and consumer preferences, limited resources options, animal epidemic diseases etc. To overcome these risks, farmers suggested risk management strategies like wider publicity regarding organic products, production at the lowest cost possible, technical support in the form of risk reducing technologies, diversifying the production and group certification through ICS etc.

## **Discussion**

UOCB appeared to be successfully implementing the organic agriculture development programme in the state of Uttarakhand through registering the farmers and providing the necessary inputs and training for carrying out the organic farming activities. Farmers seems to have gained some confidence in organic crop production activities due to the training and marketing support provided by the UOCB, but the activities concerning organic livestock production such as training, marketing facilities for organic products and disease in livestock and reduced prospects of export of livestock products from India may be considered as potential risks coming on the way of expansion of organic livestock production in the state. Nevertheless, farmers were

ready to give a try to organic livestock production, mainly looking at the prospects of high premiums on such products even in domestic markets.

### **Conclusions**

Prospects of organic animal husbandry are bright in the state of Uttarakhand, especially due to its hilly terrain, favourable government policies and likely expected increase in demand for organic livestock products in future. Moreover, most of the existing livestock production practices of the organic farmers were in consonance with most of the organic standards. The UOCB may find it much easier to motivate farmers for organic livestock production due to the variety of favourable conditions.

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## Handling of animal welfare and disease challenges

## **A Longitudinal Study of Mastitis on an Experimental Farm with Two Herds, One Managed Organically, the other Conventionally**

Thatcher, A.<sup>1</sup>, Petrovski, K.<sup>1</sup>, Holmes, C.<sup>1</sup>, Dowson, K.<sup>1</sup>, Kelly, T.<sup>2</sup> & McLeod, K.<sup>3</sup>

Key words: mastitis, organic, bulk milk somatic cell count, *Staphylococcus aureus*

### **Abstract**

*Mastitis in two herds managed as a comparison between organic and conventional dairy farming systems was monitored for 4 years utilising regular bacterial culture of milk samples, individual and bulk somatic cell counts and observation by farm staff. The objective was to develop strategies for the control of mastitis in organic cows without the use of antibiotics. The herds showed differences in clinical mastitis incidence, subclinical mastitis prevalence and bulk milk somatic cell count. Despite these differences, the level of mastitis in the organic herd remained manageable.*

### **Introduction**

In 2001, Massey University set up its Dairy Cattle Research Unit (DCRU) as a system comparison between organic and conventional farming. It is the only comparative grassland-based open grazing dairy study in the world. The farm is a seasonal producer with calving from late July until mid October. All cows are dried off by the end of May, the exact date depending largely on pasture availability.

The DCRU was split into two similar units. The organic unit covers an area of 20.4Ha and the conventional 21.3Ha, carrying typically 46 organic cows (2.27cows/Ha) and 51 conventional (2.39cows/Ha), respectively. In 2003, the organic unit achieved its full AgriQuality (New Zealand) organic certification. From August 2006, all organic dairy suppliers to Fonterra NZ Ltd were required to meet the standards set by the USDA National Organics Program. Each of the two units is managed individually according to "best practice" for its particular type of management system and environmental conditions. Thus, no attempt is made to replicate on one farm what is done on the other. The project has been described in detail by Kelly *et al.* (2006).

Mastitis control for the conventional herd is based on the Seasonal Approach to Managing Mastitis (SAMM) Plan, a nationwide scheme administered by the National Mastitis Advisory Committee. Control in the organic herd is based on the same principles excluding (since 2005) the use of antibiotics. An iodine-based teat spray is used on both herds post milking. Treatment of clinical (CM) and sub-clinical mastitis (SCM) in the organic herd generally relies on homeopathy along with supportive therapy. Financial penalties apply to bulk milk submitted with a somatic cell count (SCC) exceeding 400,000 cells per mL. The predominant major mastitis pathogen in

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New Zealand is *Streptococcus uberis* followed by *Staphylococcus aureus*. The most commonly isolated minor pathogen is Coagulase Negative *Staphylococcus* (CNS) (McDougall, 1998). Incidence of CM and prevalence of SCM are important pre-requisites to estimating the cost of mastitis to the dairy industry. This study presents the incidence of CM, prevalence of SCM, and describes the bulk milk somatic cell count (BMSCC) from both herds involved in the system comparison.

## Materials and methods

In November 2003, a sampling regime began whereby milk from each cow in both herds was submitted for bacterial culture. Sampling occurred 4 times per season; at calving, 14 days after calving, at mid lactation and at drying off. Culture and classification of organisms was initially carried out by a post-graduate student (Silva *et al.*, 2005) and subsequently by New Zealand Veterinary Pathology Ltd (NZVP). Additional data was gathered from monthly individual somatic cell counts (ISCC) carried out by the Livestock Improvement Corporation as part of routine herd testing and daily BMSCC provided by Fonterra. Episodes of CM were recorded by DCRU staff.

## Results

### *Clinical mastitis*

Of the total 402 cow-lactational seasons included in the study, 61(15.2%) had at least one episode of mastitis. The incidence of CM varied significantly between herds, from 14.2 cases/100 cow-lactational seasons in the organic herd to 16.9 cases/100 cow-lactational seasons ( $p<0.001$ ) in the conventional. In 34 of the cases (27.2%), more than one quarter was affected at the same time. There were 19 (33.3%) cases with multiple quarters in the organic herd and 15 (22.1%) cases with multiple quarters in the conventional herd.

Each affected organic cow averaged 1.5 quarters diagnosed with CM per episode and for each front quarter, 2.2 rear quarters were affected. Each conventional cow with CM averaged 1.4 quarters per episode and for each front quarter there were 1.8 rear quarters affected.

### *Subclinical mastitis*

Milk samples were collected from a total of 5004 quarters – 2365 from the organic and 2639 from the conventional herd. 69.9% of organic quarter samples did not grow causative organisms. The most frequently isolated organisms were *S. aureus* (41.8% of all isolates), CNS(29.8%), and *S. uberis* (11.1%). 74.2% of conventional quarter samples did not grow causative organisms. The most frequently isolated organism were CNS (39.5% of the isolates), *S. aureus* (26.6%) and *S. uberis* (12.3%). A total of 1392 (27.8%) quarters were affected by subclinical mastitis, based on culture results, in 1251 tests of 391 cow-lactation seasons. For each front quarter there were 1.2 rear quarters affected by SCM with 1.3 and 1.1 rear quarters affected in the organic and conventional herds, respectively. The differences in the incidence of isolation of *S. aureus* or *S. uberis* between herds and quarters were significant, whilst differences of *S. uberis* isolation between different quarters were non-significant throughout the study period. Differences between the two systems for *S. uberis* isolation were also generally non-significant whereas differences for *S. aureus* during the first three seasons were generally highly significant (Figure 1).



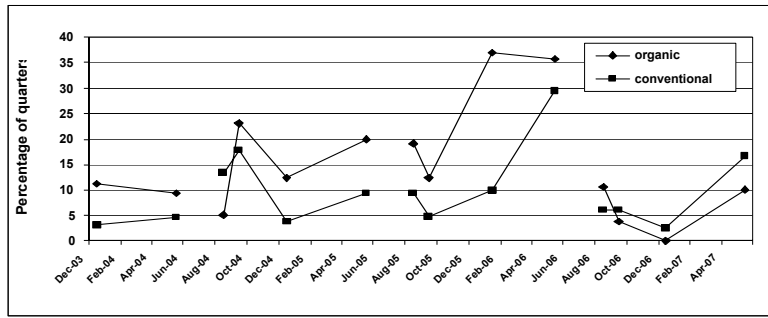


Figure 1: Proportion of *S. aureus* isolates among herds over 4 seasons

BMSCC data are presented in Figure 2. While the conventional herd demonstrated typical U-shaped curves each season, the organic herd demonstrated irregularities in the curve shape and generally higher values. Most of the daily collections had significantly different BMSCC.

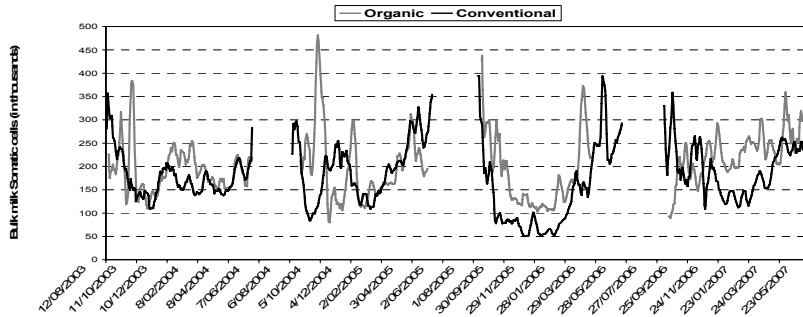


Figure 2: 10-day rolling average of BMSCC unadjusted for milk volume

A large proportion of the somatic cells appearing in the bulk tank originate from a relatively small proportion of cows (Table 1).

Tab. 1: Percentage of cows with ISCC >400,000 cells/mL two or more times per season

Season	2003/2004	2004/2005	2005/2006	2006/2007
Organic	17	24	17	23
Conventional	20	17	8	15

## Discussion

Both herds have exhibited a number of unusual trends throughout the course of the study. The incidence of clinical mastitis is relatively high as is the prevalence of *S. aureus* isolated at culture. Although the herds are milked into two separate bulk tanks, the same milking machine is used, the conventional cows being milked immediately after the organic. Thus there is potential for the spread of *S. aureus* from the organic to the conventional herd. The structural limitations of the soil type mean careful management is required during wet periods and it was initially considered that its poor drainage characteristics may enhance the survival of environmental pathogens. The numbers of *S. uberis* recoverable from the environment of pasture-based systems are related to moisture levels and inversely related to ambient temperature and solar radiation. A number of initiatives were undertaken to keep contamination of teats to a minimum during critical times of the year and these appear to have been largely successful. Moreover, throughout the project, the bulk of quarters from which *S. uberis* was recovered at calving were negative at the 14 day test. Management of BMSCC has tended to focus on the relatively small proportion of chronic SCM cases, identified by ISCC and monitored on a daily basis using the California Mastitis Test. Changes in management procedures targeting the incidence of *S. aureus* in the organic herd were instigated at the start of the 2006/07 season, including oral dosing with apple cider vinegar, an intensive homeopathy programme and improved teat spraying. Although there has been a decline in the incidence of *S. aureus* and CNS recovered from milk samples and in the incidence of CM in the organic herd, BMSCC has remained relatively high.

## Conclusions

Control of *S. aureus* is likely to be the most important factor in managing mastitis in a pastoral-based organic herd, while environmental pathogens are easier to control with adequate management of the cow's surroundings. The difficulty in eliminating *S. aureus* once well established in the udder means BMSCC may remain relatively high despite minimal spread of infection between cows.

## Acknowledgements

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# Effect of colostrum type on serum gamma globulin concentration, growth and health of goat kids until three months

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Key words: goat production, goats kids, colostrum, immunity, immunoglobulin

## Abstract

*In this study the effect of three colostrum types; goat, cow and artificial colostrum, on serum gamma globulin concentration (GGC), growth and health of goat kids during the first three months of the rearing phase was measured. Thirty newborn goat kids were randomly assigned to three experimental groups; goat colostrum (GC), cow colostrum (CC) and artificial colostrum (AC). At 2, 28, 56 and 86 days serum GGC and live weight were measured. The three colostrum types were analysed on immunoglobulin G (IgG). Goat colostrum contained twice as much IgG as cow colostrum and artificial colostrum. At 2 and 28 days GC kids had a higher serum GGC than CC and AC kids. At 56 and 86 days no significant differences in serum GGC between the groups were found. No effect of colostrum type on daily weight gain was found. Eight out of thirty goat kids under study suffered from health problems. Health problems and mortality were heavier among the AC kids. It can be concluded that for a successful passive transfer of immunity goat colostrum is necessary. When it is not possible to provide goat colostrum because of health reasons (disease transmission), cow colostrum is the best alternative. In that case good farm management is even more important.*

## Introduction

In ruminants, the placenta impedes the transfer of immunoglobulins from mother to foetus. Consequently, the consumption of colostrum by the progeny plays a fundamental role in the building up of immunity. O'Brien and Sherman (1993) concluded that failure of passive transfer of maternal antibodies to kids via colostrum leads to increased morbidity and mortality from infectious disease in young goats. In practice each farm carries its own variety of pathogens. Colostrum originating from the own farm, consists out of farm specific antibodies that cause immunity against disease agents but also against ubiquitous bacteria's and protozoa. For organic dairy goats it is important that the immunity during the rearing phase is well developed. However, beside a source of useful elements, colostrum can also cause transmission of diseases as *Caprine Arthritis Encefalitis* (CAE), *Caseous Lymphadenitis* (CL) and paratuberculosis from mother to goat kid. Prevention against these diseases is necessary for animal welfare and prevention of economical damage. To prevent transmission of diseases from mother to kid, farmers provide artificial colostrum or cow colostrum in stead of colostrum originating from the own goats. Zadoks et al (2000) showed that artificial colostrum contains insufficient immunoglobulin to develop immunity. An experiment of Orsel et al. (2000) with cow colostrum resulted in higher values of antibodies compared to artificial colostrum but lower than goat colostrum.

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The objective of this study was to evaluate the effect of three colostrum types; goat, cow and artificial colostrum, on serum gamma globulin concentration (GGC), growth and health of goat kids during the first three months of the rearing phase.

### **Materials and methods**

All kids in this study were born on an organic commercial dairy goat farm in the south of The Netherlands. Thirty newborn goat kids were randomly assigned to one of the three experimental groups; goat colostrum (GC), cow colostrum (CC) and artificial colostrum (AC). All goat kids were fed 200 ml colostrum, 100 ml within one hour after birth and 100 ml four hours after birth. All colostrums were given by hand through bottle feeding. Four millilitres of blood was obtained from each kid at birth by jugular venapuncture. At the same time, the animals were weighted. Sampling was repeated at 2, 28, 56 and 86 days. All samples were analysed by the National Animal Health Service on protein spectrum and total protein. From these parameters the GGC was calculated.

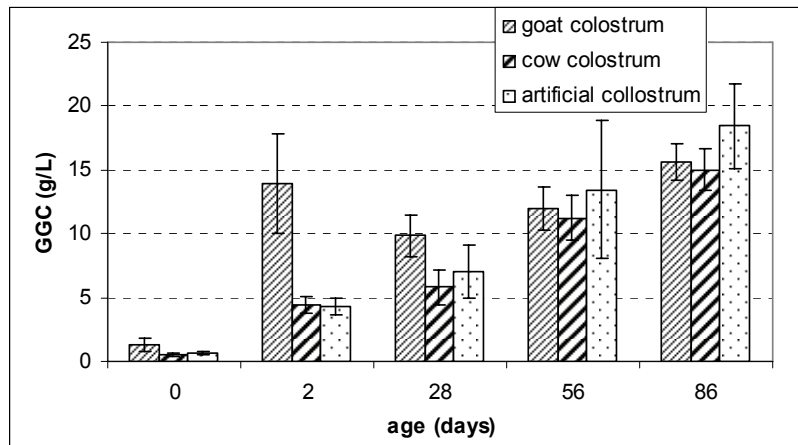
The goat colostrum used for this experiment was collected from four goats, which had recently kidded for the first time. Cow colostrum was obtained from two dairy farms that were free from Para tuberculosis. The used artificial colostrum was of the brand Colobis. By preparing this colostrum 25 grams of powder was dissolved in 100 ml warm water. All colostrums were individually analysed by the National Animal Health Service on immunoglobulin G (IgG).

Data were analysed with GenStat Release 9.1 2006, Lawes Agricultural Trust (Rothamsted Experimental Station). The ANOVA unbalanced design procedure was used for measuring significance.

### **Results**

On average, goat colostrum contained twice as much IgG (58 g/L) as cow colostrum (26 g/L) and artificial colostrum (23 g/L).

Serum GGC of the goat kids was at birth on average 0.8 g/L. GC kids had at birth a slightly higher GGC compared to AC en CC kids ( $P < 0.05$ ). Two days after birth GC kids had a significant higher GGC compared to CC kids and AC kids ( $P < 0.01$ ). Twenty eight days after birth, the average serum GGC in GC kids was still significantly higher than in CC kids ( $P < 0.05$ ). GGC in AC kids differed not significantly with the two other groups. At the age of 56 and 86 days no significant differences in serum GGC between the groups were found (figure 1).



**Figure 1: Average GGC and st. dev. in blood of the three groups of goat kids at 0, 2, 28, 56 and 86 days.**

No significant effect of colostrum type on daily weight gain was found. At 56 days, the GC kids and the CC kids weighted more than the AC kids. At 86 days no significant difference in weight between the three groups was found. Variation in and between groups was high.

Eight out of 30 goat kids under study suffered from health problems. Six of them died during the study. One of the GC kids died due to severe caprine arthritis, two of the CC kids due to unknown reasons and three of the AC kids due to lung problems, meningitis and unknown reason.

### Discussion

In literature several values are mentioned as minimum value for serum GGC of goat kids. Sherman (1990) mentioned 5.0 g/L as minimum value, while O'Brien and Sherman (1993) suggested that a minimum of 12 g/L of serum GGC should be achieved in newborn kids to help insure good health and survival to weaning. The National Animal Health Service suggests a minimum of 5 g/L in calves and piglets and preferably 10 g/L gamma globulin. When serum GGC is lower than 5 g/L the passive immunity of the animal is insufficient (Counotte, 2007). Ten percent of the CC in this study and also ten percent of the AC kids had at 48 hours a serum GGC higher than 5 g/L, whereas all GC reached this level. 60 percent of the GC kids had at 48 hours a serum GGC higher than 12 g/L and none of the CC and AC kids reached this level.

Constant et al. (1994) showed that with good farm management low GGC does not have to cause mortality. Mortality in the goat kids in our study was higher than normally encountered at farm level. Probably due to frequent blood sampling and weighting the goat kids suffered a higher stress level than normally. Under these circumstances morbidity and mortality was the highest within the AC kids group, followed by the CS kids group. Only one kid died in the GC group.

Although not significant, GGC in the AC group was at 56 and 86 days higher than in GC and CC group (figure 1). At the age of a couple of days GGC in the blood of a goat kid is an indicator for passive transfer of immunity. When older, high GGC can be an indication that the kid has formed immunoglobulin against infectious diseases. Therefore a high GGC can be negative in that stage.

No effect of colostrum type on daily weight gain was found. Variation in weight gain was high. O'Brien and Sherman (1993) did also not found a relation between GGC and average daily weight gain.

### **Conclusions**

Goat colostrum gives in general a higher serum GGC of goat kids than cow and artificial colostrum. For a successful passive transfer of immunity goat colostrum is necessary. When it is not possible to provide goat colostrum because of health reasons, cow colostrum seems to be the best alternative. In that case good farm management is even more important.

### **Acknowledgments**

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## Control of bovine sub-clinical mastitis by using herbal extract during lactation

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Key words: sub-clinical mastitis, phyto-derived, dairy cow

### Abstract

*Objective of the study was to evaluate the effects of feeding administration of herbal extracts for the control of bovine subclinical mastitis during lactation. A total of 36 Italian Friesian lactating cows with subclinical mastitis were randomly divided into three homogeneous groups: phyto-treated group, placebo-treated group, and control group. In phyto-treated group, cows received 5 gr. of standardised fluid extract of *Spirea ulmaria* L. and 6 gr. of standardised extract of *Astragalus membranaceus* BUNGE, administered orally as complex once daily for 15 days. Milk samples were collected from the mammary quarters before the beginning of the experiment, and then 14, 28 and 56 days after for analysis of bacteria, and somatic cells count (SCC). Milk flow and production were also recorded. The treatment positively influenced the health status of mammary glands, resulting particularly effective against Coagulase Negative Staphylococci. A reduction of infected quarters was highlighted in treated group (16.7% vs 30.2% and 37.5%, respectively in control and placebo groups;  $P < 0.05$ ). Further studies are needed to ascertain some aspects of herbal extracts action in ruminants and their effectiveness in different experimental and practical conditions.*

### Introduction

Subclinical mastitis represents one of the most severe and common disease in dairy cow farming, affecting animal health and profitability (Fetrow et al.2000,). Mastitis therapy accounts for very large proportion of antibiotic drug use in dairy production systems (Sawant et al. 2005). The usage of antibiotics is not totally effective in curing all types of existing udder infections during lactation (Erskine et al.,2003), and it results highly expensive due to the cost of treatments and to the sub-sequent withdrawal time. Moreover the usage of antibiotics during lactation increases the risk of residues in milk and dairy products (Hady et al. 1993) and there are global concerns for the development of antimicrobial drug resistance (Witte, 1998; Ungemach et al., 2006). The EU- Regulation (1804/99) suggests complementary therapies, such as homeopathic and phyto-derived remedies, to treat animals reared under organic farming, in preference to allopathic chemically synthesised products. Such alternative medical approaches are under debate, either from a scientific point of view, due to the scarcity of appropriate and comparable research trials, or from a practical point of view, since their efficacy and validity is not always reproducible. The aim of the present work was to evaluate, in field conditions, the efficacy of herbal extracts for the control of dairy cow sub-clinical mastitis.

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## Material and methods

The study was carried out in a commercial dairy cow farm located in the province of Roma. For a preliminary check of mammary glands status, individual quarter milk samples from 80 Italian Frisian lactating cows were collected 15 and 7 days before the beginning of the experiment, to determine somatic cell count (SCC). Thirty-six cows with two consecutive SCC over 200.000 cell/ml in at least one quarter and no evidence of clinical mastitis were considered affected by sub-clinical mastitis (Bradley and Green, 2005) and selected for the trial. Three groups of twelve cows were randomly formed, balanced for days in milk and parity: phyto (PH) (days in milk  $177 \pm 22$ , parity  $3,7 \pm 0,48$ ), placebo (P) (days in milk  $161 \pm 27$ , parity  $3,5 \pm 0,44$ ), and control (C) (days in milk  $169 \pm 23$ , parity  $3,1 \pm 0,46$ ). Cows from PH group received 5 gr. of standardised fluid extract of *Spirea ulmaria* L. and 6 gr. of standardised extract of *Astragalus membranaceus* BUNGE (Biorama), administered orally as complex once daily for 15 days. Cows from P group received the same quantity of physiological solution. Herbal extract and physiological solution were given orally using a disposable syringe. For animals treated with herbal extract, a precautionary withdrawal time of 18 days was planned (15 days of trial, and 3 days after). Aseptic milk samples were collected from quarters of each cow during the evening milking at day 1 (beginning of experiment), and then after 14, 28, and 56, according to the International Dairy Federation guidelines. All samples were processed for bacteriological analyses. A portable milkmeter Lactocorder (WMB AG, CH Balgach) was used to record milk production and to measure milk flow. Milk samples (10  $\mu$ l) were spread on blood agar (5% defibrinated bovine blood) and Edward's medium modified plates. The plates were incubated aerobically at 37°C and examined for growth after 24 and 42 h. Mastitis status of milk samples was determined by diagnostic procedures recommended by National Mastitis Council (National Mastitis Council, 1987). Milk samples were analysed for somatic cells content (SCC) by fluoro-opto-metric method with Fossomatic 5000 (Foss Electric, Hillerød, Denmark). Data analysis was performed by using Chi-Square and Student-t statistical significance tests (MedCalc, 2006). Results were considered statistically significant when  $p < 0.05$ . Results are presented as mean  $\pm$  S.E.M.

## Results

During the entire period, none of the cows showed clinical signs of mastitis. The most prevalent pathogens were environmental streptococci, mainly *Streptococcus uberis* and *Streptococcus dysgalactiae*, isolated in 109 quarters (55,6%). Coagulase negative staphylococci (CNS) were isolated in 76 quarters (38,8 %), while *Staphylococcus aureus* was isolated only in 6 quarters (3,1%). The prevalence of Gram negative bacteria was very low (5 quarters, 2,5 %). At the beginning of trial, 16 quarters (32,7 %) resulted infected in PH group, 20 quarters (41,7 %) in P group, and 17 quarters (35,4 %) in C group. In PH and P groups two cows showed infection by *S. aureus* in a single quarter. Percentage of quarters infected resulted quite variable during the trial. The bacteriological status did not differ significantly among groups at day 0, 14, and 28, while a significant ( $P < 0.05$ ) reduction of quarters infected was observed in PH group at the end of the experiment (day 56) (Table 1).



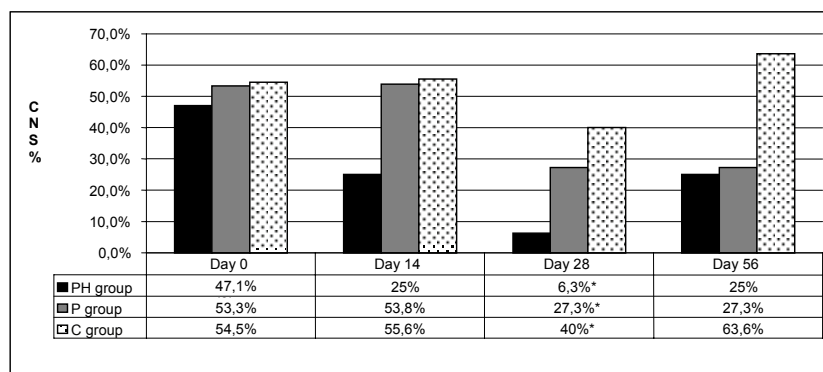
**Tab. 1: Relative percentage of quarters infected during the experiment**

	PH group	P group	C group
Day 0	32.7	41.7	35.4
Day 14	23.1	36.1	25.0
Day 28	28.6	30.6	13.9
Day 56	16.7(*)	37.5(*)	30.6

(\*) P<0.05

Considering single species of intramammary gland pathogens, an average reduction of infections induced by CNS was observed in PH group (figure 1), with lowest values (P<0.05) at third control (day 28). No differences among groups were detected for infection induced by environmental streptococci. Quarters infected by *S. aureus*, at 28 and 56 days after treatment resulted negative in PH group, while remained positive in P group.

**Figure 1: relative percentage of quarters infected by CNS during the experiment**



(\*) P<0.05

The phyto-derived treatment induced in PH group a progressive, but not significant, reduction of SCC in the quarters infected (table 3). A variable trend of SCC was observed in P, and C groups.

**Tab. 3: Mean values  $\pm$  E.S. of SCC in infected quarters during the experiment.**

	PH group (SCCx1.000/ml)	P group (SCCx1.000/ml)	C group (SCCx1.000/ml)
Day 0	2.030 $\pm$ 1.159	430 $\pm$ 131	3.944 $\pm$ 2.254
Day 14	1.185 $\pm$ 513	640 $\pm$ 415	862 $\pm$ 676
Day 28	482 $\pm$ 117	2.038 $\pm$ 1.483	1.837 $\pm$ 1.495
Day 56	426 $\pm$ 198	942 $\pm$ 468	1.567 $\pm$ 1.484

Regarding milk production and milk flow parameters, better results were observed in PH group, although non significant. In detail, at the end of trial the milk yield resulted higher in PH group (10,73 $\pm$ 0.83 kg), compared with P group (10,68 $\pm$ 0.82 kg) and C group (10,16 $\pm$ 0.82 kg). The average milk flow during time resulted greater in PH group

(2,56 ±0.12 kg/min), than in the P group (2,29 ±0.12 kg/min) and C group (2.32 ±0.15 kg/min).

## Discussion

Results obtained from the study indicate beneficial effects of phyto-derived remedies against subclinical mastitis of lactating dairy cows, particularly against forms caused by CNS. Our data are not comparable with results obtained by other authors, due to differences in active compounds chosen for the experiment. The positive effects may be related to the specific anti-inflammatory actions of *Spiraea ulmaria* L., and immunomodulatory actions of *Astragalus membranaceus* BUNGE (Campanini, 2004). The scarcity of results against environmental streptococci, highlighted also in previous experiments with intramammary antibiotic therapy (Bramley, 1997), is probably due to the presence of chronic unresponsive infections. For a perspective of application in the livestock farming system, potential useful herbal extract need to be properly assessed for quality of production, concentration and use. The process of licence should also evaluate specific withdrawal periods.

## Conclusion

Phytotherapy may represent, together with other complementary therapies, an useful tool to control the incidence and negative effects of subclinical mastitis in lactating dairy cow. Phytotherapy can not substitute the application of good management practices, such as a good health program to enhance animal health and welfare. Further studies are needed to ascertain effectiveness in different experimental and practical conditions.

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# Mastitis incidence and milk quality in organic dairy farms which use suckling systems in calf rearing

Wagenaar, J.P.T.M.<sup>1</sup> & Smolders, E.A.A.<sup>2</sup>

Key words: udder health, suckling systems, mastitis, somatic cell count

## Abstract

*In order to identify important factors influencing animal health and general disease resistance, detailed qualitative and quantitative farm data were collected from 99 organic dairy farms in the Netherlands. Mastitis incidence and milk quality were focal points of the data collection. In this paper the results of a group of farms which rear dairy calves in suckling systems (n=11) are presented. It was found that compared to other farms in the study (n=88), suckling systems in calf rearing had no clear adverse effects on mastitis incidence and milk quality. In 2006 average clinical mastitis incidence on suckling farms was 14%, on other farms 20%. The percentage of cows with a somatic cell count less than 250,000 at drying-off was lower (60 vs. 66%) at suckling farms. Also immediately after calving the percentage of cows with a somatic cell count less than 250,000 was lower (65 vs. 75%) on suckling farms. Between other farms and suckling farms, but also within suckling farms, distinctively different attitudes to disease management prevailed. Most suckling farms recently introduced suckling systems in calf rearing. Only 1 or 2 generations of suckled heifers had been introduced into the herds up to now. In order to judge whether suckling systems have a potential to improve udder health in future dairy herds, evaluation should be carried out again once suckled heifers constitute the majority of the herd.*

## Introduction

Farmers consider mastitis and high somatic cell count (SCC) in milk the most important health related issues which cost them money in terms of production loss and rejection of marketable milk. Also in organic dairying, curative treatment with antibiotics is an important treatment of udder infections. In organic dairying the use of antibiotics is bound to strict regulations. Moreover, farmers are stimulated to decrease the use antibiotics.

The search for alternative strategies to improve udder health is important. Wagenaar and Langhout (2007a, 2007b) described how some farmers try to decrease mastitis incidence and high SCC by rearing calves in suckling systems. By exposing calves to farm specific germs in early life, farmers expect the calves to have fewer problems with mastitis and SCC once they become dairy cows. Besides, suckling calves frequently "milk" their mothers, which might have a direct positive effect on udder health.

This paper describes mastitis incidence and milk quality in organic dairy farms which use a suckling system in calf rearing. The collected baseline information will be used for future evaluation of dairy cows raised in suckling systems.

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## Materials and methods

All 350 organic dairy farms in the Netherlands were approached to participate in a study on animal health and general disease resistance. One hundred and thirty farms responded and provided basic data, including data on calf rearing, mastitis incidence and milk quality. They also gave permission to access digital farm data e.g. production and milk quality records and breeding data. Out of 130 respondents, 32 farms indicated they allowed calves to suckle their dams or a nurse cow after birth. Out of these 32 farms only 11 qualified for the “suckling” group. Qualifying farms applied a suckling system which allowed calves to suckle for 75 to 105 days after birth (on average 3 months), started using the suckling system before 2005 and had digital farm data over the period 2004-2006 readily available. From the remaining responding farms, 88 qualified to serve as a reference group (“other”).

A questionnaire was developed to collect additional quantitative and qualitative information from the selected farms, e.g. information on animal health and treatments. The questionnaire was completed by a researcher during a 3 hours farm visit. Up to October 2007 fifty questionnaires (farms) were completed, including all 11 “suckling” farms. Available data and information were processed and analysed.

## Results

No big differences in cow breed exist between the 2 groups of farms. In both groups the main breed is Holstein Frisian (75%), in the “suckling” group followed by Blaarkop (7%) and in the “other” group by MRY (7%). Jersey, Brown Swiss, Flekvieh, Belgian Blue and Montbeliarde are also present, but make up less than 4% of the herd.

In table 1 the average production performance in the period 2004-2006 is presented. There is a clear difference between the milk yield of “suckling” farms (n=11) and “other” farms (n=88). Because some farms use nurse cows in suckling, milk consumed by calves only partly explains the difference.

**Tab. 1: Average lactation information: milk yield, fat and protein, 2004-2006**

Farm type	N cow	Days	Kg Milk	Kg FPCM	% fat	% protein
Suckling	1301	399	6534	6481	4.44	3.53
Other	10989	351	7479	7146	4.36	3.43

In 2006 average clinical mastitis incidence in “suckling” farms was 14% ± 6.3%. On “other” farms this was 20 ± 13.9%. Farmers said they treat animals with clinical mastitis with antibiotics (30%), homeopathy (30%), frequent milking and/or manual milk removal (30%), mint cream (5%) or drying-off the infected quarter (5%).

Cows with a SCC of more than 250,000 cells per ml of milk are considered to have a high SCC. In the period 2004-2006 on average 28.1% (± 8.0%) of the cows on “suckling” farms had a high SCC. For “other” farms this was 22.5% (± 6.4%).

Table 2 presents the average SCC of cows in the last milk recording pre-drying and the first milk recording post-calving for the different SCC classes in the period 2004-2006. The data give an indication how animals from different SCC categories get through the dry period. Table 2 shows that a higher percentage of cows from “suckling” farms are found in the higher SCC classes (>250,000), both before and after the dry period. In the category 250,000-500,000 the dry period has a positive effect on SCC, in the category above 500,000 a negative effect.

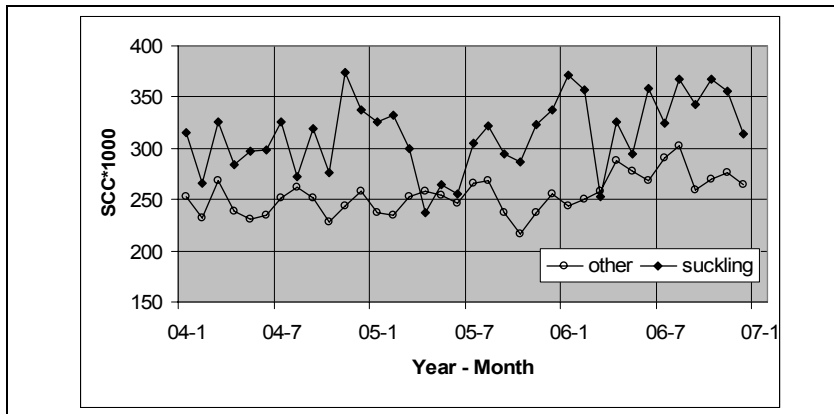
Compared to cows, heifers had lower SCC in first milk recording post-calving:  $84 \pm 12.4\%$  and  $87 \pm 6.3\%$  for “suckling” and “other” respectively. At the “suckling” farms the difference between heifers and cows was larger than at “other” farms.

**Tab. 2: Average percentage of cows per SCC class pre-drying and post-calving in the period 2004-2006**

SCC-class	Period	N cow	<250,000		250,000-500,000		>500,000	
			Dry	Calving	Dry	Calving	Dry	Calving
Suckling		1301	61	66	28	16	11	18
Other		10989	66	75	22	11	12	14

Only 3 out of 11 “suckling” farmers said to treat animals with high SCC before drying-off. In 2006 they on average treated 8% of the cows before drying-off using antibiotics (35%), super mastidol (30%), milk removal (30%) and homeopathy (5%).

Figure 1 shows the average SCC in bulk tank milk of “suckling” and “other” farms. “Suckling” farms on average have a higher bulk tank milk SCC.



**Figure 1: Average SCC in bulk tank milk**

## Discussion

Although attempts to come up with effective alternative treatments improve udder health are plentiful, progress is slow. In a Swiss study (Klocke *et. al.*, 2006) two antibiotics reduction measures, a teat sealer and homeopathic treatment, were not found to effectively treat mastitis. Smolders (2007) described animal health and management on organic farms which do not use antibiotics in the Netherlands. He concluded that, depending on the farmer’s attitude to preventive measures, housing and feeding, many farmers should be able to drastically reduce the use of antibiotics.

Because of the multi-factorial nature of mastitis, it is not easy to identify single factors determining mastitis incidence in a wide range of practical dairy farms. Also in this

study it became clear that farmers use different strategies or different combinations of measures to avoid problems with mastitis and high SCC. While not all elements of a strategy might work, farmers always have 1 or 2 elements that do something towards controlling high SCC. Farmers and veterinarians should focus on these positive elements in further attempts to adjust the strategy to tackle high SCC.

It should be realised that farmers do not use one standard suckling system in calf rearing, but adapt a suckling system to their own need and situation. Compared to the attitude of farmers on "other" farms, the attitude of farmers on "suckling" farms towards animal health and welfare, preventive measures and treatment therapies could also be fundamentally different. But also between "suckling" farmers attitudes differ. This becomes clear if we look at the way "suckling" farmers treat mastitis or high SCC before drying-off. While some farmers are persistent in not using antibiotics, others consequently do use antibiotics. This complicates the evaluation of suckling systems.

## Conclusions

Based on the results presented in this paper it is hard to judge whether suckling systems have a potential to improve udder health in future dairy herds. Udder health and milk quality on "suckling" farms are not as good as on "other" farms. It is however too early for evaluation. Most "suckling" farms started a suckling system between 2004 and 2005 and are now introducing second and third generations of heifers into their herds. The increasing number of cows raised in suckling systems over the next couple of years, will improve the circumstances to evaluate the full potential of suckling systems. While evaluating calf rearing systems, farmers' attitude towards dairy management in general and animal health in particular, should be included.

## Acknowledgments

We would like to thank all the farmers that participated in our study.

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# Dry cow therapy in an organic dairy herd of a milk and a dual purpose breed

Barth, K.<sup>1</sup>

Key words: mastitis, dry cow therapy, monitoring udder health

## Abstract

*According to the EU-Regulation for organic farming breeds chosen for the organic production should have the capacity to adapt to the local conditions to reduce the risk of diseases. The study compared the udder health status and the necessity of application of dry cow therapy (DCT) on cows of a dual purpose and a milk breed (Red and White Holsteins vs. Holstein-Friesian) kept under the same management conditions. Data records of one and a half year and 49 cows were analysed. 132 of 203 udder quarters were treated with an antibiotic at drying off. The treated quarters had significant higher readings for electrical conductivity, California Mastitis Test and the somatic cell count during lactation than the untreated group. Red and White Holstein cows received significantly more often a DCT than Holstein-Friesian cows. Thus, the results of our study do not support the presumption that older breeds are more robust against diseases and therefore fit better into organic dairy farming. Discussions about this topic should consider that the term "local condition" includes not only the climate but also the management conditions of the organic dairy farm.*

## Introduction

Mastitis is still an important disease in organic dairy production and antibiotic dry cow therapy (DCT) is an effective method to avoid intramammary infections during the dry period. However, organic dairy farming aims to reduce the use of drugs, especially allopathic products, and prophylactic antibiotic treatment of animals is not permitted. DCT is limited to cows with symptoms of mastitis: an increase of the somatic cell count (SCC) in the milk or pathogens cultivated in an aseptically gained fore-milk sample. One recommendation given by the EU-Regulation (No. 2092/91) to prevent diseases is to choose adapted breeds for the organic production. In this context, the presumption that older breeds better fit in the organic system than the high yielding breeds used in conventional farms is widely spread. This study compared DCT applied to a dual purpose and a milk breed.

## Materials and methods

The investigation was carried out at the experimental organic farm of the Institute of Organic Farming, Trenthorst. The dairy herd contains cows of two breeds: Holstein-Friesian (HF) and the dual purposed type of Red and White Holsteins (RW). The breeds are kept separate in identical cubicle housing systems and under the same management conditions. In 2006 the mean milk yield per cow and year was 5,596 kg and 4,937 kg for the HF and the RW, respectively.

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Cytobacteriological analyses of quarter foremilk samples were carried out according to the standards of DVG (2000) during the first ten days after calving and three times per year. Electrical conductivity (EC) of quarter foremilk prior to milk ejection was measured monthly by means of a handheld conductometer. After EC measurement the California Mastitis Test (CMT) was carried out using the same sample. All data relevant for the health status of the udder quarters of each cow were documented and were used for the decision whether a cow would receive a DCT or not. Cows with at least one positive result of all cyto-bacteriological analyses and/ or high somatic cell counts (SCC > 100,000 cells per ml) recorded for at least one quarter were selected for DCT. In addition, cows with a high variability of EC readings were treated, too. Animals were dried off 45 days minimum prior to the expected date of calving.

Orbenin-DC (Cloxacillin, Pfizer AG) was used for the DCT. Each quarter of the cow was treated regardless of the health status of that particular quarter. Cows which fulfilled the requirements of drying off without treatment received no other treatments. Milking was cut off at the calculated day for drying off. During the dry period the cows were kept within the herd, moved two times per day through the milking parlour but no teat dipping was carried out.

All cases of dry off between January 2006 and July 2007 were included in the statistical analysis which was carried out using SPSS 12.0 for Windows®. The means of EC, CMT results and SCC (common logarithm) for the lactation were calculated. The results of the cyto-bacteriological analysis after calving were evaluated following the standards of DVG.

## Results

Data of 49 cows (54 lactations) could be included in the analyses. Five cows were part of the study twice. Most of the cows were in their second and third lactation (table 1) and on average at the 372<sup>nd</sup> and 331<sup>st</sup> day of lactation (DIM) HF and RW, respectively. The dry period lasted 55 and 67 days on average for the HF and the RW, respectively.

**Tab. 1: Frequency of the lactation numbers depending on the breed**

	Number of lactation			
	1	2	3	4
Holstein-Friesian (n = 28)	4	11	14	2
Red and White (n = 21)	2	14	7	-
Total (n = 49)	6	25	21	2

132 quarters were treated with the antibiotic. RW cows were significantly more often treated than cows of the HF breed ( $\chi^2 = 4.273$ ,  $p = 0.05$ , table 2). The RW cows had higher EC readings and were higher scored at the CMT. There were no significant differences of SCC between the breeds. As expected, the lactation means of EC, CMT and SCC were different for the treated and untreated animals (table 3).

**Tab. 2: Frequency of udder quarters with or without DCT**

	without treatment	DCT	Total
Holstein-Friesian	47 (41.6 %)	66 (58.4 %)	113 (100.0 %)
Red and White	24 (26.7 %)	66 (73.3 %)	90 (100.0 %)
Total	71 (35.0 %)	132 (65.0 %)	203 (100.0 %)



**Tab. 3: LSM of data used for the decision on application of DCT**

	DCT	Holstein Friesian	Red and White
EC [mS cm <sup>-1</sup> ]	without	6.0 ± 0.1 <sup>a,A</sup>	6.3 ± 0.2 <sup>b,A</sup>
	with	6.4 ± 0.1 <sup>a,B</sup>	6.8 ± 0.1 <sup>b,B</sup>
CMT Score	without	0.2 ± 0.1 <sup>a,A</sup>	0.6 ± 0.2 <sup>b,A</sup>
	with	0.9 ± 0.1 <sup>a,B</sup>	1.2 ± 0.1 <sup>b,B</sup>
lgSCC	without	4.41 ± 0.08 <sup>A</sup>	4.56 ± 0.11 <sup>A</sup>
	with	4.86 ± 0.06 <sup>B</sup>	5.04 ± 0.06 <sup>B</sup>

<sup>a, b</sup> significant differences (p=0.05) within the row; <sup>A, B</sup> significant differences (p< 0.05) within the column

Pathogens were revealed at least once during the lactation in milk samples of 67 quarters, these are 33 % of all quarters. In 49 cases the infection was caused by coagulase-negative staphylococci (CNS). *Staphylococcus aureus* was found in 8 quarters. After calving in 163 samples (80 %) no pathogen could be detected. In 10 quarter samples *S. aureus* was present, 6 of these quarters had no infection during the previous lactation. CNS were detected in 18 of the 40 positive tested samples. Streptococci were of little importance in this herd.

Although the number of normal secreting quarters was reduced after the calving in the non-treated group (table 4), the calculation of Odds ratio revealed no effect on the incidence of suspicious quarters due to the omission of DCT. The antibiotic was successfully applied in the RW-herd where 32 of 47 quarters showed a normal secretion after calving.

**Tab. 4: Frequencies of quarters with normal secretion\* and quarters suspicious for mastitis or latent infection\*\* before and after the dry period**

			previous lactation			
			Holstein Friesian		Red and White	
			normal	suspicious	normal	suspicious
after calving	without DCT	normal	24	3	14	5
		suspicious	15	5	4	1
	with DCT	normal	25	13	13	32
		suspicious	12	16	6	15

\*No pathogen detected and SCC ≤ 100,000 cells per ml

\*\*Pathogen detected and/ or SCC > 100,000 cells per ml

## Discussion

Although a rating of breeds should base on a broader data set, the comparison of breeds under the same management and environmental conditions offer the opportunity to keep the influence of these conditions as equal as possible. Thus, our results can only extrapolated to animals kept under the conditions of a relative intensive organic dairy production: animals had no access to the pasture, but to a free-range area located between the feeding and the lying area.

The observed differences of the mean EC and CMT readings during lactation might be explained by the shape of the udders. The udders of HF cows had a better form than that of RW cows. In case of machine milking this is an advantage, which should not be underestimated. The risk of milk droplet impacts caused by vacuum fluctuations during milking increases with uneven udder halves or quarters, and vacuum fluctuations or sudden air admission lead to a higher risk of intramammary infections (Baxter et al. 1992). In addition, twisted milking units may lead to tissue damages and increasing EC readings during lactation (Barth, 2005).

The increased number of suspicious quarters after calving in the non-treated group points to new infections which occurred during the dry period or a few days *post partum*. However, some of the healthy quarters treated with the antibiotic showed symptoms of subclinical mastitis or a latent infection after calving, too. Thus, in this study, DCT did not protect healthy quarters against an infection if the evaluation is based on udder quarters. Berry et al. (2003) investigated the interdependence of quarter and recommended the application of dry-cow strategies at the cow and not at the quarter level to limit the risk of healthy quarters of a cow with mastitis to become infected.

A second reason that DCT failed in the HF group, might be the great number of quarters with unspecific mastitis. The use of another strategy such as the application of an internal teat sealant might offer a solution.

### Conclusions

The presumption that older breeds are more robust against diseases and therefore fit better into organic dairy farming can not supported by the results of this study. More research on this field is strongly recommended. The capacity of animals to adapt to local conditions should be discussed not only from the point of the origin of the breed but should also take into account the management conditions and accordingly the type of organic farm where the animals are kept.

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## Incidence of anthelmintic resistance in cattle farms in Northern Germany – first results

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Key words: animal health, cattle, animal husbandry and breeding, gastro-intestinal nematodes

### Abstract

*Anthelmintic resistance (AR) is an increasing problem worldwide especially for small ruminants and it is also rising in cattle. To maintain the efficacy of anthelmintics is an important objective. The current project aims at the investigation of the current efficacy of macrocyclic lactone anthelmintics for strongylid nematodes in first season grazing (FSG) calves in Northern Germany. On 8 participating farms in Northern Germany faecal egg count reduction tests (FECRT) with ivermectin (IVM) were performed. On 3 farms the efficacy of IVM was found to be  $\leq 90\%$  and on only 4 farms it was  $> 95\%$  at 14 days post treatment (d.p.t.). Only 2 farms showed a reduction  $\geq 95\%$  at 21 d.p.t.. This survey reveals a rising problem of AR. The problem of drug resistance places the welfare of animals at risk. In organic farming, without a preventive treatment, livestock may harbour high worm counts. Therefore it is necessary to maintain powerful anthelmintic drugs to guarantee the welfare of animals that need salvage treatment. To investigate the AR problem in cattle more surveys with different anthelmintic drug classes are urgently needed.*

### Introduction

Animal husbandry on pasture requires a concept to avoid gastro-intestinal parasites. The main gastro-intestinal nematodes (GIN) in Northern Germany for FSG calves are the strongylids *Cooperia oncophora* and *Ostertagia ostertagi*. Depending on the level of infection GIN may cause parasitic gastroenteritis with apparent disease symptoms like diarrhoea, reduced feeding and significant production losses. Although optimized grazing management systems can contribute to lower pasture infectivity, the use of anthelmintics is still essential to control gastro-intestinal parasites in cattle.

AR in cattle has been reported mainly in the southern hemisphere. Reports showed resistance against benzimidazoles (Mejia et. al 2003) and macrocyclic lactones (Anziani et. al 2001, Waghorn et al. 2007). Until now in Europe AR was only described for IVM in England (Coles et. al 2001).

The object of this survey is to evaluate the efficacy of IVM against GIN in cattle in Northern Germany.

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## Materials and methods

To evaluate the situation of IVM resistance FECRTs (Coles et al. 2006) were performed on 8 farms in Northern Germany in 2006. The participating farms had at least 24 FSG calves on pasture. The calves were naturally infected by grazing on pasture. During grazing season pooled faecal samples were collected in order to find the point of treatment. Once sufficient nematode egg counts were detected, the animals were treated. This day was called day 0. On 6 farms the mean EPG at day 0 was above 100, the other farms were included upon request of the farmers. The animals were treated by subcutaneous injection of 0.2 µg IVM (Merial) per kg body weight. The body weight was estimated by measurement of girth tape (chest circumference). Individual rectal faecal samples were collected from each animal prior to treatment.

A modified McMaster technique (Wetzel 1931 and Schmidt 1971) was used to obtain the faecal egg count, measured as eggs per gram fresh faeces (EPG). The animals with the highest EPG counts were included in the trial. For the FECRT about 10 - 15 calves per farm were tested after treatment. On day 14 and day 21 after treatment individual rectal faecal re-samples were taken and the EPG was determined. The reduction was calculated for this group.

## Results

The results of the FECRT using IVM at day 0 of FSG calves in the year 2006 are shown in table 1.

**Tab. 1: FECRT data** (the data were calculated by the program „Bootstreat“, from Jacques Cabaret as part of the EU-Project PARASOL, in preparation)

Farm	No. of calves on farm	No. of test-calves	EPG of test-calves			Faecal Egg Count Reduction in % (IcI) in test-calves	
			day 0	day 14	day 21		
No.	n	No.	arith. mean	min	max		
1	34	11	185	100	533	96 (91-100)	95 (88-98)
2	34	15	950	600	2000	90 ( 83-98)	84 (72- 95)
3	30	10	137	67	180	97 (90- 100)	94 (88-100)
5	39	10	40	0	100	87 (68- 99)	81 (66-94)
6	25	10	193	100	500	98 (96-100)	94 (88-100)
7	33	10	146	100	266	91 (82-98)	93 (83-99)
8	35	10	58	33	100	69 (34-82)	35 (-18-66)
9	24	16	107	67	150	100	96 (89-100)

Further statistic analysis will be published in association with the data analysis of the EU- Project PARASOL.

On day 14 post treatment at three farms the reductions were only 90% or less. On 4 farms the reduction on day 14 was below 95%. This is a sign of reduced efficacy of IVM on these farms.

## Discussion

According to the guidelines of the World Association for the Advancement of Veterinary Parasitology (Coles et al. 1992) AR is present, if FECRT results are < 95% and the 95% confidence level is < 90%. The present data suspect the onset of IVM-resistant gastro-intestinal nematodes in Northern Germany. The results confirm with the notice that the importance of AR has increased dramatically in nematodes (Coles et al. 2006). Since no new drug classes can be expected to be commercialized in due course, it is important to maintain the efficacy of the current anthelmintics.

To postpone the development and spread of resistance some options are pointed out (Coles et al. 2001, Koopmann et al. 2007). A possible approach could be Targeted selective treatment (TST) strategies. TST means that only a part of the animal group is treated with anthelmintics, contrary to the current manner to treat the whole group. Through TST the use of anthelmintics can be reduced and selection pressure on susceptible endoparasite isolates decreases.

## Conclusions

The results of this survey indicate that resistance against macrocyclic lactone type drugs in cattle may occur more often in the northern hemisphere than currently expected. Further surveys involving larger sets of farms and compounds from different anthelmintic drug classes are urgently needed.

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## Effects of red clover and maize silages on the carriage of gut pathogens in steers

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Key words: Red clover silage, maize silage, pathogens, cattle, faecal shedding

### Abstract

An experiment investigated the effects of increasing proportions of red clover (RC) (*Trifolium pratense*) silage relative to maize (M) (*Zea mays*) silage in the diet of steers on the pathogenic microflora of gut digesta and faecal samples. The experiment consisted of 3 periods of 21 d. Eight Hereford x Friesian steers were used, with 4 maintained on a 90 % maize: 10 % red clover (90M:10RC) silage diet throughout and 4 receiving 90M:10RC silage in period 1 then 50M:50RC, 10M:90RC in periods 2-3, respectively. Populations of *Listeria monocytogenes* and *E. coli* were enumerated at time points in each period. *L. monocytogenes* data showed disparity between periods. In the latter part of period 2, *L. monocytogenes* populations were higher in the rumen, duodenum and faeces of steers offered 50M:50RC but in period 3, *L. monocytogenes* populations were lower in the faeces of steers fed the higher level of red clover silage ( $P < 0.05$ ). Despite negligible *E. coli* levels in the diets, populations of *E. coli*, including *E. coli* 0157, were detected in the steers throughout the trial. Diet effects on *E. coli* levels were not apparent at any of the three sites examined. Further research is needed to elucidate the effects of red clover and dietary pathogen load on gut and faecal pathogen populations.

### Introduction

In agricultural systems, the use of manure and slurry may result in the contamination of land and water courses with pathogens, such as *Escherichia coli* and *Listeria*. These pathogens may then be transferred from contaminated forage and water to livestock, animal products and, thus, to humans. *Listeria monocytogenes* is the agent of listeriosis, a serious infection caused by eating contaminated food. This pathogen is a main contaminant of forage which can multiply during ensiling; therefore, silage feeding is a common route of infection for farm animals. Listeriosis is being recognized as an important public health problem as, in humans, the overt form has a mortality of greater than 25%. While infected animals rarely directly cause human infections, animal-derived food products (e.g., raw milk) and raw foods of plant origin, contaminated by manure from infected animals, represent links between human and ruminant infections (Nightingale *et al.*, 2004). Research has found that up to 50% of faecal samples collected from ruminants with no clinical symptoms of listeriosis may contain *L. monocytogenes* (Ho *et al.*, 2007).

Ruminants may be described as reservoirs of verocytotoxin producing *E. coli*, food-borne pathogens implicated in several outbreaks of disease in humans (US FDA, 1998). The commonest *E. coli* responsible for human disease in Europe is *E. coli*

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0157. Similar to *L. monocytogenes* infections, studies have shown that ruminants can harbour *E. coli* without any overt clinical signs (Kudva *et al.*, 1996). In humans, infections can result from the consumption of contaminated beef and milk products, drinking and bathing water. In most instances, the source of contamination was faecal material (Phillips, 1999).

Studies have shown that dietary factors can influence pathogen shedding, with some evidence that red clover can reduce pathogen growth, possibly due to the action of secondary plant metabolites such as formononetin (Duncan *et al.*, 2000). The aim of the current study was to determine the effects of increasing the proportion of red clover silage offered in the diet of steers when compared with maize silage on the subsequent shedding of *L. monocytogenes* and *E. coli* pathogens.

## Materials and methods

Eight Hereford x Friesian steers (600 kg approx. weight) prepared with rumen and duodenal cannulae were offered a mix of a red clover (*Trifolium pratense*) silage (RC) and a maize (*Zea mays*) silage (M). The experiment was a continuous design consisting of 3 periods of 21 days. Four animals received 90M:10RC silage in period 1 then 50M:50RC and 10M:90RC in periods 2 and 3, respectively. The remaining four steers were maintained on the 90M:10RC diet throughout. Due to the simple nature of the diets, silages were switched with immediate effect at the end of each period, with no gradual changeover. Steers were housed individually and received their food in two equal feeds at 09.00 and 16.00. Refusals were removed before early morning feed and daily dry matter (DM) intakes were recorded. Samples of diets offered were accumulated weekly. Samples of rumen and duodenal digesta and faeces were collected prior to the morning feed on day 0, 1, 2, 4, 8, 16 and 21. All samples were incubated on agar plates following a series of dilutions to  $10^{-3}$  in Ringers solution (Oxoid Ltd., Basingstoke, UK) and enumerated for *L. monocytogenes* using Listeria Isolation Medium (LAB M Limited, Bury, UK) and *E. coli* and *E. coli* O157 using Sorbitol McConkey with B.C.I.G. Agar (Oxoid Ltd., Basingstoke, UK). Data for one steer on the 90M:10RC treatment were excluded on account of antibiotic treatment in periods 2 and 3. Within period mean counts on days 16 and 21 were compared between the two groups of steers by one-way analysis of variance using levels in the preceding period as a covariate where appropriate.

## Results

All diets showed *L. monocytogenes* counts in excess of  $6.2 \times 10^4$  colony forming units (CFU) /g DM. *L. monocytogenes* counts for 90M:10RC, 50M:50RC silages were similar and 10M:90RC counts tended to be lower by a factor of 10. Taking DM intake into account, this resulted in steers offered 10M:90RC silage having a lower *L. monocytogenes* challenge compared with steers offered a 90M:10RC silage diet in period 3. *L. monocytogenes* populations in the rumen and faeces are presented in Figure 1. Trends in *L. monocytogenes* levels in the duodenum were broadly similar to those in faeces although less pronounced. Results showed disparity between periods. *L. monocytogenes* populations were higher in the rumen, duodenum and faeces of steers fed the higher proportion of red clover compared with maize silage in Period 2 ( $P < 0.05$ ). In Period 3, *L. monocytogenes* populations were lower in the duodenum and faeces ( $P < 0.05$ ) of steers fed the highest level of red clover. However, faecal shedding remained in excess of  $10^5$  CFU/g DM.

Silage contamination with *E. coli* pathogens was negligible. Only the 10M:90RC diet contained any *E. coli*, with counts of 2 and 4 CFU/g DM in the final two weeks of the experiment. *E. coli* 0157 was not detected in any of the treatment silages. Populations of *E. coli* pathogens, including *E. coli* 0157, were detected in the rumen, duodenum and faeces of steers within this experiment. However, data of *E. coli* populations were highly variable and no significant effects of diet were apparent.

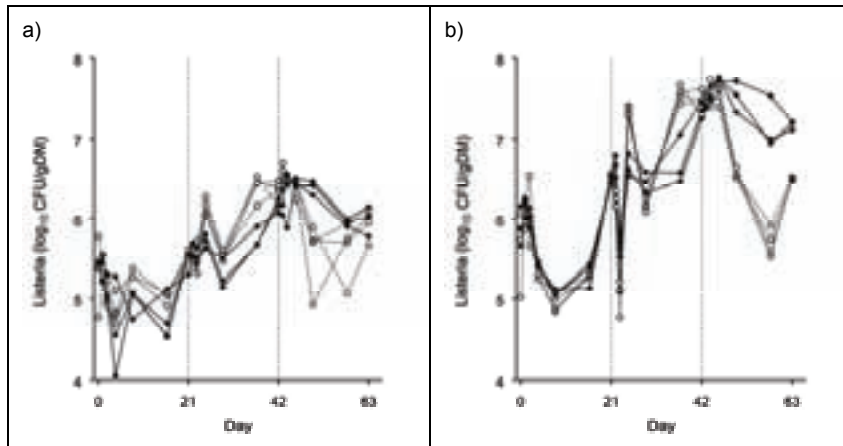


Figure 1: Populations of *Listeria* in a) rumen digesta and b) faeces from steers fed increasing proportions of red clover silage (denoted by open circles with broken lines) compared with steers receiving 90%maize:10% red clover silage. Vertical broken lines denote transitions between periods.

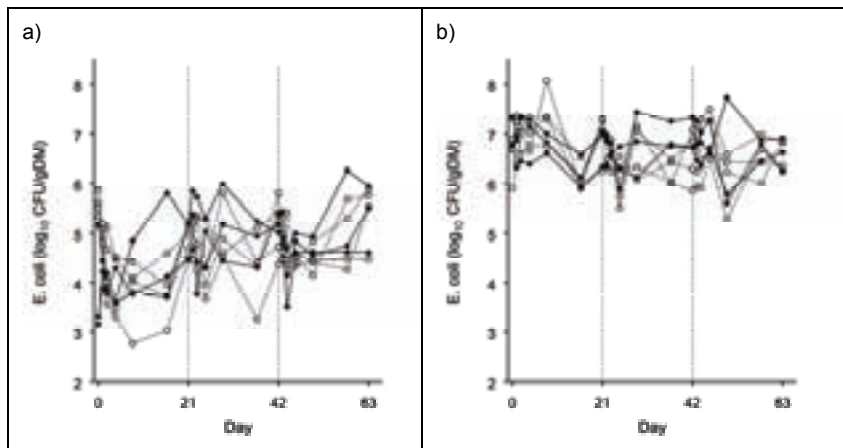


Figure 2: Populations of *E. coli* in a) rumen digesta and b) faeces in steers fed increasing proportions of red clover silage (denoted by open circles with broken lines) compared with steers receiving 90%maize:10% red clover silage.



## Discussion

The results are in agreement with other studies showing that there are high levels of variation in the day-to-day shedding of *L. monocytogenes* and *E. coli* within the same herd (Ho *et al.*, 2007). It appears that with respect to *L. monocytogenes*, the dietary pathogen load also had an impact on the shedding of this pathogen, as the low populations in the 10M:90RC silage resulted in fewer *L. monocytogenes* in the faeces on steers offered this diet. Overall, the transient nature of these infections may help to explain the disparity found in the results between different periods for the *L. monocytogenes* populations and the high variability observed for the *E. coli* populations with regards to the effects of diet on pathogen population numbers.

## Conclusions

There are no clear indications from the findings in this study as to the dietary effects of red clover silage on the shedding of *L. monocytogenes* and *E. coli* from ruminant animals. Further studies are needed to determine the effects of red clover on *L. monocytogenes* and *E. coli* contamination during the ensiling process and to determine the dose-response effect of dietary pathogen load on pathogen shedding when different proportions of red clover are consumed.

## Acknowledgments

The authors would like to thank Martin Leyland and Naomi Ellis at IGER Trawscoed for the care of the animals throughout these experiments. This work was carried out with funding from the EU framework VI QLIF project and the Department for Environment, Food and Rural Affairs, UK.

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# Experiences of Veterinarians Using Acupuncture on Farm Animals

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Key words: Acupuncture, farm animals, veterinarians, Germany

## Abstract

*The aim of this study was to collect information about experiences of veterinarians with acupuncture. 27 German veterinarians who regularly used acupuncture on farm animals were interviewed. Most vets had received special training in acupuncture. This treatment method was most often used on horses, followed by cattle (mainly dairy cows). It was especially applied against common diseases which could easily be cured. Treatment costs were higher for horses than for cattle. There has been an increased demand for acupuncture mainly for horses.*

## Introduction

Acupuncture is a part of Traditional Chinese Medicine (TCM) which looks back at a 5,000 year old history. It is used to stimulate and strengthen the body's own healing mechanisms as well as to remove blockages or imbalances in the natural energy flow. This is done by sticking needles into so-called 'acupuncture points' along the body's meridians.

In the Western world veterinarians started using acupuncture in the 1970s. They transmitted the concept of energy flow in meridians of human acupuncture to animals. This concept has never existed in the Traditional Chinese Veterinary Medicine.

With regard to organic agriculture, acupuncture could be an interesting issue. The IFOAM Basic Standards state that surgeons should use natural medicines and treatments, including homeopathy, Ayurvedic medicine and acupuncture whenever appropriate (no. 5.7). However, EU-regulations concerning organic agriculture do not mention acupuncture in particular. Hörning et al. (2004) and Rahmann et al. (2004) found that relatively few organic farmers in Germany make use of natural medicines. Leon et al. (2006) asked 358 organic farmers in this country if they used alternative treatments and medicine on their farm animals. More than 70% said they used homeopathy (mainly against mastitis) and about 40% used phytotherapy. Approx. 50% of farmers used homeopathy against 60% - 100% of all diseases. Phytotherapy was used by 60% of farmers against a maximum of only 20% of diseases. Information about acupuncture was not provided. The aim of this study was to collect information regarding experiences with using acupuncture on farm animals.

## Materials and methods

Addresses of veterinarians were chosen from a list published by the *Gesellschaft für Ganzheitliche Tiermedizin* (Society for Holistic Veterinary Medicine). 80 of the 194 vets listed carried an additional title called 'veterinary acupuncture' (special training).

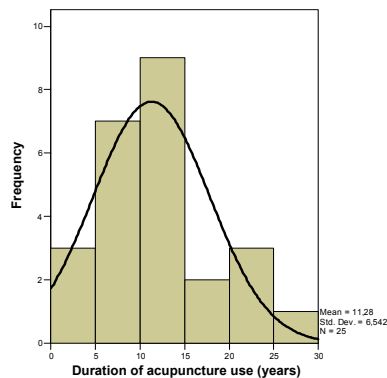
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A total of 27 veterinarians who had treated farm animals with acupuncture needles were interviewed. More vets could either not be contacted (n = 71), they were not interested in participating (6) or used acupuncture only on pets (90). Telephone interviews were carried out in May and June 2007 (by Benjamin Brandt, BA thesis).

## Results and discussion

The interviewed veterinarians lived in 8 of the 16 federal German states. In Germany vets can enrol for a variety of courses in acupuncture. 77.8% of veterinarians had completed special training classes in veterinary acupuncture offered by the *Akademie für tierärztliche Fortbildung (ATF)*. Another 11.1% of them had studied acupuncture at the International Veterinary Acupuncture Society (IVAS). Max. 1 to 2 vets had chosen other educational institutions of lesser importance for their training. The training had lasted between 1 to 6 years. The veterinarians had on average 11.3 years of experience with using acupuncture (range 3 years – 30 years, s = 6.54) (fig. 1).



**Figure 1: Experience with acupuncture (years)**

88.9% of the veterinarians used acupuncture on horses, 70.4% on cattle, 22.2% on pigs, 18.5% on sheep and 3.7% on poultry. Acupuncture was mainly used on animals with a high individual economic value, e.g. dairy cows. 70.4% of vets treated horses most often, followed by cattle at 18.5% (3.7% of vets: half cattle and half horses). Eight veterinarians stated that they mainly used acupuncture on conventional farms. Only one vet used this treatment more often on organic farms. Six other veterinarians said that about 25% of the farms to which they were called for acupuncture treatments (1% – 75%) were organic ones. 12 veterinarians could not answer the question. Obviously, most veterinarians did not specialize in the veterinary care for organic farms. This could be explained by the fact that most organic farmers seek the help of regional veterinarians who have no experience with natural medicine. However, another reason could also be that organic farmers themselves were not familiar with acupuncture treatment and therefore were not asking for this special method, either.

Vets were asked about diseases which they frequently treated with acupuncture (tab. 1). Acupuncture was used against many common health disorders, depending on the species.

Vets were asked about the success of acupuncture treatments with regard to different diseases. They either gave purely qualitative answers ("good", "very good", etc.) or considered the therapeutic success by means of percentage of treatments. The second number in table 1 includes statements for 'good', 'very good' or treatment success of 50% or better (most estimates were at least 80%). Veterinarians most often used acupuncture against those diseases which responded well to this treatment method and showed high rates of recovery. Some vets successfully combined acupuncture treatments with other alternative methods such as homeopathy and phytotherapy. Vets were asked about average treatment costs. Rates for German vets stipulate € 12.78 per acupuncture treatment. However, costs quoted by the vets differed between species. Most treatment costs for horses averaged € 70 – € 90 and for cattle € 25 – € 50. For pigs and sheep there were only 1 – 2 statements (fig. 2).

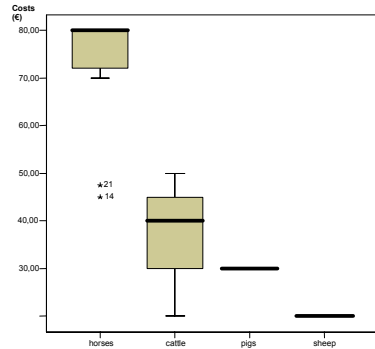
**Tab. 1: Number of diseases frequently treated with acupuncture (1<sup>st</sup> number) and its therapeutic success (2<sup>nd</sup> number)**

	Horses	Cattle	Pigs	Sheep	Poultry
Lameness	17 / 16	1 / 1			
Locomotor disorders	10 / 10				
Laminitis	4 / 4				
Back problems (Azoturia etc.)	11 / 10				
Reproductive disorders		6 / 2		2 / 1	
Obstetrics		14 / 13	4 / 2	4 / 3	
Prolapse of the uterus		5 / 4			
Mastitis		6 / 5		3 / 3	
Respiratory disorders	7 / 6				
Coughing / chronic coughing	14 / 11				
Pneumonia	6 / 5				
Colic	6 / 5				
Skin diseases	6 / 5				
Metabolic disorders	5 / 3	7 / 7			
Inappetence		2 / 2		2 / 2	
Displacement abomasum		1 / 1		0 / 1	
Back muscle necrosis			1 / 1		
Allergies	5 / 5				
Infectious diseases					1 / 1

59.3% of vets have observed an increase in the demand for acupuncture treatments during the last two years. The percentage was higher for vets who only treated horses with acupuncture needles. This could perhaps be related to a growing interest in leisure riding.

## Conclusions

Acupuncture treatments on farm animals are not very common in Germany. With regard to horses acupuncture is most often used on riding horses, as far as cattle is concerned it is most often used on dairy cows.



**Figure 2: Costs for acupuncture application (€ per treatment)**

One reason for this could be high treatment costs. Acupuncture is used against many common health disorders. Not surprisingly, vets most often used acupuncture against diseases which responded well to this treatment and exhibited high recovery rates. Information about diseases with lower recovery rates are not available. Because only those vets who frequently perform acupuncture treatments were included in this study it cannot be concluded that acupuncture in general works well. Further research is needed in order to compare acupuncture to other therapeutic methods.

## Acknowledgments

We are grateful to and would like to thank all veterinarians who were willing to participate in this study.

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# Growth performance of broilers fed with different strains of probiotics

Tarun, M.<sup>1</sup>

Key words: Broilers, probiotics

## Abstract

*Generally, this study aimed to determine the effects of different strains of probiotics on the growth performance of broilers. Specifically, to determine the effects of feeding different strains of probiotics on the growth performance of broiler and utilizing broiler chicks. An all mash ration with 21% CP was formulated. Completely Randomized Design (CRD) was used and Least Significant Differences (LSD) when comparing treatments; T<sub>1</sub>-Control (0 Probiotics), T<sub>2</sub>- 2 kg Lactobacillus sp./MT of feeds, T<sub>3</sub>- 2 kg Bacillus sp./MT of feeds, and T<sub>4</sub>-2 kg Pediococcus sp./MT of feeds. Statistical analysis revealed highly significant differences among treatments on the final body weight of broilers given diets with different strains of probiotics. Based from the result of the study, the inclusion of 2 kg Lactobacillus sp./MT of feeds in the diet of broilers had improved the growth of the experimental birds in terms of body weight, gain in weight, feed conversion and its economic returns due to the lactic acid content of Lactobacillus sp. The result obtained from this study suggest that inclusion of 2 kg of Lactobacillus sp. per metric tons of feeds can safely be used in the diet of broilers to produce an organically grown chicken for table meat as it produced the highest gain in weight, feed conversion and return above feed cost.*

## Introduction

Previous studies revealed significant performance of animals when probiotics was given instead of antibiotics. Probiotics is a live or dead non-pathogenic bacteria which could be used as feed additives to the diet of animals. These are bacteria that can compete with other bacteria to enhance and stabilize beneficial intestinal flora. Although, recently a study on the utilization of probiotics in Kabir chicken was undertaken, a follow-up study has yet to be conducted in order to validate the results made using the recommended levels. This study attempts to find out the effects of different strains of probiotics on the growth performance of broilers in terms of body weight, body weight gain, feed consumption, feed efficiency, mortality, dressing percentage and the economy of using probiotics, hence this study.

## Materials and methods

Procurement of Stock. One hundred twenty straight-run day old Broiler chicks were purchased from a reputable dealer at Cauayan City, Isabela. The chicks were inspected for any deformities and health problems such as lameness, crooked legs and beaks, pasty vents and unhealed navels.

Formulation of Experimental Diets. All mash rations containing 21% Crude Protein was formulated for the study. The experimental diets were formulated using the

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following ingredients: ground yellow corn, soybean meal, fish meal, molasses, limestone, copra meal, salt, vitamin/ mineral premix and strains of probiotics. The composition, calculated nutrient contents, nutrient analysis of the different experimental diets are shown in Table 1 and 2.

**Tab. 1: Composition and Calculated Nutrient Contents of Broiler Diet Containing Different Strains of Probiotics (kg.).**

INGREDIENTS	T <sub>1</sub> (Control)	T <sub>2</sub> ( <i>Lactobacillus</i> sp.)	T <sub>3</sub> ( <i>Bacillus</i> sp.)	T <sub>4</sub> ( <i>Pediococcus</i> sp.)
Yellow corn (ground)	53.65	47.49	47.49	47.49
Soybean Meal	48.46	24.56	24.56	24.56
Rice Bran D <sub>1</sub>	10.00	10.00	10.00	10.00
Copra Meal	8.00	8.00	8.00	8.00
Fish Meal	6.00	6.00	6.00	6.00
Molasses	2.00	2.00	2.00	2.00
Lactobacillus sp.	-	0.20	0.20	0.20
Bacillus sp.	-	-	-	-
Pediococcus sp.	-	-	-	-
Limestone	1.00	1.0	1.0	1.0
Salt	0.25	0.25	0.25	0.25
Vit./Min. Premix	0.50	0.50	0.50	0.50
<b>TOTAL</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>
<b>Calculated Nutrients</b>				
Crude Protein (%)	21.00	21.00	21.00	21.00
Metabolizable Energy (Kcal/kg.)	2,793.00	2,801.00	2,801.00	2,801.00
Calcium (%)	1.01	1.02	1.02	1.02
Phosphorus (%)	0.35	0.34	0.34	0.34

**Tab. 2: Nutrient Analysis of Broiler Diet Containing Different Strains of Probiotics\***

Nutrient	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>
Crude Protein (%)	17.72	18.57	18.80	19.11
Calcium (%)	1.25	1.05	0.96	1.09
Phosphorus (%)	0.67	0.75	0.65	0.67

\*Based from the analysis conducted at the Animal Nutrition Analytical Services Laboratory, UPLB, College of Agriculture, College, Laguna.

**Experimental Design, Treatments and Distribution of Birds.** The Completely Randomized Design (CRD) was used in the study. The chicks were randomly distributed to the different treatments and replicated thrice with ten (10) birds per treatment. For comparison of treatment means, Least Significant Differences (LSD) was used. There were four (4) treatments used as follows: T<sub>1</sub> - Control (0 Probiotics), T<sub>2</sub> - 2 kg Lactobacillus sp./ MT of feeds, T<sub>3</sub> - 2 kg Bacillus sp. / MT of feeds, T<sub>4</sub> - 2 kg Pediococcus sp./MT of feeds.

**Management/Experimental Procedures**

**Brooding.** Identical care and management was provided to all birds in the different treatments throughout the duration of the study.

*Feeding.* The birds in the different treatments were fed with their corresponding rations throughout the duration of the study. Ad libitum feeding was practiced. Clean fresh water was provided as drinking water to the birds throughout the study.

*Data Collection.* The following data were collected during the experimental period.

*Body weigh, feed consumption, feed conversion ratio, dressed weight, mortality and livability, other observations and economic analysis.*

## Results and discussion

Result of the study was summarized as follows

1. The initial weights of the birds before the feeding trial were all the same.
2. Birds fed with *Lactobacillus sp.* consistently obtained the highest final weight, gain in weight, feed conversion ratio and return above feed cost compared to other treatments and birds fed without probiotics.
3. The inclusion of the different strains of probiotics greatly enhanced the feed conversion ratio of the birds as compared to birds fed without probiotics.
4. Probiotics did not affect any significant differences on the dressing percentages and liver weight of the experimental birds.

**Tab. 3: Average Initial, Weekly and Final Body weight of Broilers Fed Diets Containing Different Strains of Probiotics (g)**

TREATMENTS	Average Initial and Weekly Weight (g)					
	Initial	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	Final
T <sub>1</sub> (O Probiotics)	54.25	190.00 <sub>b</sub>	433.33 <sub>c</sub>	808.33 <sub>c</sub>	1083.33 <sub>b</sub>	1300.00 <sub>c</sub>
T <sub>2</sub> (Lactobacillus sp)	59.66	223.33 <sub>ab</sub>	566.67 <sub>a</sub>	916.67 <sub>a</sub>	1358.33 <sub>a</sub>	1625.00 <sub>a</sub>
T <sub>3</sub> ( Bacillus sp	59.25	211.33 <sub>ab</sub>	523.33 <sub>ab</sub>	883.33 <sub>ab</sub>	1300.00 <sub>a</sub>	1516.67 <sub>b</sub>
T <sub>4</sub> (Pediococcus sp.)	58.98	240.00 <sub>a</sub>	503.33 <sub>b</sub>	865.00 <sub>b</sub>	1233.33 <sub>ab</sub>	1358.33 <sub>c</sub>
C.V. (%)	5.5	10.5	5.3	2.2	7.0	3.5
LSD (%)						
.05	6.02	42.72	50.99	35.54	164.75	96.09
.01			74.17	51.70	239.67	139.78
	ns	ns	**	**	*	**



**Tab. 4: Average gain in body weight (g), feed consumption (g) and fFeed conversion (%) of broilers fed with diets containing different strains of probiotics (g)**

TREATMENTS	Feed Consumption	Gain in Body Weight	Feed Conversion	Dressing Percentage		Liver Wt
				W/ Giblet	W/o Giblet	
T <sub>1</sub> (O Probiotics)	3052.00	1245.75 <sup>c</sup>	2.45 <sup>b</sup>	75.86	70.09	55.33
T <sub>2</sub> (Lactobacillus sp)	3073.33	1565.64 <sup>a</sup>	1.96 <sup>a</sup>	74.89	61.04	55.00
T <sub>3</sub> ( Bacillus sp)	3062.67	1457.42 <sup>b</sup>	2.10 <sup>a</sup>	78.96	65.90	54.00
T <sub>4</sub> (Pediococcus sp.)	3039.00	1299.35 <sup>c</sup>	2.34 <sup>b</sup>	87.74	69.89	55.33
C.V. (%)	0.8	3.6	3.8	10.4	9.7	1.5
LSD (%)						
.05	43.54	93.80	0.16			
.01	63.34	136.45	0.23			
	ns	**	**	ns	ns	ns

### Conclusions

Based from the result of the study, the inclusion of 2 kg *Lactobacillus sp.* /MT of feeds in the diet of broilers had improved the growth of the experimental birds in terms of body weight, gain in weight, feed conversion and its economic returns which might be due to the lactic acid content of Lactobacillus. The result obtained from this study suggest that inclusion of 2 kg of *Lactobacillus sp.* per metric tons of feeds can safely be used in the diet of broilers to produce an organically grown chicken for table meat as it produced the highest gain in weight, feed conversion and return above feed cost.

### Acknowledgment

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## **Welfare and production of organic sows and piglets**

## **Prolonged suckling period in organic piglet production – Effects on some performance and health aspects**

Bussemas, R.<sup>1</sup> & Weissmann, F.<sup>2</sup>

Key words: Organic piglet production, prolonged suckling period, weaning age, performance, health aspects

### **Abstract**

*The organic piglet suckling period typically takes about 6 weeks due to the minimum requirement of the EEC Regulation 2092/91 of 40 days. But piglets weaned in such a period are often characterized by inferior performance and health status. It is the aim of the present study to examine whether a prolonged suckling period of 63 days results in better performance and health status of the piglets. Therefore 36 sows were divided into 2 groups of 18 sows each as a control group with 42 days suckling period and a test group with 63 days suckling period. The rearing period for both the control group and the test group ended on day 77 p.n., which was also the end of the piglets' data collection period. Three farrowing cycles with 108 litters were recorded. The extended suckling period resulted in an improved growth rate and in a reduced number of medically treated piglets and did not negatively affect the body condition and teats of the sows. Hence a prolongation of the suckling period compared to the minimum requirement of the EEC Regulation 2092/91 seems to be advisable.*

### **Introduction**

In many cases organic piglet production is characterized by inferior animal health status and level of performance. Whereas the number of piglets born alive is satisfactory, the number of reared piglets is definitely too low (Löser, 2007). It is postulated that one of the reasons for this could be the piglets' weaning date. The organic piglet suckling period typically takes about 6 weeks due to the 40 days minimum requirement of the EEC Regulation 2092/91. But at this point of time piglets are in a fragile physiological status, partly as a result of their limited feed intake capacity and their simultaneously high nutrient requirements (Zollitsch, 2007). Hence piglets are ill-equipped to cope with the burden in the context of weaning. It is the aim of the study to examine whether a prolonged suckling period of 63 days results in piglets with an improved immune status (see Ahrens et al. 2008 in the present volume) as well as an enhanced status of health and performance.

### **Materials and methods**

The trial was performed from midyear 2005 to midyear 2007 at the experimental organic farm of the Institute of Organic Farming of the Federal Agricultural Research Centre (since 2008: Johann Heinrich von Thunen-Institute, vTI) in Trenthorst,

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Germany, in accordance with the Regulation 2092/91/EEC and IFOAM Basic Guidelines. A total of 44 sows of the genotype "Schaumann" (crossbreed of German Landrace, German Large White, and Duroc) were kept: 36 sows were used for the investigation and 8 sows were kept in reserve in a parallel farrowing rhythm in order to replace sow losses. The 36 sows were divided into 2 groups of each 18 sows: control group with 42 days suckling period and test group with 63 days suckling period. In-pig sows were kept outdoors on grass clover. Farrowing and suckling period were indoors. Fourteen days after single grouped farrowing the sows were grouped in threes with their respective litters and were group housed till day 42 or 63 p.p., respectively. At the weaning date the sows came outdoors again. Insemination started with the first oestrus after weaning. At the end of pregnancy the sows were randomly reintegrated in the experimental design. The weaned piglets remained in their familiar surroundings for 4 days. Then they were housed in separate indoor rearing pens in the composition of the previous suckling pig groups. The rearing period for both the control group and the test group ended on day 77 p.n. (after birth) which is the end of the piglets' data collection period too. The trial included 3 farrowing cycles.

Data collection of sow and piglet performances included biological production traits. Health status was mainly characterized by the documentation of significant diseases (incl. post mortem examination and repeated parasitological faeces examinations), number of treatments, amount of drug use and number of losses. The present paper only deals with a limited amount of the corresponding criteria, which can be seen in the following chapter "results".

The data base rested upon a total of 3 farrowing cycles with 108 litters of 36 sows. Statistical analyses were performed with the GLM and MIXED procedure in SAS (SAS Inst. Inc., version 9.1) using a linear model with the fixed effects of suckling period, dam parity, sex of the piglets, and the interaction of suckling period and dam parity.

## Results

A selection of the most important biological production traits of sows and progeny are presented in the Table 1. There were no teat problems recorded for the sows, either in the control group or in the group of 63 days suckling period.

Table 2 outlines the amount of treated piglets in the first 14 days after weaning without a specification of the related diagnoses. The dominating clinical picture during the whole trial was related to piglets' diarrhoea with a total of 470 treated piglets. In both suckling groups about 65% of the cases occurred in the first 10 days after birth. Most of the findings were surveyed in the first of the three farrowing cycles assumedly due to the well known fact of an inferior immune status of gilts. Medical intervention (antibiotic and/or homoeopathic) took place when the piglets' faeces were thin mushy (stadium between thick mushy and liquid). Further clinical pictures were mainly related to stunting of piglets and in a few cases related to dermatitis. Respiratory diseases did not occur and all animals (sows and piglets) were free of gastro-intestinal parasites.

Total piglet losses were 232 animals: 125 piglets i.e. 17.8 % came from the 42 days suckling period group and 107 piglets i.e. 14.8 % originated from the 63 days suckling period group. In both suckling groups about 95 % of the losses occurred during the suckling period and 82.5 % during the first 10 days respectively. A total of 23 piglets were lost due to diarrhoea. The differences between the two systems were statistically insignificant. Three sows were lost due to rupture of liver, urinary tract infection with

*Clostridium septicum*, and rupture of uterine vein, respectively. The losses occurred outdoors during pregnancy and were not related to the experimental conditions.

**Tab. 1: Some biological production traits of sows and piglets (LSQ-Means)**

	S u c k l i n g   p e r i o d		Signifi- cance
	42 days	63 days	
Litters, n	54	54	
Piglets per litter born alive, n	13.1	12.8	n.s.
Live weight per piglet born alive, kg	1.5	1.5	n.s.
Litter weight of piglets born alive, kg	19.8	19.5	n.s.
Stillborn piglets per litter, n	1.4	1.5	n.s.
Total piglets per litter, n	14.0	14.1	n.s.
Weaned piglets per litter, n	10.8	11.2	n.s.
Live weight of piglets at weaning, kg	12.1	20.8	***
Daily weight gain of sucking piglets, g	251	323	***
Sucking piglet losses per litter, n	2.3	1.7	n.s.
Live weight of lost sucking piglets, kg	1.9	2.0	n.s.
Reared piglets per litter, n	10.7	11.1	n.s.
Live weight of reared piglets <sup>1</sup> , kg	26.7	28.9	***
Daily weight gain of rearing piglets, g	420	506	***
Rearing piglet losses per litter, n	0.09	0.05	n.s.
Live weight of piglets on day 42, kg	12.1	12.0	n.s.
Daily live weight gain of piglets from birth till day 42, g	251	249	n.s.
Live weight of piglets on day 63, kg	19.4	21.7	***
Daily live weight gain of piglets from day 42 till day 63, g	332	475	***
from birth till day 63, g	277	323	***
Live weight of reared piglets on day 77 (= end of trial), kg	26.8	28.8	***
Daily live weight gain of piglets from day 63 till day 77, g	541	506	**
from day 42 till day 77, g	420	490	***
from birth till day 77, g	327	360	***
Body weight loss per sow during suckling period, kg	16.1	6.2	**

\*\* Significant for P<0.01, \*\*\* Significant for P<0.001, <sup>1</sup> corresponds with day 77 (end of trial)

**Tab. 2: Distribution of piglet treatments for the first 14 days after weaning**

	S u c k l i n g   p e r i o d		Significance
	42 days	63 days	
Total piglets <sup>1</sup> , n	559	592	
Treated piglets, %	37.0	5.4	***

<sup>1</sup> All piglets alive at weaning day, \*\*\* Significant for P<0.001

## Discussion

The data of Table 1 show that the production performance of the herd is high (Löser, 2007). It is consistent with the experimental design that there are no differences recorded between the two systems till day 42 after birth. Table 1 clearly shows the improved growth rates of the later weaned piglets. This corresponds with analogous findings in conventional piglet production systems (Main et al., 2004). The prolonged suckling period did not result in noteworthy body weight losses of the sows (Table 1) but enabled them to restock. Thus the piglets' improved performance seems to be an effect not so much of the supply of mother's milk but the maternal protection of the piglets and the longer period they spend in familiar relationships. Hence older piglets cope better with the stress of weaning (Mason et al., 2003). The opinion of the unimportance of mother's milk supply towards the end of the 63 days suckling period is supported by the observation of considerable feed intakes of the elder sucking pigs.

The necessity for treatment of animals is an effect of the individual local situation. In the present investigation the number of treatments after weaning was considerably lower in the long-suckling group compared to the short-suckling group (Table 2). These findings are in accordance with the assumption of reducing disease susceptibility by enhancing weaning age (Blecha et al., 1983; Main et al., 2004).

The level of piglet losses is tolerable compared to organic production (Löser, 2007). More than 85 % of the losses happened in the first week after birth which is compatible with the mean live weights of the lost piglets (Table 1). The main reasons were crushing and hypothermia of weak piglets, which is connected with the high number of piglets born per sow (Table 1). Therefore losses are not strictly related to the suckling regime.

## Conclusions

The data of the present investigation show that a suckling period of 63 days was unproblematic for the sows and resulted in improved growth rates and reduced medical treatments of the piglets, whereas the piglet loss rate remained unaffected. It is reasoned that a prolongation of the suckling period compared to the minimum requirement of the EEC Regulation 2092/91 seems to be recommendable.

## Acknowledgments

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## Group suckling in organic sow units

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Key words: organic pig production, lactating sows, group housing, animal health

### Abstract

*Group suckling - a combined system of single and group housing of lactating sows - appears a suitable system for organic pig production. The aim of the study was to describe the status quo of group suckling in organic farms. 31 organic sow units in Germany, Austria and Switzerland were investigated. Stockmen were interviewed, stables were inspected and animals were examined during three visits on each farm enterprise, respectively. The majority of farms kept three sows with piglets in one group suckling unit. 76 % of the group suckling sows (n=192) were in a good nutritional condition, 18 % were considered thin and 8 % of sows were too fat. Relatively few sows showed skin lesions caused by poor housing conditions. Only 18 of 203 sows behaved anxiously or aggressively. On average 9.1 piglets per sow and litter were weaned. Amongst the investigated farms, none was optimally managed. However, no plausible correlations between biological performance, animal health, human-animal relationship on the one hand and farm-specific production conditions (housing, management, feeding, watering) on the other hand were determined. It can therefore be deduced that the "success" or "failure" of the study farms can be attributed to the interaction of different factors rather than to individual production factors.*

### Introduction

The housing and management of lactating sows is one of the most challenging issues in organic pig production. Alternative to permanent single housing in farrowing pens, lactating sows and their litters can also be kept in groups. The literature and the experience of some farmers indicate that group housing of lactating sows is an interesting system for organic farming from an animal welfare and an economic point of view. The housing allows the natural social behaviour of the sows: Lactating sows kept in a natural environment rejoin the primary maternal group after separation for farrowing and the first days of the piglet's life; Piglets of several litters are reared together (Stolba & Woodgush, 1989). In commercial pork production this system reduces stress for piglets at weaning because there is no need for mixing (Bünger et al., 2004). Reduced investment costs for the stable and a more functional pen design

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are further advantages of group housing of lactating sows compared to single housing. Some studies describe negative effects of the group suckling system. Weight at weaning and daily weight gain can be reduced. Too many sows in one suckling group (Brodmann & Wechsler, 1995), a lack of milk or an interruption of lactation of group housed sows (Weber, 2000) can cause excessive cross-suckling with an increase of weight difference between piglets. Based on the literature (i.e. Baumgartner et al, 2002) we expected a big diversity of group suckling systems in organic farms and a lack of hard production data. The aim of our study was to describe the status quo of group housing systems in German-speaking countries and to identify the success factors of this system on a farm level.

### **Materials and methods**

Data collection took place in 31 organic farms with group housing system in Germany (n=10), Austria (n=10) and Switzerland (n=11). Each farm was visited two times at weaning and one time at grouping the sows and piglets. The farmers were interviewed about management, housing, feeding and animal health. The housing conditions of the piglet production were inspected and recorded. At weaning the piglets were weighed and evaluated for skin lesions, injuries of legs and signs of diarrhoea. The sows were checked for body condition score (BCS), skin lesions and lameness. The human-animal relationship was evaluated within using a handling test with the stock person and an approach test with the investigator. Productivity data were collected on notes of the stockman. The data were analysed with descriptive statistics, analysis of correlation and ANOVA using the programmes Excel und SPSS 11.0. Finally an overall evaluation of the group suckling system of each farm was calculated. For this purpose target values based on the literature and the experiences of experts were defined in the areas of housing, management, feeding, animal health, human-animal relationship and productivity. Each farm was rated in these categories. If a farm achieved the target value, it was rated as "good", if not it was "bad" or in between "mid". In addition, success criteria for group suckling systems were defined: health of sows and piglets, homogeneity in piglet's weight at weaning, normal behaviour of the sows at handling, productivity data.

### **Results**

The group suckling systems found in the farms investigated were extremely inhomogeneous. The results did not differ as much between countries as they did between farms within one country. The mean size of the sow herds was 35 (11 – 90).

Housing: Group suckling was practised in 25 farms in modified buildings. Six stables were recently built for group suckling purposes. The size of the lying area per sow ranged from 1.6 m<sup>2</sup> to 6.7 m<sup>2</sup>. Most farmers (19) kept three sows in one group suckling unit. The average weaning age was 47.8 days (n=1194 litters). The most obvious insufficiency in housing was found in the design of the piglet nest: lack of space (< 0.1 m<sup>2</sup> per piglet), deficient heat supply and inadequate protection from draft were found. Furthermore the water supply was insufficient frequently.

Management: Concerning management most farmers seek a low age difference between litters of one suckling group. In 83.5 % of all grouped litters (n=405 groups) the age difference was less than eight days. For the stockperson it seems to be difficult to manage the planned group size, only six out of 29 farmers had the planned number of animals in more than 75 % of the suckling groups.



**Animal health:** The main health problem in the farms was post-weaning diarrhoea (21 out of 31 farms). The majority of the group suckling sows (n=192) was in a good nutritional condition, 18 % were considered thin and 8 % of sows were too fat. Only few sows (61 out of 206 sows) in few farms (7 out of 30 farms) showed severe skin lesions. The prevalence of skin lesions in the head-neck-side region correlated significantly (p=0.01) with the group size in the suckling group. Sows and piglets showed an approach more often than retreat, flight or aggression in the approach test with a strange person. In the handling test the behaviour of the stockperson was considered positive or neutral in 18 out of 24 farms. Only 18 out of 203 group suckling sows behaved anxiously or aggressively during BCS.

**Productivity data:** Piglet losses from birth to grouping for group suckling were 15.6 % on average (5.9 – 25.0 %). The loss rate in the group suckling period was 3.9 % (0.6 – 9.3 %). On average 9.1 piglets per sow and litter were weaned (5.8 – 11.5).

**Final evaluation of farms:** The overall evaluation of each farm by an expert panel showed, that the piglet nest is the most critical housing factor and feeding of sows and piglets has to be improved in most of the farms. A minority of the farms can be considered as good in housing, feeding and management (Table 1).

**Tab. 1: Summarised results of farms with group suckling (n=31) in different factors of production evaluated by an expert panel**

Factor	Good	Mid	Bad
Pen design	9	17	5
Piglet nest	4	8	19
Outdoor run	6	18	7
Feeding	4	10	17
Management	8	11	8

Looking at productivity, only one farm with group suckling can be rated as successful. All farms had problems in animal health in a greater or lesser extend. In the other animal based welfare parameters a minority of farms showed bad results (Table 2).

**Tab. 2: Summarised results of farms with group suckling (n=31) in different success criteria evaluated by an expert panel**

Success criteria	Good	Mid	Bad	Missing
Productivity	1	13	13	4
Animal Health	-	14	16	1
Skin lesions, BCS, behaviour	6	20	4	1
Human animal relationship	6	13	5	7

The overall evaluation of each individual farm revealed, that none of the farms provided optimal conditions to the pigs in the areas of housing, feeding and management. Consequently, none of the farms can be considered successful both in productivity, animal health and human-animal relationship. However, no plausible correlations between success criteria on the one hand and farm-specific production conditions on the other hand could be found.

## Discussion

The situation found in the organic farms with group housing of lactating sows and litters participating in this study was inhomogeneous and did in this respect, not differ from other studies on organic sow units (Baumgartner et al., 2002). Our results indicate that a group size of three to four sows are optimal for group suckling which is also described in other studies (Brodmann & Wechsler, 1995). Keeping the difference in age of the litters within a suckling group as low as possible is an important management factor. Even organic pig producers with group suckling systems still underestimate the importance of an optimal piglet nest for animal health and productivity. The problem of weaning diarrhoea, which is evident in conventional and organic pig production too, can not be solved with a group suckling system unless general deficiencies in feeding, hygiene, housing and management are eliminated. The marginal prevalence of skin lesions of the sows in this study indicates that aggressive behaviour of group housed lactating sows is low because this system allows the natural social behaviour. The group suckling system seems to facilitate a good human-animal relationship too. Productivity data do not differ between the group housed sows investigated in this study and single housed organic sows described in the literature (Loeser, 2004). The critical phase for the piglets is the time in the farrowing pen in the first weeks. None of the 31 investigated farms was optimally managed. Plausible correlations between farm-specific production conditions and the criteria of success such as productivity could not be determined. The relatively small number of farms investigated in combination with great variability in the production conditions of the farms did not allow a general statement about a successful group housing system. It can therefore be deduced that the "success" or "failure" of the study farms can be attributed to the interaction of different factors rather than to individual production factors.

### **Conclusions**

Group housing of lactating sows is an alternative system to single housing for organic pig producing farms. Group suckling has advantages in both animal welfare and economic respects. To ensure success the basic requirements of pig production in the areas of housing, feeding, management and veterinary treatment must be adhered to. Experimental based further research is needed.

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# Development of a mobile organic piggery for outdoor pork production – function, productivity, animal behaviour and environmental risk assessments

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Key words: Outdoor, fattening pigs, foraging, feed conversion, plant nutrient balance

## Abstract

*Pens in outdoor pig systems in general become permanent during the grazing period. The excretion behaviour of the pigs creates plant nutrient hotspots within pens. In this study we developed a mobile organic piggery (MOP) without electric fencing that can be moved to a new grazing area each day. The aims were to distribute plant nutrients evenly, provide the pigs with continuous access to fresh herbage, and improve productivity and the working environment. Initially, 25 fattening piglets were installed in the MOP on a clover/grass ley. Nitrogen, P and K flows to and from the MOP were monitored during 87 days. The purchased feed included 80% of the energy norm for pigs in indoor systems and the pigs were automatically fed. The MOP was moved 65 times. Behavioural studies including excretion behaviour were conducted during a two-week period. Net nutrient accumulation was 88 kg N, 31 kg P and 10 kg K ha<sup>-1</sup> for the total grazing area (4212 m<sup>2</sup>). Average liveweight gain was 675 g day<sup>-1</sup>. Average feed conversion rate was 2.7 kg feed kg<sup>-1</sup> liveweight gain. The pigs grazed, on average, almost half the day. With the MOP system it was possible to use a lower quality concentrate feed in terms of energy and protein supply in combination with regular access to fresh herbage. The MOP system also allowed a more even distribution of animal manure within the total grazing area, compared with permanent pens. Avoiding harmful point loads of nutrients decrease the risk of nutrient losses.*

## Introduction

More economical and environmentally-friendly outdoor systems for organic fattening pig production are urgently required. The organic outdoor systems currently used in Sweden have to give pigs access to grazing during the summer. In reality, pens with electric fencing become permanent during the grazing period, which makes it more difficult to harvest surplus grass and to sow a winter crop on rooted areas. Feed are transported across the grazing area regularly, increasing the risk of soil compaction (Andresen, 2000). Although each pen may have a balanced overall pig density (corresponding to an application of 22 kg P ha<sup>-1</sup> year<sup>-1</sup> in Sweden), pig defecation and urination behaviour can create unacceptable point loads of nitrogen (Salomon et al., 2007a).

Homogeneous distribution of manure is expected to be a key factor in optimising plant nutrient availability in crop production, while also decreasing the risk of plant nutrient

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losses. Movement of the pen to provide continuous access to new grazing also stimulates forage intake by pigs, which can decrease the need for purchased feed (Andresen, 2000). However, equipments and fences currently available for outdoor production are not sufficiently user-friendly to allow regular moving. Screening of the working environment on six organic pig farms showed that manual feeding and watering increased the risk of accidents and created an unacceptable ergonomic load, compared with semi-automatic feeding (Geng & Torén, 2005).

The aim of this study was to develop and evaluate a mobile organic piggery (MOP) without electric fencing that can be moved to a new grazing area each day. Specific objectives were to create an outdoor system that: 1) Gives an acceptable distribution of nutrients; 2) provides continuous access to fresh herbage; 3) increases the possibilities of establishing a subsequent crop; 4) reduces working time and work load; 5) improves pig liveweight production.

## Materials and methods

The two MOP prototypes developed were evaluated during two grazing periods on a commercial organic pig farm that had its own sows and bred its own piglets. This pig farm is situated in southern Sweden (56°02'N 13°42'E), with a mean annual temperature of 7.4 °C and a mean total precipitation of 773 mm (local meteorological station). The soil at the site is a sandy loam.

The construction of the MOP2 year 2 (hut and pen) was designed to house 30 fattening pigs and to allow smooth repositioning by tractor under field conditions. The rectangular pen (9 x 6 m<sup>2</sup>) is made of 10 guardrails of steel tubing. Each guardrail rests on steel runners to allow smooth forward movement. The corners of the pen are flexible to prevent breakages during turning. The rear end of the pen is stabilised with a road-drain. The hut (9 x 3 m<sup>2</sup>) has no floor but three walls and a roof. The fourth wall is partly open to allow access for the pigs. The hut has three wheels, adjustable in the vertical direction. During transportation on roads the pen can be dismantled and the drawbar can be moved to the gable of the hut. Within the MOP, the pigs have access to purchased feed, drinking water and a bath-tub (3 m<sup>2</sup>) linked to the back gable of the hut.

In the second year MOP2 was constructed and evaluated. Based on former experiences, the pen design from MOP1 year 1 was used without modifications (Salomon et al., 2007a). However, the hut was modified to include a 9-m long feed container for storage of one week's feed requirements. Along the bottom of the feed container run upper and lower augers with steel casings. The lower auger has an outlet for feed every 0.6 m, corresponding to alternate feeding stations, and is run by a 12 V battery supported by a solar cell. A time relay controls how much, when and how often the pigs are fed. Below the feed container is a 9 m long feeding trough where up to 30 pigs have space to feed at the same time.

The experimental period was 87 days. In May, 25 fattening pigs with an average liveweight of 36.8 kg were installed in MOP2 on a first year clover/grass ley. Nitrogen, P and K flows to and from MOP2 were monitored (Eq. 1). Behavioural studies including excretion behaviour were conducted every day over a two-week period.

$$\text{MOP2 balance} = [\text{Purchased feeds} + \text{Piglets}] - [\text{Pigs} + \text{Ley harvest}] \quad (\text{Eq. 1})$$

The planned frequency of moving MOP2 was based on a maximum N application of 170 kg ha<sup>-1</sup> according to the EU Nitrate Directive. The concentrate feed contained 80% of the energy norm for pigs in indoor systems and the crude protein content was 15.9 % of DM (dry matter). Lysine was 6.1 g kg<sup>-1</sup> DM and methionine 2.3 g kg<sup>-1</sup> DM in the concentrate. This corresponded to 72.5% of the norm for lysine and 89.1% for methionine. The amounts fed per week were based on farm documentation. The pigs were automatically fed at 6.00 a.m, 11.00 a.m, 4.05 p.m and 8.00 p.m.

The pigs were weighed individually at the start of the trial and three times before slaughter. The average liveweight at slaughter was 110 kg pig<sup>-1</sup>. Nitrogen, P and K contents in pig carcasses were taken from the literature. One cut of silage was taken in June on half the total grazing area. Analysis of the clover/grass ley showed a plant nutrient content of 12 g crude protein, 3.7 g P and 31.5 g K kg<sup>-1</sup> DM.

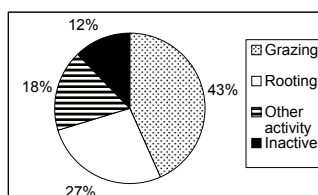
General behavioural studies on 5 pigs were conducted for 4 h in the morning and 4 h in the afternoon. Grazing, rooting, passive and other activities conducted in the hut and at the front and back of the pen were recorded on these occasions. Continuous recordings were made for defecation and urination.

## Results

**Tab. 1: Plant nutrient balance for the total grazing area (4212 m<sup>2</sup>) traversed by 25 fattening pigs during 87 days**

Flow	N	P	K
Pigs, kg in	+24	+5	+2
Feeds, kg in	+86	+23	+19
Pigs, kg out	-66	-13	-5
Harvested silage, kg out	-7	-2	-12
Balance, kg per hectare	+88	+31	+10
Balance, kg per fattening pig	+1.5	+0.5	+0.2

The largest inflow of N, P and K was from purchased feed, while the largest outflow of N and P was from pigs and of K from harvested silage. The balance resulted in a net accumulation of N, P and K on the total grazing area (Table 1).



**Figure 1: Foraging behaviour, expressed as average % day<sup>-1</sup>.**

The average liveweight gain was 675 g day<sup>-1</sup> which corresponded to 33.6 MJ (metabolisable energy) kg<sup>-1</sup> liveweight gain. Feed conversion rate was on average 2.7 kg feed kg<sup>-1</sup> liveweight gain. There was no remarks on defective pig health from the abattoir. On average, the pigs grazed almost half the day (Figure 1). Defecation and

urination behavioural studies showed that the pigs excreted without exception outside the hut, preferably at the back of the pen.

## Discussion

The net accumulation of 88 kg N ha<sup>-1</sup> and 31 kg P ha<sup>-1</sup> was environmentally acceptable and lower than with MOP1, for which the corresponding values were 155 kg N ha<sup>-1</sup> and 48 kg P ha<sup>-1</sup>. One important reason for this was that MOP2 was moved more frequently (65 times) than MOP1 (36 times) (Salomon et al., 2007b). Frequent moving distributes nutrients in faeces and urine more evenly compared with stationary pens (Salomon et al., 2007a). On average, each pig received 3.7 kg N with purchased feed, which was lower than with MOP1 (4.6 kg N pig<sup>-1</sup>). The reason was that with MOP1, the feed consumption was too high due to spillage and manual feeding in feeding troughs once a day, which made it difficult to adapt feed intake to pig liveweight. The feed conversion rate was on average 2.7 kg concentrate feed kg<sup>-1</sup> liveweight gain, which was lower than in MOP1 (3.0 kg concentrate feed kg<sup>-1</sup> liveweight gain) and rather low for organic pig production in general (Andresen, 2000). The forage intake thus influenced the growth rate positively, although in this experiment we did not measure actual forage intake. It has been reported that when pigs are frequently given access to new grazing areas, they spend more time grazing than in permanent pens (Andresen, 2000). Growth rate in this experiment was lower than in conventional production, which can be explained by the low crude protein content and rather low quality of the concentrate protein in terms of lysine and methionine content. In terms of feed conversion, the results were comparable to Swedish indoor pig production.

## Conclusions

With the MOP2 system it was possible to use a lower quality of feed in terms of energy and protein supply in combination with regular access to fresh herbage. The MOP system also allowed a more even distribution of animal manure within the total grazing area, compared with permanent pens. Avoiding harmful point loads of nutrients decrease the risk of nutrient losses.

## Acknowledgments

This study was financed by the Swedish Board of Agriculture.

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# Effect of additional heating, floor length, straw quantity and piglet nest accessibility on piglet losses in organic farrowing pens

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Key words: farrowing, piglet mortality, organic, pig, pen design

## Abstract

*Newborn piglets on organic pig farms have a lower chance to survive their first week than conventional piglets. Poorer climatic conditions, a loose housed mother, large litters with low birth weights are some of the causes. In a series of experiments the effect of housing and climate measures were investigated. Additional floor heating around farrowing to increase vitality did not reduce piglet mortality. Enlargement of the solid floor to facilitate maternal behaviour also didn't show a lower mortality. In the third experiment the amount of straw didn't give a lower mortality, but longer flaps in the opening of the piglet nest tended to reduce mortality.*

## Introduction

Newborn piglets in organic farrowing pens have a lower survival rate than in conventional farrowing pens. This difference is mainly caused by housing the sow loose and by climatic effects of the outdoor temperature combined with relatively large litters. This results in a higher risk on crushing as a secondary cause of death in weakened piglets (Weary et al., 1998; Edwards, 2002). These housing and climate conditions were the main topics in three projects on reduction of piglet mortality. According to EU- regulations lactating organic sows should have at least 7.5 m<sup>2</sup> indoor area with straw, a 2.5 m<sup>2</sup> outdoor run and a weaning age of 40 days. The aim of this project was to increase piglet survival in order to improve animal welfare as well as the profitability of organic pig farms.

Three subprojects were conducted to reach the aims of the project:

1. Additional floor heating around farrowing
2. Solid floor size
3. Straw quantity and accessibility of piglet nest

## Materials and methods

### 1. Additional floor heating around farrowing

Beside the continuous floor heating of the piglet nest the solid lying area where the sow gave birth to the piglets was heated from 12 hrs before farrowing until 24-30 hrs after farrowing. Heating means pumping water of 35 °C through the floor resulting in a surface temperature of 30 °C. The floor was covered with a thin layer of straw. The hypothesis was that this would result in dryer, warmer and more vital piglets with a lower risk on crushing. Every three weeks two rooms with each six pens were

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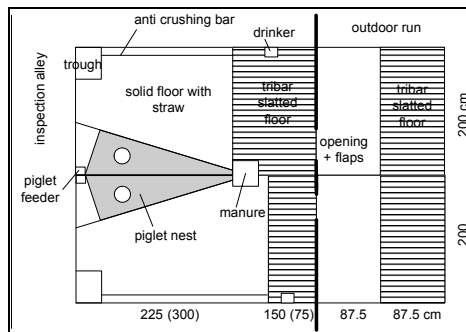
allocated to the treatments “Warm” and “Cold”. We used 83 litters per treatment. The layout of the pen is drawn in figure 1. Lying behaviour of sow and piglets was observed during the first five days post partum and post mortem section of the piglets was carried out to check the stomach content and the status of the lungs (live or dead born). Performance data and fraction dead piglets were analysed using GLM (Genstat) with litter size and birthweight as covariables in the model beside the main effects.

## 2. Solid floor size

To give sows the opportunity to perform a higher quality of maternal behaviour the surface of the 2.0 m wide solid floor was elongated from 2.25 m (Small) to 3.00 m (Large). This resulted in “Large” in a decreased slatted floor size from 1.50 m to 0.75 m deep (see fig. 1). In both treatments 42 litters were born. Lying position of sows and piglets, dunging pattern and performance were recorded.

## 3. Straw quantity and accessibility of piglet nest

In this 2x2 factorial design we used 112 litters. Half of the pens was strawed with a thin layer and half with a thick layer of straw just before birth. The second factor was the accessibility of the piglet nest (grey area in fig. 1): long transparent flaps (ending 8 cm above the floor) and short flaps (ending 30 cm above the floor). Lying position of sows and piglets, sow posture changes and performance were recorded.



**Figure 1: Layout of two farrowing pens with different solid floor sizes in the indoor area; the outdoor area is on the right in the drawing.**

## Results

### 1. Additional floor heating around farrowing

The extra heat during farrowing did not result in a lower piglet mortality. The performance of the sows in the two treatments was not statistically different. Table 1 shows the results. On average 12.63 liveborn piglets in “Cold” resulted in 10.12 weaned piglets and for “Warm” 12.36 liveborn piglets resulting in 9.94 weaned piglets. This leads to a mortality of respectively 20.0 and 19.4% (NS).



**Tab. 1: Performance of sows farrowing on a heated and non-heated floor.**

	Cold	Warm	Sign.
Liveborn (number)	12.63	12.36	ns
Stillborn (number)	1.19	1.18	ns
Birthweight (kg)	1.51	1.50	ns
Weaned (number)	10.12	9.94	ns
Mortality (% of liveborn)	20.0	19.4	ns
Weight loss sow (kg)	32	37	ns

\* significant for  $P < 0.05$  ; ns = not significant

Behavioural observations showed no difference in use of the solid floor by the sow; all farrowings took place on the solid floor. Crushing was the cause of death in 43% and 45% of the total mortality in Cold and Warm. On the first day after birth 58.0% (Cold) and 50.5% (Warm) of the piglets were in the piglet nest ( $P < 0.05$ ), outside the "danger zone". The dead piglets in "Warm" had more often milk in their stomach than in "Cold" (62% and 42% resp.), indicating more vital pigs in "Warm".

## 2. Solid floor size

The larger solid floor did not result in a higher survival of the newborn piglets. The difference in birth weight was not reflected in the weaning weight (Table 2). The lying behaviour of the sow did not differ, but the large floor was dirtier than the small floor. However the majority of the excretion behaviour was performed in the outdoor area.

**Tab. 2: Performance of sows farrowing on a large and small floor.**

	Large floor	Small floor	Sign.
Liveborn (number)	12,4	12,6	ns
Stillborn (number)	1,2	0,9	ns
Birthweight (kg)	1.64	1.51	*
Weaning weight piglets (kg)	12.2	12.1	ns
N weaned	9.3	10.0	ns
Mortality (%)	25	21	ns

\* significant for  $P < 0.05$  ; ns = not significant

**Tab. 3: Performance of sows with 2 straw quantities and 2 lengths of nest flaps**

	Low Straw	High Straw	Sign.	Long Flaps	Short Flaps	Sign.
Liveborn (number)	13.3	14.5	*	13.7	14.1	ns
Dead born (number)	0.9	1.2	ns	1.0	1.1	ns
Birthweight (kg)	1.67	1.63	ns	16.90	16.05	ns
Weaning weight (kg)	12.45	12.07	ns	12.39	12.14	ns
Weaned (number)	10.43	11.02	ns	11.02	10.43	ns
Mortality (% of liveborn)	22.2	24.2	ns	19.7	26.7	# ( $P = 0.06$ )

\* significant for  $P < 0.05$  ; # tendency  $P < 0.10$ ; ns = not significant

## 3. Straw quantity and accessibility of piglet nest

The longer flaps of the piglet nest resulted in a tendency for a lower mortality, but the extra straw was not successful in reducing mortality (Table 3). This matches the thick

straw bedding not resulting in fewer postural changes compared to the thin layer. We also did not find any difference in lying preference of the piglets.

## Discussion

The results do not show a very strong effect of the different housing and climate measures on the survival of the newborn piglets. Unfortunately some of the housing measures seem to bring positive and negative aspects. Heating the floor around the sows is favoured by the sow (Phillips et al., 2000), but attracts the young piglets to this potentially dangerous area. Long flaps in the entrance of the piglet nest keep the heat inside but reduce the accessibility. Straw bedding insulates the newborn piglets but also hampers them when escaping from a rolling sow, which is a risk factor for crushing according to Damm et al. (2004). However heating around parturition is crucial in keeping the piglets vital (Herpin et al., 2002). These results led us to the conclusion that there is more to gain in maternal behaviour, nutrition (milk production) and management (human animal relationship). In the next years the focus will be more on these topics.

## Conclusions

From the described experiments it can be concluded that:

- Floor heating in the lying area of the sow during one day after parturition did not increase piglet survival;
- Enlargement of the solid floor to facilitate maternal behaviour did not increase piglet survival;
- Increasing the amount of straw did not give a lower piglet mortality;
- Longer flaps in the opening of the piglet nest increased piglet survival.

## Acknowledgments

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# Towards loose housing in Swedish organic dairy production

Swensson, C.<sup>1</sup>

Key words: milk production, dairy cow houses, tethered cows, loose housing

## Abstract

For hundreds years there has been a tradition with tethered dairy cows in Sweden. The last decades the old fashioned way to hold cows have been questioned and the number of dairy cows in loose housing has been increasing. Last year (2004) 19 percent in total of all farms with milk production in Sweden had their cows in loose housing. Because of EU-legislation concerning all organic production no farms are allowed to build tie stalls any more and after 2010 all organic dairy cows are supposed to live in loose-housing systems.

The aim of the thesis was mainly to find out the number of farms with tethered organic dairy cows. Furthermore the purpose was to study if there are any regional differences regarding the building system for organic dairy herds. There are important differences between buildings made for conventional dairy cows and organic ones. Some examples from organic rules are that calf and cow are allowed to go together during the whole colostrums period and the area per animal in some cases is bigger. That often makes organic buildings for dairy cows more expensive to build than conventional ones.

In the end of 2004 60 percent of the organically kept dairy cows, which is equivalent to 40 percent of the farms in Sweden, were already in loose-housing systems depending on that decision. There are big regional differences.

## Introduction

For hundreds years there has been a tradition with tethered dairy cows in Sweden. Historical investigations concerning cow houses in Sweden during the 18th century find only examples of cow houses with tethered cows independently of herd size (Israelsson, 2005). When organic dairy farming started in Sweden approximately 25 years ago, the tradition with tethered dairy cows continued. Referring to the organic principles of agriculture (IFOAM), tethered dairy cows should be forbidden. The "Principle of fairness" insists, "that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behaviour and well-being". Also the EU -legislation on organic animal production highlights that "the housing conditions for livestock must meet the livestock's biological and ethological needs". According to an overview regarding the situation in Europe for organic animal production, only 5 countries of 17 investigated had no tied stalls (Vaarst et al., 2006). Hence, there is a conflict between the traditional housing systems for dairy cows and the organic principles. Furthermore, this conflict is most common in mountain areas, for instance the Alps, and areas not suitable for large-scale farming or large dairy herds. Examples of the latter are the northern part of Sweden.

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Due to the EU-legislation concerning all organic production no farms are allowed to build tie stalls any more and after 2010 all organic dairy cows are supposed to live in loose-housing systems (EEC, 1991). There are important differences between buildings made for conventional dairy cows and organic ones. Some examples of organic rules are that calf and cow are allowed to be together during the whole colostrums period and the area per animal in most cases is larger. The investment for an organic dairy cow stall compared to a conventional dairy cow stall is therefore often bigger.

Hence, there is a conflict between the Swedish traditional system of dairy cow housing and the rules for organic dairy production.

The aim of this presentation is mainly to find out the number of farms with tethered organic dairy cows in Swedish organic dairy production. Furthermore the purpose is to study if there are any regional differences in Sweden.

### **Materials and methods**

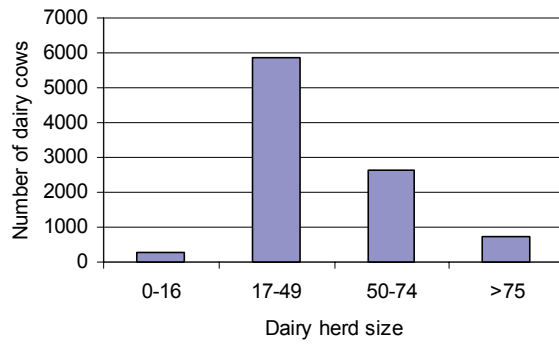
The investigation was carried out during 2005 and data were collected concerning 2004. Information sources to the investigation were the dairy plants, the controllers of KRAV (private labelling organisation) and the dairy farmers themselves. All dairy plants in Sweden, which are selling organic milk, claim that the dairy farms are affiliated to KRAV.

Information from controllers of KRAV gave statements regarding type of housing from 76% of the 440 organic dairy herds in Sweden with 21 641 dairy cows (year 2005). The missing information was collected by interviewing the dairy farmers by telephone. One percent of the dairy farmer was unable to contact despite they were contacted by telephone at least 5 times.

### **Results**

In the end of 2004 60 percent of the organically kept dairy cows, which is equivalent to 40 percent of the farms in Sweden, were already in loose-housing systems. There are large regional differences both regarding housing system and where the organic dairy cows herds are situated (Table 1).

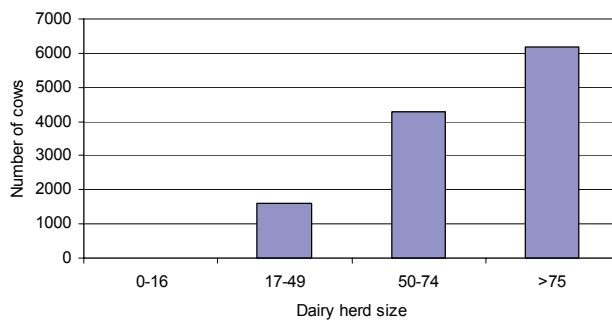
Some of the tethered dairy herds were rather large (Fig. 1), although the herd size is larger in loose housing systems (Fig. 2).



**Figure 1: Number of tethered dairy cows in different herd sizes**

**Tab. 1: Regional differences regarding dairy herds and housing system in Swedish organic dairy production**

	% of dairy herds of all Swedish organic dairy herds	% of dairy cows of all Swedish organic dairy cows	% loose housing system of all dairy herds in the region
Southern Sweden	58	61	40
Middle Sweden	23	24	37
Northern Sweden	19	15	38



**Figure 2: Number of dairy cows in loose housing system in different herd sizes**

## Discussion

The new EU-regulation- EG 834/2007 – which is implemented from 1<sup>st</sup> January 2009 has not yet any detailed regulations concerning how to deal with tethered cows or tethered animals in general. Considering animal welfare and the individual need of animals the overall goal must be loose housing for organic dairy cows. However, there are several dilemmas with this standpoint. Firstly, the organic rules according to EU made an exception for tethered dairy cows in small dairy herds. However, the definition of small dairy herds has never been decided on EU-level. Instead, it was decided that the definition of small herd should be decided on national level. According to Swedish authorities, a small organic dairy herd in Sweden has 45 dairy cows, slightly below the average dairy herd size in Sweden. Referring to figure 1, roughly 3 000 dairy cows are in tethered dairy barns with more than 45 dairy cows. This means that 15 % of the total organic dairy production is produced from organic dairy cows in dairy barns which are going to be forbidden in the year 2011. Today the market of organic dairy products is increasing and in some regions in Sweden it is difficult to recruit new organic dairy producers. Secondly, some of the organic milk is produced in areas with small opportunities to increase herd size due to lack of land, especially in Northern Sweden. In these areas, there is a need of cattle on pasture to keep the landscape open. Organic tethered dairy herds in these areas have difficulties to make heavy investments in loose housing which means that these dairy farms quit dairy production and hence, society loses the open landscape in the long run. The mountain regions in Europe, for example, France and Austria, have the same problems.

Another point of view is that most organic dairy farmers emphasise natural behaviour among animals and supports animal welfare (Lund et al.2002). Still, in several European countries there are a lot of tethered dairy cows. It seems that tradition in animal husbandry means more than animal welfare. To survive, organic dairy production has to be market driven and probably is consumer's view of organic dairy production a loose housing system. In other words, there is a need to develop loose housing systems for small-scale organic dairy production.

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## Excreting behaviour of pigs from organic housing systems in relation to ammonia emission

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Key words: pigs, organic housing, excreting behaviour, ammonia emission

### Abstract

*The objective of this study was to establish a pattern of excreting behaviour of pigs in relation to ammonia emission and to predict the ammonia emission rates from clean and fouled with excretions areas.*

*The study involved 3 organic pig farms in which the housing systems included straw pens inside and a paved yard outside. Two pens with fattening pigs were chosen on each farm and measurements of excreting behaviour and ammonia emission were made at two stages in the fattening period, at approximately 45 and 80 kg of body weight. Behaviour was observed with video cameras at two consecutive days for 24 hours. From video recordings urinations and defecations, including the corresponding times, were noted. Diagrams of the excretion activity pattern during the day for every weight class and every farm were made. From the figures of the frequency of urinations during the day it was clear, that in all the three farms there were two excretion peaks – one in the morning and one in the afternoon-evening hours. Clean areas inside emitted  $1.9 \text{ g ammonia.day}^{-1}\text{m}^{-2}$  and clean areas outside –  $2.7 \text{ gday}^{-1}\text{m}^{-2}$ . Inside polluted areas had a higher emission than the polluted areas on the outside yard –  $13.3 \text{ gday}^{-1}\text{m}^{-2}$  vs  $11.4 \text{ gday}^{-1}\text{m}^{-2}$ , resp.*

### Introduction

One of the most important objectives of organic farming is to consider the physiological and behavioural needs of the animals, according to Regulation No 1804/1999. In this regulation the use of straw is based on the statement that pig's welfare can be improved in straw-based systems compared to conventional, intensive systems. In the same time this can contribute to increasing of ammonia emission in organic production systems. Increased area per pig and the availability of outside yards in this type of housing could also become a significant source of ammonia volatilization.

Excreting behaviour of pigs is in close relation to ammonia emission rates. It is important to know not only the rates of ammonia emission, but also variation with time during the day and the emissions from clean and fouled with excretions areas. Both variations and degree of fouling of pen floor could be monitored by observations of the excreting behaviour of pigs. The objective of this study was to establish a pattern of excreting behaviour in relation to ammonia emission and to predict the ammonia emission rates from clean and fouled with excretions areas.

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## Materials and methods

The study involved 3 organic pig farms in which the housing systems had straw pens inside and a paved yard outside. Two pens with fattening crossbred pigs (Large White x Dutch Landrace) were chosen on each farm and measurements of excreting behaviour and ammonia emission were made at two stages in the fattening period, at approximately 45 and 80 kg of body weight. The number of the pigs in pen in every farm was different, depending on the size of the pens.

Behavioural observations were made by video cameras. For this purpose, two or four cameras were installed for each pen (inside and outside the building). The cameras covered 90% of the area on farm 1 and 100% on farms 2 and 3. Time-lapse video recorders on tapes recorded the signal from the cameras. The recording was done on two consecutive days simultaneously for fatteners of 45 and 80 kg on each farm. The data on the excreting behaviour (number of urinations and defecations and whether they occurred (inside or outside) obtained from the video recording were analysed. Diagrams of the excretion activity pattern during the day (24 hours) for every category and every farm were made.

Ammonia emission was measured using a ventilated chamber both inside the building and on the outside paved yard. The total surface areas of polluted and clean areas were determined. The ammonia measurements were carried out at 9, 10 and 8 locations in each of the two periods in every pen on farm 1, 2 and 3, respectively, at similar number of fouled and clean locations, as it is shown at Fig. 1.



Figure 1: Measuring points and fouled areas in pens of 45-kg fatteners on farm 1.

## Results

Urination activity is closely related to the rate of ammonia emission, that's why the urination frequency during the day is shown on the figures 1-3. On farm 2 and 3 only a few urinations inside occurred therefore only urination activity of outside yard in 45 and 80-kg pigs were presented. From the figures of the urination activity during the day it is clear that at each farm there are two peaks – one in the morning and one in the afternoon-evening hours. Difference exists between 80-kg pigs at farm 3 and the other two farms as well as between 80 kg pigs and 45-kg pigs at the same farm, with two picks in the morning hours close to each other and not very clear pick in the



afternoon hours. In farm 1 and 2 afternoon activity in urinations is higher than in the morning. The peak in the afternoon has a longer duration – from 14 to 19 h at farm 1 and from 16 to 20 h at farm 2. This pattern of excretion frequency is the same as it was observed by Aarnink (1997).

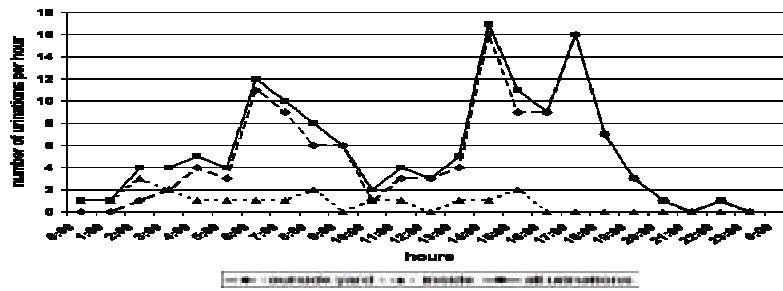


Figure 2: Urination activity of 45-kg fatteners at farm 1.

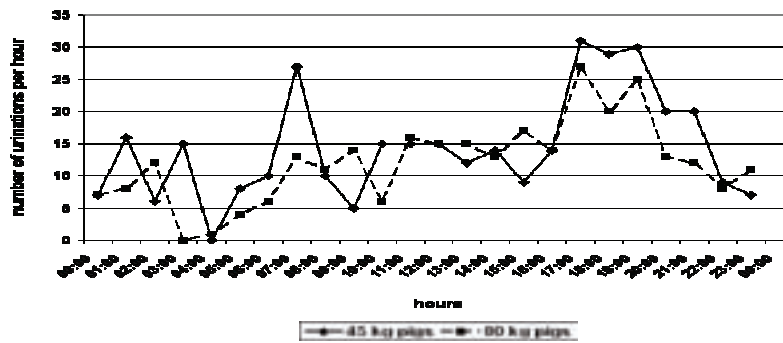


Figure 3: Urination activity of 45-kg and 80-kg fatteners at farm 2.

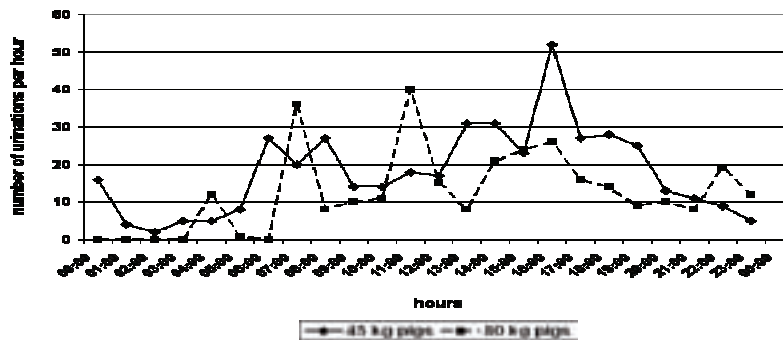


Figure 4: Urination activity of 45-kg and 80-kg fatteners at farm 3.

**Tab. 1: Predicted means of NH<sub>3</sub> emissions (gday<sup>-1</sup>m<sup>-2</sup>) for interaction between location and degree of fouling in fattening pigs at three organic farms.**

Location	Clean	Fouled	S.E.D
Inside	1.9	13.3	Location - 3.1
Outside	2.7	11.4	Fouled - 3.1

In table 1 the effect of fouled and clean areas for all three farms on ammonia emission is summarized. A fouled area inside caused higher emission per m<sup>2</sup> than a fouled area outside. These results correspond to the results of von Wachenfelt and Jeppsson (2006) from outside yards of organically raised pigs (9-12 gday<sup>-1</sup>m<sup>-2</sup>).

### Discussion

Ammonia emission from pig buildings is influenced very much from the pattern of excreting behaviour. When given the choice, the natural behaviour of pigs is to separate the lying and dunging places (Aarnink et al., 1996, van Putten, 2000). In our study, the pigs had a preference to urinate and defecate on the outside yard and to keep the lying area inside clean. Thus the polluted area outside was larger than that inside. Because ammonia emission is positively related to the fouled area (Aarnink et al., 1996), this also could explain the effect of clean and fouled areas inside/outside. In our study fouled areas inside emitted more ammonia than that outside, because of a building up of dung and urine in the straw. This could contribute to the longer emission of ammonia. Fouled straw inside the building, used in organic pig production compulsory to improve animal welfare, could also increase this effect because of a larger emitting area than paved outside yard.

As it was discovered before (Aarnink, 1997) the peaks in emission coincide with the peaks of urinating frequency. Since number of excretions is closely related to the ammonia emission, this could provide information for their variation during the day. So in our study the peaks in ammonia emission could be predicted from urinating behaviour once in the morning and second in the afternoon hours.

### Conclusion

There were two excretion peaks – one in the morning and one in the afternoon-evening hours. Clean areas inside the building emitted 1.9 gday<sup>-1</sup>m<sup>-2</sup> ammonia and clean areas on the outside yard – 2.7 gday<sup>-1</sup>m<sup>-2</sup>. Inside polluted areas had a higher emission - 13.3 gday<sup>-1</sup>m<sup>-2</sup> than the polluted areas on the outside yard – 11.4 gday<sup>-1</sup>m<sup>-2</sup>.

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# Profitability of Sow husbandry in organic farming– Performance and construction costs for group housing of lactating sows

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Key words: sows, group housing, profitability, performance, construction costs of sow housing

## Abstract

*The group housing of lactating sows represents an economically interesting and also animal welfare alternative to the otherwise usual individual housing in this phase. Aim of this study is to fill existing information gaps and create more planning security.*

*The performance efficiency of the housing system is determined on the basis of biological parameters, based on empirical data of a co-operation project. The influence of the housing system on the construction costs for housing sows is examined by construction models, which are defined on the basis of empirical data and by an expert interview.*

*Better performance data are reached by the group housing system analysed here compared to other studies. The results show that the housing system is both suitable and efficient on farm level.*

*The group housing of lactating sows causes a reduction of construction costs. This difference is especially noticeable when modifying existing buildings. The saving potential is 993 € per housing place.*

## Introduction

The group housing of lactating sows represents an economically interesting and also animal welfare alternative to the otherwise usual individual housing in this phase. It probably has the potential to optimise the profitability of sow husbandry in organic farming (FiBL 2007). However, these group housing systems are as yet not common (Kühberger & Jais 2006) and there is a lack of economic data. Due to this a comparison with other forms of housing is impossible.

The most important target is to analyse whether the group housing of lactating sows is a possibility to potentially increase the profitability of sow husbandry. This study makes a contribution to fill existing information gaps and create more planning security for farm managers. The economic effect of the housing system is primarily recognisable on the performance, the housing construction costs and working time requirement. Therefore the performance with group housing is measured using biological parameters. Furthermore, the potential for cost reduction within the range of sty construction is analysed. The correlation with working time requirement is not part of this research paper.

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## Materials and methods

In this study the term group housing means the combination of individual and group housing over time, because all farms in this research practise it in this way. The empirical data on performance and construction of sow styes are available in a co-operation project (FiBL 2007). The database for this study covers 30 farms, 10 in Germany, 9 in Austria and 11 in Switzerland. For the investigation of the biological parameters, the farmers made written notes for an average of 9 months. 1214 litters were available for evaluation. The empirical data on housing structure was available in the form of sketches and photo documentations.

The biological parameters of "piglet losses", "weaned piglets/ litter" and "reared piglets/ litter" are the interfaces, on which the economic effects of the housing system is recognisable. Firstly, parameters are calculated on the level of each individual farm and afterwards an integrated evaluation is carried out. The parameters in the calculation conform to the arithmetic mean or the weighted mean. Additionally to the means of all farms the parameters are also evaluated for the 25% best, the average ones and the 25% worst. The classification of success is based on the number of weaned piglets per litter. Since this parameter has a normal distribution according to the Shapiro Wilk test, the evaluation conforms to the formation of quartiles. Afterwards the results are to be compared with those of other studies. This procedure makes it possible to determine the performance ability of farms with group housing even if the real influence of the housing system cannot thereby be proven.

The influence of the housing system on the sty construction costs is examined by modelling. Doing so, uniform conditions and realisation can be simulated, that again makes it possible to compare different options of construction concerning the costs. According to the target to determine the financial saving potential of group housing, the investigation focus is concentrated on the housing for farrowing and lactating sows. The empirical data of the group pens on the farms in the research are the basis for further modelling. Additionally to the construction models, the necessary farm models are defined: population of 72 sows, 36 housing places in the housing for farrowing and lactating sows. An additional expert interview supports the accuracy of the achieved results. A scenario for new construction and for modification of buildings (building shell already exists) is depicted. The calculation of construction costs (structure of the costs) is according to DIN 276. The kind of cost calculation is according to DIN 276 cost estimation and cost accounting. In this study only cost groups 300 (construction), 400 (technical facilities) and 500 (outside facilities) are calculated. Other cost groups remain unconsidered, since they are not relevant to answer the given question.

## Results

Performance (Tab. 1):

- The parameters of piglets born alive, weaned and reared piglets per litter are significantly different between the farms in research.
- Better farms have less loss of piglets even if the differences were not significant.
- The performances in group housing are better throughout than those of the farms in the comparative studies (partly even comparing the average of this study with the best of these in other studies).

- Based on the assumption of additional 0.5 piglets per litter (ca. 1 piglet per sow and year) and a price of 80 € per piglet, means that there is an extra income of 80 € per sow and year.

**Tab. 1: Sow husbandry - Performance parameters (comparison)**

Parameter	Farms number of farms in research	all farms [mean]	25% worst farms [mean]	25% best farms [mean]
live born piglets/ litter [mean]	30	11,01 <sup>a</sup>	9,94 <sup>b</sup>	12,02 <sup>c</sup>
mortality in the farrowing pen [% of live born piglets]	27	15,06	15,75	13,48
mortality in the grouping pen [% of live born piglets]	27	3,35	4,01	2,94
total suckling piglet mortality [% of live born piglets]	28	18,62 (21*)	19,76	16,43 (16,7*)
weaned piglets/ litter [mean]	30	9,00 <sup>a</sup> (8,1*)	7,96 <sup>b</sup> (7,2*)	10,05 <sup>c</sup> (8,5*)
rearing loss (after weaning) [% of live born piglets]	16	1,90 (5,5*)	1,46	2,91
reared piglets/ litter [mean]	16	8,59 <sup>a</sup> (7,5*)	7,63 <sup>b</sup>	10,11 <sup>c</sup> (8,15*)
total piglet mortality [% of live born piglets]	16	all farms [mean]: 21,2 (2002/03: 26,6 %**, 2004/05: 23,6 %**)		

Different letters per row indicate significant differences at  $p < 0.05$  (Tukey HSD).

\* Source: Löser & Deerberg 2004 (17 organic piglet producers-no differentiation between housing systems)

\*\* Source: Löser 2006 (2002/2003: 17 organic piglet producer; 2004/2005: 20 organic piglet producers-no differentiation between housing systems)

Construction costs (Tab. 2):

**Tab. 2: Comparison of construction costs in sow husbandry**

	farm model 1		farm model 2 (farrowing house with 36 housing places)
	farrowing house (12 housing places)	sty with grouping pens (24 housing places)	
capital expenditure for modification of buildings	33.662 €	31.582 €	100.986 € (2.805 €/ housing place)
	65.244 € (1.812 €/ housing place)		
capital expenditure for new construction	82.721 €	110.952 €	218.471 € (6.069 €/ housing place)
	193.673 € (5.380 €/ housing place)		

farm model 1: group housing (population of 72 sows)

farm model 2: individual housing (population of 72 sows)

- Group housing reduces construction costs by 993 € per housing place when existing buildings can be modified.
- Group housing reduces construction costs by 689 € per housing place when new construction of buildings is necessary.
- The annuity of 993 € (11 years useful economic life, 5 % interest rate) is 120 € per year, equivalent to 1.5 piglets.
- Group housing reduces costs since there are not so many expensive farrowing pens necessary.

## Discussion

Performance:

The comparison with the parameters measured by Löser and Deerberg shows that on farms with group housing, examined for this study, better results are reached. It could be concluded that group housing of lactating sows leads to an increase in performance. Nevertheless the causality is not yet finally proven. Appropriate results from comparative housing experiments, are at present not adequately existent.

Construction costs:

The calculation in this study is done for a farm model, so that the costs in a real planning situation have to be examined. In this calculation complete new sty equipment is assumed as well as all services from construction firms. In practice the situation is often different, so that the construction costs may be lower. The cost difference for newly built styes is lower because 2 houses in farm model 1 are assumed.

## Conclusions

The results show that the housing system is suitable and efficient on farm level. With group housing of lactating sows the construction costs could be reduced considerably. According to the present level of knowledge the profitability of sow husbandry in organic farming can be optimised by the analysed group housing system.

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# Relationships between sow and piglet traits in organic production outdoors and indoors

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Key words: organic production, piglet mortality, piglet growth, weight loss, backfat loss

## Abstract

The aim of this study was to describe sow and piglet traits and the relationship between them in animals bred for conventional production kept in organic outdoor and indoor environments. *40 sows were studied during a seven week lactation. In parity one and three the sows farrowed outdoors (April to September) in huts and were moved to family grazing paddocks two weeks post partum (pp). In parity two and four the sows farrowed indoors (October to March) in individual pens and were moved to family pens with deep straw bedding two weeks pp.* High backfat and weight loss during lactation was related to low piglet mortality and the relationship was stronger outdoors than indoors. Large litters had lower piglet growth than small litters and the relationship was stronger indoors than outdoors. Sows with larger litters were thinner and lighter at weaning than sows with smaller litters and the relationships were stronger outdoors than indoors. Our interpretation is that the outdoor environment stimulates sows to mobilise their energy reserves and produce milk, to a larger extent than the indoor environment does.

## Introduction

The animals used in organic piglet production today are in most cases animals bred for high production in conventional environments. There is a range of housing and management systems in organic piglet production, determined by herd conditions and country regulations for organic production. Traits have different importance in different environments. Production level differs between breeds in outdoor environments (McGlone and Hicks, 2000). Sow and piglet traits differ in production level between outdoor and indoor environments (Wülbers-Mindermann et al., 2002).

To select suitable animals and develop good management procedures for different organic environments, it is important to know how the animal material used performs in the different environments. The aim of this study is to describe sow and piglet traits and the relationship between them in animals bred for conventional production kept in organic outdoor and indoor environments.

## Material and methods

Forty Yorkshire x Swedish Landrace sows and their first four litters were studied at a research station, on the 60th latitude. The research station was not certified as organic but rules of the Swedish organic certification organisation KRAV were followed, with three exceptions; the sows were dewormed, the feed was not organically grown and

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the indoor housing did not have outdoor access. The sires of the litters were Hampshire boars. The sows were born and raised outdoors. Sows farrowing during winter and spring were kept indoors and sows farrowing summer and autumn were kept outdoors during pregnancy. In parity one and three the sows farrowed in huts (3.9 m<sup>2</sup>) in individual grazing paddocks (2500 m<sup>2</sup>). Two weeks post partum (pp) four sows and their piglets were moved to grazing paddocks (14000 m<sup>2</sup>) with one hut (13.0 m<sup>2</sup>) and one sun shed (11.0 m<sup>2</sup>). In parity two and four the sows farrowed indoors in conventional Swedish farrowing pens without crates (8.2 m<sup>2</sup>). Two weeks pp, four sows and their litters were moved to pens (55m<sup>2</sup> – 114m<sup>2</sup>) with deep straw bedding in an uninsulated building. The sows were individually fed during pregnancy, in the farrowing paddocks and in the farrowing pens. In the family paddocks and the family pens the sows were fed ad lib from an automatic feeder, to which piglets had access. The feed followed a typical Swedish organic feed composition, with 12.2 MJ ME, 154.3 g crude protein, 122.6 g digestible protein and 7.5 g lysine per kg feed. The sows were weighed and measured for backfat (ultrasound) five days before expected farrowing as well as at two and seven weeks of lactation. The piglets were individually weighed at day four, two weeks and seven weeks pp. Piglet mortality was registered continuously from farrowing until weaning. During the first parity two sows were excluded the second week pp, one was treated for disease and the other was culled. Three sows were culled after weaning their first litter. During the second parity one sow was culled the second week and another during the fourth week pp. Two sows were culled after weaning their second litter and seven sows after their third litter.

The statistical analyses were performed with the SAS package, version 9.1 (SAS institute, 2007). PROC GLM was used to estimate residual correlations. Number of live born piglets (15 classes), farrowing season (4 classes) and parity (4 classes) were included in the model. There was no significant interaction between season and parity. Number of live born piglets was excluded from the model when calculating correlations with litter size. For piglet weight day 4 and at weaning, age at weighing (days, 4 and 16 classes, respectively) were included in the model. For sow weight at farrowing and sow weight loss from farrowing to weaning, days from weighing to farrowing (mean 6 days std. 1.9) was included in the model (12 classes). Sow weight five days before expected farrowing was pre-corrected for estimated litter, placenta and amniotic fluid weight to better reflect the sow weight directly after farrowing.

## Results

Least square means for production traits in different parities are given in Table 1. The negative correlation between litter size and piglet growth was stronger indoors than outdoors (Table 2). Sows with larger litters were lighter and thinner at weaning than sows with smaller litters and the relationships were stronger outdoor than indoor. Sows that lost much weight during lactation and were light and thin at weaning had lower mortality in their litters compared to fat and heavy sows, both indoor and outdoor. (Table 2). Piglet growth was not significantly correlated to sow weight or backfat loss. Outdoor litters with high mean piglet weight four days pp had lower mortality than litters with low piglet weight (Table 2). Large indoor litters had higher mortality than small litters (indoor  $r=0.30^*$ , outdoor  $r=-0.10ns$ ).



**Tab. 1: LS-means<sup>1</sup> for production traits in parity 1 to 4**

	DF	Parity 1 Outdoor N=37- 40	Parity 2 Indoor N=33- 36	Parity 3 Outdoor N=31	Parity 4 Indoor N=25
Litter size at d4	125	8.8 <sup>a</sup>	11.6 <sup>b</sup>	10.5 <sup>b</sup>	12.8 <sup>b</sup>
% total mortality until weaning	107	30.1	23.3	31.2	20.5
Piglet mean weight at d4 (kg)	104	1.9 <sup>a</sup>	2.4 <sup>b</sup>	2.4 <sup>b</sup>	2.3 <sup>b</sup>
Piglet growth, d4 - weaning (g/day)	86	283 <sup>a</sup>	393 <sup>b</sup>	348 <sup>b</sup>	409 <sup>b</sup>
Sow weight at weaning (kg)	104	196 <sup>a</sup>	228 <sup>b</sup>	264 <sup>c</sup>	273 <sup>c</sup>
Sow weight change (kg)	91	-22 <sup>ab</sup>	-19 <sup>a</sup>	-32 <sup>a</sup>	-8 <sup>b</sup>
Sow backfat thickness at weaning (mm)	104	13.0	12.6	15.2	15.9
Sow backfat change (mm)	103	-6.9 <sup>a</sup>	-4.2 <sup>ab</sup>	-3.4 <sup>bc</sup>	-1.5 <sup>c</sup>

<sup>1</sup>The values marked with different superscripts on the same row differ from each other (p<0.05). The effect of parity and weighing days were included in the model.

**Tab. 2: Residual correlations between litter size, piglet mortality and piglet and**

	Number of piglets d4		% piglets dead until weaning of live born	
	Outdoor Parity 1 and 3	Indoor Parity 2 and 4	Outdoor Parity 1 and 3	Indoor Parity 2 and 4
Piglet mean weight at d4	-0.53 <sup>***</sup>	-0.72 <sup>***</sup>	-0.41 <sup>**</sup>	- 0.30 <sup>†</sup>
Piglet growth, d4 - weaning	-0.45 <sup>***</sup>	-0.72 <sup>***</sup>	0.39 <sup>*</sup>	0.04
Sow weight at weaning	-0.35 <sup>**</sup>	-0.03	0.44 <sup>**</sup>	0.43 <sup>*</sup>
Sow weight change	-0.12	-0.28 <sup>†</sup>	0.44 <sup>**</sup>	0.38 <sup>*</sup>
Sow backfat thickness at weaning	-0.47 <sup>***</sup>	-0.40 <sup>**</sup>	0.39 <sup>**</sup>	0.53 <sup>***</sup>
Sow backfat change <b>sow traits</b>	-0.20	-0.16	0.42 <sup>**</sup>	0.00

\*\*\* = p<0.001, \*\* = 0.001<p<0.01, \* = 0.01<p<0.05, † = 0.05<p<0.1.

### Discussion and conclusions

During lactation, the sow has to handle the parent-offspring conflict; she has to prioritize between her own, her present litter's and her future litters' needs (Manning and Stamp-Dawkins, 1998). During the first parity the sow is not yet fully grown and need to prioritize energy also to her own growth (Noblet et al., 1998). In accordance to this we found that in first parity litter size, piglet mean weight, piglet growth and sow

weight at weaning were significantly lower, and sow weight loss was significantly higher than in later parities (Table 1). Wülbers-Mindermann et al. (2002) found that sows with large litters lost more weight and fat during lactation than sows with small litters and that the relationship was stronger outdoor than indoor. In the present study we found no significant correlation between litter size and sow weight or backfat loss. Yet, we found that sows with large litters were lighter and thinner at weaning and the relationship was stronger outdoor than indoor. The outdoor environment seems to stimulate sows to mobilize energy reserves to produce milk to a larger extent than the indoor environment does and this seems to be important also for piglet survival. In our study, sows losing little weight and backfat during lactation had higher piglet mortality in their litters, both indoor and outdoor. Outdoor this relationship was also found for backfat change. These findings are in accordance to Grandinson et al. (2005). In order to have energy for the next parity, it is important that the sow has the ability to store and rebuild fat and weight (Whittemore, 1996). In this study, backfat loss during lactation decreased and backfat thickness at weaning increased with parity number (Table 1).

Our interpretation of the estimated correlations from different environments is that an outdoor environment stimulates sows to mobilize their energy reserves and produce milk in favour of piglet growth, to a larger extent than the indoor environment does. It is important for organic pig producers to take these differences between environments into consideration in order to develop good sow management procedures for different organic environments.

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## Effects of silage or probiotics on performance and gut microbial composition of organic growing-finishing pigs

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Key words: organic, growing-finishing pigs, nutrition, performance, microbiota

### Abstract

*This paper will deal with the effects of the oral application of a probiotic preparation (Bifidobacterium animalis) and of the provision of forage (maize and grass silage) to growing-finishing pigs on the composition of the intestinal microbial population and faecal microflora as an important determining factor for pork safety. 76 pigs were reared in 4 different dietary treatments. Clinical health and immune status plus faeces samples and samples of the gut content from the duodenum, ileum, caecum and colon were collected from each animal. Since the second round of the feeding experiment was only finished in March, the datasets are still incomplete because analyses are ongoing, but preliminary results are already available. Microbial analysis showed that CFU (per g DM of faeces) of bifidobacteria ranged from  $2.6 \cdot 10^8$  (maize silage treatment) to  $8.7 \cdot 10^8$  (probiotic treatment). CFU counts of E.coli showed a significantly lower amount for the control treatment ( $4.4 \cdot 10^5$ ) compared with the grass silage- group ( $3.0 \cdot 10^6$ ). Blood analysis did not show significant differences between treatments. Both the high level of animal performance (ADG between 902 and 929 g/d) and the negative clinical findings confirm the good health status of the animals. Statistical analysis with the complete data set will soon show whether the trends from these preliminary results will be confirmed for the overall experiment.*

### Introduction

Organic pork is placed as a premium product on the meat market. Besides the eating quality, the nutrient content and other product quality traits, organic production also has to guarantee a high level of food safety. Meat contaminated with pathogens will potentially threaten public health (Leclerc et al., 2002). Pathogens may be introduced into the pig production chain at several levels, reaching from the feed mill to the pork distributors. Therefore, control measures must be applied on different levels if meat safety is to be guaranteed (Lo Fo Wong et al., 2002). On the herd level, the occurrence of pathogens in the intestines of growing-finishing pigs can be seen as one potential starting point for further problems in the food chain. To avoid spreading of potential pathogens via this path, organic production systems focus on improved housing conditions, high quality components in nutrition and animal health and

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welfare. The concept of eubiosis seems to be a promising strategy for organic livestock; this includes the maintenance of a stable microbial population in the intestines which puts substantial competitive pressure on pathogens. Regulation 2092/91 (Council of the European Union, 1999) obliges organic farmers to provide forage as a routine management measure for monogastric livestock. This practice should lead to beneficial effects on animal health and welfare by maintaining homeostatic conditions in the intestines. The occurrence of enteric pathogens may be reduced due to the formation of organic acids and the growth of competing eubacteria which utilize a variety of fibre components (non-starch carbohydrates, oligosaccharides, cellulose etc. (Zentek, 1997; Brunsgaard, 1998; Stege et al., 2001)). Basically, a stable eubacterial microflora exerts fundamental stimuli on the formation of antibodies (Gebbers & Laissue, 1984; Alverdy et al., 1985).

Therefore in this study the effects of providing growing-finishing organic pigs with either grass silage, maize silage or a probiotic preparation were tested on performance, carcass quality and gut microbial composition.

### Animals, materials and methods

The experiments were conducted at the experimental barn of the Institute of Organic Farming and Farm Animal Biodiversity (HBLFA Raumberg-Gumpenstein) from August 2006 until March 2007. 76 pigs were assigned to 4 different dietary treatments in two experimental rounds: control diet (ct), ct+grass silage, ct+maize silage, ct+probiotics. All groups were feed restricted from 90 kg BW onwards to the end of the experiment with a maximum daily feed provision of 2.7 kg of compound feed.

Each group (4 - 5 animals) was offered two to three kilograms of silage every morning. In case the total amount of silage was consumed by one group, the amount offered was increased. Before giving the fresh silage, the leftovers from the day before was weighed back in order to record the estimated amount that disappeared. Additionally, the n-alkane method (Mayes et al., 1986) was used three times per trial to estimate the forage intake. The probiotic group received a probiotic preparation (*Bifidobacterium animalis* subsp. *lactis* Ra 18, developed at the University of Bologna) fed daily together with the compound feed. Every pig in the probiotic group was planned to receive about 200 millions of bifidobacteria per day.

### Results and discussion

Since the datasets are still incomplete due to ongoing analyses, preliminary results are presented herein. In table 1 the faecal microbial composition is given for the experimental treatments.

**Tab. 1: Microbial composition of faeces (CFU/ g DM)**

treatment	n	<i>Clostridium</i> sp.	<i>Bifidobacteria</i> sp.	<i>E. coli</i>
		p = 0.030	p < 0.001	p = 0.059
control	19	1.19*10 <sup>8</sup> <sup>ab</sup>	5.95*10 <sup>8</sup> <sup>a</sup>	3.74*10 <sup>5</sup> <sup>ab</sup>
probiotics	19	1.09*10 <sup>8</sup> <sup>ab</sup>	9.04*10 <sup>8</sup> <sup>c</sup>	1.70*10 <sup>5</sup> <sup>a</sup>
maize silage	19	8.10*10 <sup>7</sup> <sup>a</sup>	3.49*10 <sup>8</sup> <sup>b</sup>	7.48*10 <sup>5</sup> <sup>b</sup>
grass silage	19	1.57*10 <sup>8</sup> <sup>b</sup>	5.03*10 <sup>8</sup> <sup>ab</sup>	6.43*10 <sup>5</sup> <sup>ab</sup>

The only significant differences concerning the microbial composition so far detected are shown in table 1. In general the number of Colony forming Units (CFU) per g faeces was high, indicating a well established microbial community in the gastro intestinal tract. Some of the differences between treatments were significant but in microbiological terms too small to conclude a relevant effect. Realtime-PCR showed only 4 positive results in different groups and over the two experimental rounds. In the first round three samples at the slaughterhouse showed the presence of *Lawsonia intracellularis* (2 pigs from the grass silage treatment and 1 from the probiotic treatment) and in the second round one of the faeces samples contained *Lawsonia intracellularis* (grass silage treatment). Blood analysis did not show significant differences between treatments.

Both the high performance level (see table 2) and the negative clinical findings confirm the good health status of the animals.

**Tab. 2: Animal performance**

treatment	n	daily weight gain	carcass	lean meat	pH
		p = 0.634	p = 0.215	p = 0.093	p = 0.003
control	19	902 g/d	79.01 %	58.52 %	6.41 <sup>ab</sup>
probiotics	19	929 g/d	79.39 %	57.84 %	6.39 <sup>ab</sup>
maize silage	19	916 g/d	79.09 %	59.64 %	6.26 <sup>b</sup>
grass silage	19	903 g/d	79.61 %	58.74 %	6.48 <sup>a</sup>

Preliminary results for forage intake using the n-Alkane method (Mayes et al., 1986) from the first sampling period (1st experimental round) showed that all animals consumed certain amounts of forage. The control and probiotic group consumed only straw (from the straw bedding) and the grass and maize silage group a mixture of straw and silage. The relation of straw and silage is unknown but intake of grass and maize silage was observed for both silage groups.

Obtaining reliable results from daily weighing of the trough feeder was sometimes difficult. All of the animals showed distinct explorative behaviour using silage as substrate; due to its structure and other factors, maize silage was obviously more attractive for pigs than grass silage. Obvious losses had to be replenished without adding too much straw or other organic material from the area around the trough feeder. After the n-Alkane analysis is completed, the results will help to correctly interpret the results derived by weighing and to estimate the overall forage intake (table 3).

**Tab. 3: Estimated forage intake using the n-Alkane method (Mayes et al., 1986) and weight difference**

treatment	n-Alkane method (g as fed /d & pen)	weighing trough feeder (g as fed /d & pen)
control	299	
probiotics	234	
maize silage	1503	450
grass silage	588	465

However, the stimulating effect of fibre components on the gut microbiota should be granted even if the lactic acid bacteria do not survive the stomach passage. Additional effects can be expected from the formation of organic acids which help create a hostile environment for enteric pathogens in the gut (Zentek, 1997; Brunsgaard, 1998; Stege et al., 2001). From the data available so far it can be concluded that supplementing organic growing-finishing pigs with maize silage, grasssilage or a probiotic preparation consisting of a certain strain of *Bifidobacteria* sp. does not significantly affect performance and carcass traits. Effects on the microbial composition of faeces may be too small to be of practical relevance and need to be confirmed by analysis of digesta samples from different positions of the intestinal tract.

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## **Prolonged suckling period in organic piglet production – effects on selected immunological parameters**

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Key words: Organic piglet production, prolonged suckling period, weaning age, immune system

### **Abstract**

*During weaning, piglets are under strain from the loss of their dam, the change in feed, and a new microbiological environment. How much this strain influences the piglets depends mostly on their immune system. Piglets from organic production are weaned later (at least 40 days) than piglets from conventional rearing, but the performance and health status of organic piglets are often not satisfying. Therefore, it was the aim to investigate whether a prolonged suckling period of 63 days results in better immune status of piglets than with weaning at day 42. To answer that question we vaccinated piglets at different times with a “known” (by vaccination of dam) and an “unknown” antigen and analysed the plasma for immunoglobulin G (IgG) concentration and the antigen-specific IgG antibodies by ELISA. Two farrowing cycles of 36 sows were recorded. Time of vaccination did not influence IgG concentration. In contrast, early weaned piglets showed a higher IgG concentration on day 49 than late weaned piglets. During the first farrowing cycle a significant immune response against both antigens was present in piglets vaccinated on day 42. Such a response was not found in piglets vaccinated on day 63 and in piglets of the second farrowing cycle. In conclusion, the results did not show an improved immune status of piglets undergoing a suckling period of 63 days.*

### **Introduction**

Organic piglet production is often characterized by poorer performance compared with conventional reared piglets. Whereas the number of piglets born alive is the same, the number of reared piglets is definitely too low (Löser, 2007). Weaning challenges piglets in many different ways. How much the different strains influence the health status of the piglets depends mostly on the immune system. Passive immunity, first established by immunoglobulin transfer by colostrum milk from the sow to the piglets, decreases in the piglet as long as the production of endogenous immunoglobulin is at

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the beginning. This leads to an “immunological gap” between day 20 and day 40 (Lang, 2004). Even if piglets from organic production have a longer suckling period (at least 40 days, minimum requirement of the EEC Regulation 2092/91) than piglets from conventional rearing, the “immunological gap” still seems to be present in those piglets, leading to the described consequences in performance and health status. Therefore, it was the aim of the present study to investigate whether a prolonged suckling period of 63 days results in better immune status of the piglets compared to weaning at day 42. The immune response to a “known” and “unknown” antigen was tested.

## Materials and methods

The trial was performed from spring 2006 to mid 2007 at the experimental organic farm of the Institute of Organic Farming of the Federal Agricultural Research Centre in Trenthorst, Germany, in accordance with Regulation 2092/91/EEC and the IFOAM Basic Guidelines. A total of 44 sows of the genotype “Schaumann” (crossbreed of German Landrace, German Large White, and Duroc) were kept: 36 sows were used for the investigation and 8 sows were kept in reserve in a parallel farrowing rhythm in order to replace sow losses.

The 36 sows were divided into 4 groups with the following treatment of the piglets: (I) early weaning and vaccination (day 42); (II) early weaning (day 42) and late vaccination (day 63); (III) late weaning (day 63) and early vaccination (day 42); (IV) late weaning and vaccination (day 63). Fourteen days after single grouped farrowing, three sows were grouped together with their respective litters and were group housed until weaning. At the weaning date the sows were removed. The weaned piglets remained in their familiar surroundings for 4 days. Then they were housed in separate indoor rearing pens in the composition of the previous suckling pig groups. Piglets were vaccinated with two antigens: avian immunoglobulin Y (IgY), which should be “unknown” for the piglets; and the “known” ovalbumin (OVA). For that antigen, maternal antibodies should exist because of a vaccination of the sows before farrowing. Secondary vaccination (Booster) was done 21 days later.

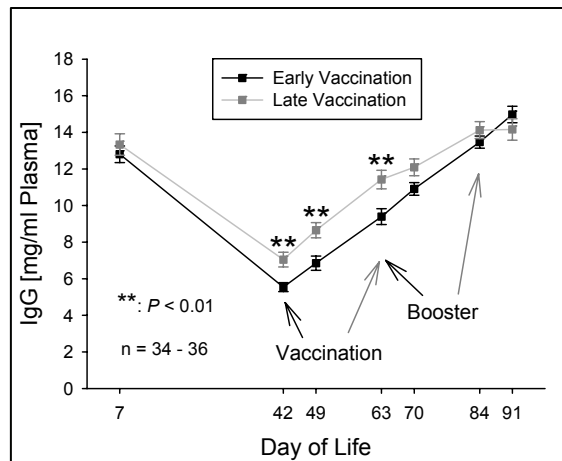
Blood was sampled from eight piglets per litter on days 7, 42, 49, 63, 70, 84, and 91. Plasma was analysed for immunoglobulin G (IgG) concentration and for specific IgG antibodies against IgY and OVA by a sandwich ELISA (Erhard et al., 2001). Two farrowing cycles were recorded.

Because of a significant influence of the sows on the IgG concentration of piglets on day 7, we pooled the values of the piglets for each litter. Thereafter, two-way analysis of variance with the factors “time of weaning” and “time of vaccination” was used for the statistical comparison of groups in IgG concentration, including both farrowing cycles. Specific IgG anti-OVA and IgG anti-IgY titer were compared between early and late weaned piglets separately for each farrowing cycle by Student's t-test and Mann-Whitney's rank sum test, respectively.

## Results

Despite a higher level in the course of IgG concentration over time of late vaccinated piglets in contrast to early vaccinated piglets, vaccination itself did not seem to have any influence on the IgG concentration (Fig. 1).





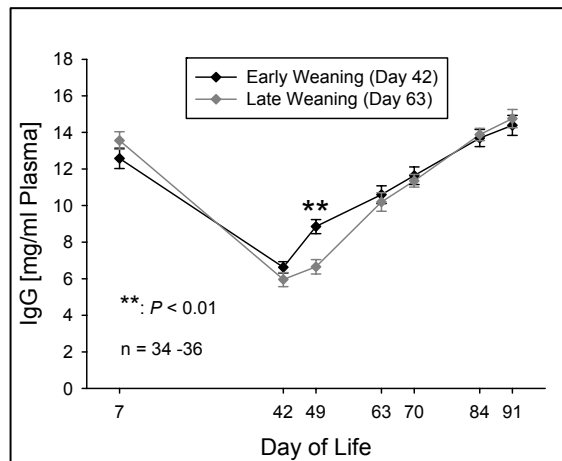
**Figure 1: IgG levels of piglets early and late vaccinated, independent of the time of weaning. Mean  $\pm$  SEM of litter means from 34 - 36 litters and eight piglets per litter.**

However, early weaned piglets showed a higher IgG concentration on day 49 than late weaned piglets (Fig. 2).

During the first farrowing cycle a significant immune response against OVA and IgY was present in piglets vaccinated on day 42, independent of the time of weaning. Such a response was not found in piglets vaccinated on day 63 and in piglets of the second farrowing cycle (data not shown).

### Discussion

The course in IgG levels over time of all treatment groups is congruent with data from conventionally reared piglets weaned after 21 days (Lang, 2004). The differences in the IgG values between early and late vaccinated piglets might be caused by the study design, where the allotment of sows and litters to the different treatments was oriented to the more important factor "time of weaning". Interestingly, early weaned piglets showed a significantly higher IgG concentration on day 49. It is known that weaning increases the production of inflammatory cytokines (Pie et al., 2004), but it is postulated that weaning stress decreases the immune response (Blecha et al., 1983). Additionally, such an IgG "response" was not present in piglets after weaning at day 63.



**Figure 2: IgG levels of piglets early and late weaned, independent of the time of vaccination. Mean  $\pm$  SEM of litter means from 34 - 36 litters and eight piglets per litter.**

### Conclusions

The results of the present study did not show an improved immune status of piglets undergoing a suckling period of 63 days. However, because good performance and health status of these late weaned piglets was found by Bussemas and Weissmann (2008, in this volume), a prolonged suckling period compared to the minimum requirement of the EEC Regulation 2092/91 seems to be recommendable.

### Acknowledgments

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# Antimicrobial effect of dietary nitrate in weaning piglets challenged or not with *Salmonella enterica* serovar typhimurium

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Key words: nitrates, intestinal microbiota, weaning piglets, *Salmonella*.

## Abstract

*The maintenance of a beneficial bacteria balance in the gut is important to increase the animal's resistance to diseases. Nitrite may kill gut pathogens representing a non-immune defence mechanism. Nitrite can be derived from dietary nitrate that is reduced under the acidic conditions of the oral cavity.*

*An in vivo study was designed in order to establish the antimicrobial effects of dietary nitrate on the gut microbiota and on the health of 96 weaning piglets. The pigs were fed a diet containing high levels of nitrate (15 mg/kg feed and 150 mg/kg feed) and then challenged with *Salmonella enterica* serovar typhimurium. Changes of the intestinal microbiota composition were assessed by analysing the stomach and jejunum contents from all the pigs.*

*Results showed that nitrate only affected the population levels of Lactic Acid Bacteria (LAB) in both segments. Pigs challenged with *Salmonella* showed a reduction in the levels of *E. coli* and clostridia in the jejunum suggesting a mechanism of competition for niches or for active sites. The time from challenge significantly decreased the number of LAB in stomach and jejunum. It also decreased the population density of clostridia in the stomach. The supplementation of feedstuff with high dietary nitrate intake contemporarily to the challenge with *Salmonella* did not affect the degree of ulceration in the pigs.*

## Introduction

To combat pathogens is of primary importance in livestock production. This due to the economically damaging problems linked with infections caused by pathogens in newborn animals (Jacobson et al., 2003).

It has recently been shown that compounds such as nitrates, become powerful antimicrobial agents to acid conditions (e.g. stomach). They increase the resistance to

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pathogens, whereas acid alone would only have a bacteriostatic effect (Dykhuizen R. et al., 1996).

When dietary nitrates are swallowed they are rapidly absorbed mostly from the upper small intestine and lesser from the stomach in the blood stream (McKnight G.M. et al., 1997). Nitrates are then concentrated into the salivary glands (Spiegelhalter B. et al., 1976). Approximately 25% of dietary nitrate is re-circulated by this process named "enterosalivary circulation". Nitrites are then formed from nitrates in the oral cavity by nitrate reductase expressed by microorganisms in the mouth and then re-secreted into the upper intestinal tract (McKnight G.M. et al., 1999; Dykhuizen R. et al., 1996).

Nitrates can have antimicrobial effects not only towards intestinal pathogens as *Salmonella*, *Yersinia* and *E. coli* strains, but also against *Helicobacter pylori* (Benjamin N. et al., 1994), a bacterium that could be responsible for ulcers in the mucous of the stomach. These ulcers represent a problem from the commercial point of view of the livestock production, due to the reduction of the feed conversion power and of the animal growth (Preziosi R. et al. 2000).

Furthermore the recirculation of nitrates by the organism into the "enterosalivary circulation" would also suggest a beneficial function of nitrates for the animals (McKnight G.M. et al., 1999).

The aims of this study were to assess the impact of increasing doses of dietary nitrate on ulceration levels in pigs and to quantify the effect of supplementing the diet of pigs with nitrates on the population density of normal stomach and upper intestine microflora.

## Materials and methods

The experiment was carried out to test the effect of two different doses of nitrate supplied by potassium salt, on normal stomach and upper intestine microbiota and ulceration levels in the stomach of pigs challenged or not with *Salmonella enterica* serovar *typhimurium*. The pigs were challenged with 1.5 ml broth orally supplied containing  $1 \times 10^9$  CFU *Salmonella enterica* serovar *typhimurium*. Control pigs received a placebo (only broth). Half of the pigs were sacrificed on day+7 (+ 2 after being challenged), and the other half on day+25 (+20 after being challenged).

A total of 96 pigs (Landrace x Large White), weaned at 21 days, were randomly assigned to one of the following treatments: 1. base diet (16 pigs); 2. base diet + 15 mg/kg nitrates (16 pigs); 3. base diet + 150 mg/kg nitrates (16 pigs); 4. base diet + Salmonella (16 pigs); 5. base diet + 15 mg/kg nitrates + Salmonella (16 pigs); 6. base diet + 150 mg/kg nitrates + Salmonella (16 pigs).

The stomach was removed for quantification of the ulcerae. The gastric content was measured for pH after sacrifice.

Using plate counts, five microbial groups were enumerated in the stomach and in the jejunum contents: LAB, *Bifidobacterium* spp., *E. coli*, *Clostridium* spp, and Yeasts. The quantitative detection of *Bifidobacterium* spp. was also performed by a direct semi-quantitative genus PCR. The pathogen *Salmonella enterica* serovar *typhimurium* was qualitatively detected in faecal samples, mesenteric lymph nodes and in jejunum contents.

The data were analysed by analysis of variance (GLM of SAS) of three factorial models, A) data in vivo before challenge: diet and block (batch); B) data post

challenge: model A + challenge (yes/not) and the interaction; C) data obtained at different days of sacrifice: model B + day of sacrifice (2 or 20 days from the challenge) and the interaction. Orthogonal pre-planned comparisons were tested for the effect of the diet: control vs. nitrate additions; between nitrate additions.

## Results

The effects of the diet, the challenge and the time from challenge on average values of cultivable microbial groups in stomach and jejunum contents are shown in table 1.

There were no interactions between the different factors.

In both segments, the population density of clostridia, bifidobacteria, yeasts and *E. coli* were not affected by the diet. However the concentration of *E. coli* in the stomach was sufficient to be recoverable by plate counts in 62.5% of the pigs in the control group, whereas in the groups of pigs receiving nitrates the frequency of pigs positive for the *E. coli* presence was lower (ranging from 31-37%). With higher intake of nitrate (150mg/kg), a significant decrease in the levels of LAB was observed in jejunum contents (P<0.05).

The time from challenge had an important effect of decreasing the counts of LAB in both segments and the counts of clostridia in the stomach (P<0.01).

In challenged pigs, *E. coli* significantly decreased in jejunum, whereas we only noted a trend of decreasing clostridia counts in the same segment.

Table 1. Effect of the diet, challenge and time from challenge on average values of bacteria in the stomach and in the jejunum contents of pigs fed high nitrate concentration.

Stomach	Diet				Challenge Salmonella			Days post challenge		
	C	Ni15	Ni150	SEM	no	yes	SEM	2	20	SEM
<i>E. coli</i> <sup>a</sup>	2.90	3.21	3.44	0.34	3.04	3.32	0.28	2.96	3.40	0.29
LAB	5.99	6.09	6.19	0.34	6.19	5.99	0.28	6.97	5.20	0.28 <sup>b</sup>
Yeasts	5.29	5.31	5.45	0.24	5.40	5.30	0.20	5.57	5.13	0.20
Clostridia	5.61	5.54	5.96	0.31	5.84	5.56	0.25	6.39	5.02	0.25 <sup>b</sup>
<i>Bifidobacterium</i> spp.	6.41	6.18	6.38	0.12	6.38	6.26	0.10	6.53	6.11	0.09
<b>Jejunum</b>										
<i>E. coli</i> <sup>a</sup>	5.82	5.90	6.01	0.32	6.32	5.50	0.26 <sup>c</sup>	5.96	5.86	0.26
LAB	6.55	7.17	6.51	0.21 <sup>e</sup>	6.93	6.56	0.17	7.14	6.35	0.17 <sup>b</sup>
Yeasts	5.79	5.87	5.82	0.22	5.82	5.83	0.18	5.78	5.88	0.18
Clostridia	7.05	7.13	7.17	0.20	7.31	6.92	0.17 <sup>d</sup>	7.16	7.07	0.16
<i>Bifidobacterium</i> spp.	6.82	7.07	6.46	0.19	6.65	6.91	0.16	6.86	6.70	0.16

<sup>a</sup> Only 32 pigs had detectable values: 10 for C, 12 for Ni15; 10 for Ni150; 20 for unchallenged, 12 for challenged pigs.

<sup>b</sup> Days Post challenge, P < 0.01.

<sup>c</sup> Challenge, P < 0.05. <sup>d</sup> Challenge, P = 0.10.

<sup>e</sup> Ni15 Vs Ni150, P < 0.05.

Interactions between different factors were never statistically significant (P > 0.05).

## Discussion

The dietary addition of nitrate and the presence of *Salmonella* did not affect the degree of ulceration in the stomach. The appearance of the gastric mucosa was indicative of a healthy condition of pigs. The supplementation of the diet with nitrates did not affect the population density of the bacteria in both segments, with the only exception of cultivable LAB in the jejunum contents that significantly decreased ( $P<0.05$ ). The reduction of LAB content with time, and therefore with age, could be linked to the suspension of milk supplementation after weaning that reduces the intake of substrates favourable for LAB growth. *Salmonella enterica* serovar *typhimurium* was found in almost all challenged pigs. In jejunum contents of challenged piglets there was a significant reduction of *E. coli* concentration ( $P<0.05$ ) and a trend of reduction in clostridia levels. This could be probably due to a niche exclusion mechanism and/or to a competition for active sites. Nitrates did not seem to confer resistance against the *Salmonella* colonisation, even though some unchallenged pigs also resulted positive for the *Salmonella* presence in the lymph nodes and in jejunum contents.

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## **Organic ruminant feeding**



# How can the organic dairy farmer be self-sufficient with vitamins and minerals?

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Key words: Dairy, Decision support model, Mineral, Vitamin,

## Abstract

*The aim of the present paper is to present a prototype of a decision support model simulating the feed and vitamin supply during a year on a farm self-sufficient with feed. The model takes into account that the content of vitamin and minerals depends on choice of crops, conservation method, season, plant development at harvest, quality of the silage production, and duration of storage together with traditional optimizing of the feeding scheme.*

## Introduction

Self-sufficiency and recirculation of nutrients within the farm are central elements of the organic principles and if supplements such as vitamins and micro minerals are necessary they should come from natural sources, if possible (IFOAM, 2002). Organic dairy herds are fed 100% organically grown feed, but most supplements of minerals and vitamins are based on inorganic and synthetic products imported to the farm. Our hypothesis is that self-sufficiency with vitamins and minerals could be obtained at farm level through optimization of the choice of forage crops, management and combination of feedstuffs.

## Materials and methods

The decision support model is a static, deterministic model that calculates the consequences of choosing different strategies for feed production. Inputs are type of crops grown, including the use of herbs; conservation methods; season, stage of plant development at harvest, quality of the silage production and duration of storage. Output is the total supply of vitamins and mineral from the feed production on the farms, as well as actual supply for the different animal groups during the season. The model is therefore also a way to plan the use of the produced feed strategically during the season taking into account the loss of vitamins during storage. In the model, focus is primarily on the supplementation of zinc (Zn), copper (Cu) and selenium (Se) and vitamin A and E.

## Results and discussion

The highest concentrations of pro-vitamin A (in the form of beta-carotene) and vitamin E (alfa-tocopherol) are found in grass, legumes and other green plants, while seeds, whole crop and corn silage only contain small amounts of vitamins. Some herbs have especially high levels of one or more minerals. A high concentrations of Zn, Cu, Se has been found in chicory and plantain (Sanderson et al., 2003) and sainfoin had a

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high Cu and Zn concentration (Kidambi et al., 1990). One means of ensuring adequate mineral nutrition of the diet is to increase the floristic diversity of the sward. The model includes the crops traditionally grown on organic dairy farms: barley, oats, wheat, maize, peas, blue lupines, perennial ryegrass, white and red clover, and lucerne. Furthermore some new crops and herbs are included: timothy, chicory, plantain, caraway, bird's-foot trefoil, sainfoin, chervil and salad burnet.

Grazing cattle normally have their requirements for fat-soluble vitamins met, whereas the content of fat-soluble vitamins may decrease to very low amounts when conserved herbage is used instead of pasture. The content of vitamin E in the ensiled crop is 59% lower for grasses and clover, when compared to the fresh crop and the content of vitamin A is reduced by 75% (Jensen, 2003) by ensiling. Hay making causes an up to 90% reduction in the content of A and E vitamin when compared with fresh grass (Jensen, 2003). The vitamin loss is lower if grasses and clover are dried for pellet production, compared with fresh crops there is a loss of vitamin E of 67% and of A vitamin of 25% (Jensen, 2003). In the model, grasses and legumes can be grazed, ensiled, harvested as hay or produced as pellets.

For grass-clover grazed it was found that the concentration of both Zn and Cu were increased during the season (Jensen et al., 2000). Also for chicory the contents of Cu and Zn were increased during the growing season (Jung et al., 1996). The model includes the effect of season by including month in which the crop is harvested.

The highest concentrations of pro-vitamin A and vitamin E are found in the green leaves, while stem and more mature crops only contain small amounts (Jensen, 2003). For lucerne and timothy, content of vitamin E fell by 20-65% depending on whether the crop was harvested at the grass-stage or at the full flowering stage (Kivimäe & Carpena, 1973). Flye & Strudsholm (1994) found that variation in plant development (digestibility) could explain 25 to 85% of the variation in content of vitamin E in whole crop silage. In the model plant development is defined as early, middle or late. It is assumed that the level of vitamin E is 33% higher than the average value for plants harvested at early development and 33% lower than average for plants harvested at late development.

In the model the quality of the silage production is defined by pH and ammonia.

The vitamins will undergo continuous degradation during storage, whereas the minerals will normally not be lost. The loss of E-vitamin in ensiled feed seems to be greater for whole crop than for grass silage, probably due to the higher risk of creating heat (Knudsen et al., 2001). According to Knudsen et al. (2001) 20% of vitamin E in the ensiled grass, clover and lucerne will be lost after six months of storage, for maize and whole crop silage the loss of vitamin E is expected to be 30-40% after six months. Number of months in storage is included in the model.

#### *Strategies for feed production*

In table 1 is presented different strategies for organic milk production based entirely on home-grown feed. Farm no 1 represent the present Danish organic milk production with a feeding level of 6415 kg dry matter per cow per year and a milk production of 8161 kg ECM per cow per year. 60% of the land on farm no 1 is grown with grass-clover for pasture and silage and 40% are grown with cereals for maturity and whole crop. On farm no 2 same strategy is used but the digestibility of the silage is lower, resulting in a lower level of feed intake and milk production per cow. On farm 3 maize

silage make up 25% of the silage during winter-feeding and all silage during summer feeding. On farm 4 cereals is replaced by grass pellets.

In Table 2 is shown the level of vitamins (E and A in the form of beta-carotene) and minerals (Zn, Cu and Se) in summer and winter-feeding for the high yielding cows. Growing silage with low digestibility reduced total E vitamin production by 21%, and the level of vitamin E in the winter feeding ration for high yielding cows could not reach the recommended level for vitamin E. Replacing cereals by grass pellets increased total production of beta-carotene by 11%. All feeding rations were above the recommended level of beta-carotene.

During summer feeding, all strategies almost reached recommended level for Zn (95 to 98% of requirement). During the winter feeding the Zn requirement was only fulfilled by 83 to 85%, except for the grass pellet strategy that reached 96% of the requirement. Regarding supply of Cu, only 56-67% of the requirement is reached by the strategies, except for the grass pellet strategy that reach 82% of the requirement. Regarding supply of Se, only 38 to 49% of the requirement was reached by the strategies.

One way to increase the supply of Cu is to add chicory and plantain to the grass-clover fields as these crops both have a high content of Cu. If chicory and plantain each make up 10% of dry matter yield in all grass-clover fields in strategy 1, the total production of Cu from the 200 ha on the farm will increase by 30%. Thereby, it becomes possible to reach 95% of the recommended level for Cu. However, as crop yield (kg DM/ha) from chicory is assumed to be 75% of that of grass-clover, and crop yield from plantain is assumed to be 36% of that of grass-clover, the total crop production from the 200 ha will be 6.6% lower than that in strategy 1. Thereby, there will be feed for seven milk producing units (cows with heifers) less than in strategy 1 and income from milk will decrease by 6.1%. As expenses not are reduced proportionally, the financial result of the farm is decreased by 23% when Cu has to be supplied as home-grown feed.

**Tab. 1: Feed ration per cow per year**

Kg DM per cow per year	1 Basic	2 Low dig.	3 Maize	4 Grass pellets
Cereals	1628	1628	1382	826
Grass pellets	0	0	332	761
Grass-clover fresh	1518	1518	1518	1518
Grass-clover, silage high dig.	3269	0	1757	2472
Grass-clover, silage low dig.	0	3140	0	0
Maize silage	0	0	1341	0
Whole crop silage	0	0	0	903
Kg DM/cow/year	6415	6286	6330	6480
Milk production				
kg ECM/cow/year	8161	7505	8017	7781
kg ECM/ha/year	4990	4771	5273	5049

## Conclusion

This model is supposed to be an effective way of combining existing knowledge with knowledge generated in other parts of this project and makes it applicable to organic farmers and advisers. This preliminary model will be developed in interaction with visits to the study farms, where the aims are to evaluate the present practice and to demonstrate relevant alternatives for mineral and vitamin supply.

**Tab. 2: Content in rations for high yielding cows during summer and winter**

Winter feed ration	1	2	3	4
E-vitamin, mg/cow/day	1248	622	1066	1290
Beta-carotene, mg/cow/day	743	685	745	775
Zn, mg/cow/day (% of requirement)	829 (84)	775 (83)	822 (85)	943 (96)
Cu, mg/cow/day	132 (67)	122 (65)	124 (64)	160 (82)
Se, mg/cow/day	0.79 (40)	0.75 (40)	0.74 (38)	0.77 (39)
Summer feed ration				
E-vitamin, mg/cow/day	1726	1772	1558	1518
Beta-carotene, mg/cow/day	1974	2007	1986	1837
Zn, mg/cow/day (% of requirement)	879 (95)	904 (95)	904 (96)	923 (98)
Cu, mg/cow/day	112 (61)	116 (61)	107 (57)	105 (56)
Se, mg/cow/day	0.91 (49)	0.93 (49)	0.88 (47)	0.89 (47)

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## Production of grain legume crops alternative to soya bean and their use in organic dairy production

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Key words: high protein pea, field bean, lupin, dairy cattle

### Abstract

*This work evaluates the possibility to substitute external soya bean, a high risk GMO alimentary source, with other legumes produced on farm, such as sweet lupin, protein pea and field bean, as alternative protein source in the formulation of diet in organic dairy cattle nutrition. In 2005/2007 periods both the field and feeding trials were carried out in an organic dairy farm in Tuscany. The performances of grain legumes crops were evaluated in terms of grain yield and quality of grains. The alimentary experiment was carried out on dairy cattle fed with two diets: A with extruded soya bean and B with bitter lupin + field bean + high protein pea. In the field trial the Italian sweet lupin varieties (Multitalia) were the most interesting for CP production and pea the best for yield. The feeding trial provided that the protein content was higher for the A diet (with soya bean) while fat, somatic cells and urea content did not differ.*

### Introduction

Grain legumes crops represent a great resource in organic agriculture both to satisfy the nutritional content of organic livestock feeding and to maintain soil fertility. The commercial availability of organic grain legume is decreasing, the costs are high and the GMO contamination risk is particularly high for soya bean, used to achieve the high protein values required by the animals. So, the cultivation of grain legumes such as sweet lupin (*Lupinus albus*), field bean (*Vicia faba var. minor*), high protein pea (*Pisum sativum*) on farm could solve the problem and improve the sustainability of the farm. In particular lupin appears more interesting and promising. It has a DM yield in grain of 1-4 t/ha with a crude protein (CP) and oil content of 30 - 35 % and 10%, respectively (on DM). On contrast soy bean, a high risk GMO supplement, has a DM yield in grain of 2784 kg/ha and 40 - 41% of CP (on DM). Although sweet lupin is widely used in Northern Europe and other large areas of the world, in Italy it is not anymore widely cultivated and only one registered variety (Multitalia) is available. In this work we evaluate the substitution of soya bean with lupin to dairy cattle diet in terms of milk production.

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## Materials and methods

The performances of grain legumes crops (sweet lupin, field bean and high protein pea) were evaluated in an organic dairy farm of Tuscany in 2005-06 (Migliorini et al., 08) and 2006-07 in terms of grain yield, competitive ability against weeds and quality of grains. The feeding trial was carried out on 36 dairy cattle of the Italian Holstein breed from the same dairy farm in Tuscany, divided in two groups, and fed with diet A, containing soya bean and diet B, containing lupin, from June 2006 to March 2007. To avoid the influence of age, season and ration, each group of 18 animals was composed with the same number of primiparous (9) and pluriparous (9), 6 in the 1st 100 days of lactation, 6 the 2nd (100-200 days) and 6 in the last part (>200 days). The two diets (table 1) were conform to the Reg CE 2092/91 for concentrate/forage ratio and they satisfied the energetic and protein needs of 600 kg milking cows with 32,5 kg/day milk production at 4% of fat (INRA, 1988). Feeds were analysed in order to determine dry matter (DM), crude protein (CP), fat, crude fiber (CF), ash according with AOAC methodology (AOAC, 1990) and fibrous fraction (NDF, ADF, ADL) according with Van Soest et al. (1991). Unfortunately, we were limited by commercial reasons to the use of bitter lupin and the one produced in the farm was not yet available. In a previous trial, in order to investigate alkaloids and anti-nutritional factors contained in the bitter lupin (Singh et al., 1994; El-Adawy et al., 2001), we compared two different diets (with and without bitter lupin) to evaluate the apparent digestibility (Lorenzini et al., 2007). Moreover, in order to eliminate the bitter flavour of the lupin bean that cattle seemed not to like, it was necessary to crush and mix the lupin with field bean and protein pea, to make it more appealing to the animals.

**Tab. 1: Characteristics of the two diets provided to two groups of milking cow.**

Components	Dry matter kg		Crude protein kg		UFL	
	Diet A	Diet B	Diet A	Diet B	Diet A	Diet B
Alfalfa hay	1.7	1.7	0.2	0.2	1.1	1.1
May hay	0.9	0.9	0.1	0.1	0.5	0.5
Maize silage	7.2	7.2	0.6	0.6	6.1	6.1
Alfalfa silage	2.1	2.1	0.3	0.3	1.5	1.5
Corn cob silage	3.4	3.4	0.3	0.3	3.1	3.1
Extruded soya bean	0.9	-	0.4	-	1.1	
Barley	2.7	2.7	0.3	0.3	3.1	3.1
Bitter lupin	-	0.8	-	0.3		0.9
Field bean + protein pea	2.2	2.9	0.6	0.8	2.3	2.9
Total	21.1	21.7	2.8	2.9	18.8	19.2
Notes	For. 72%/ Conc. 28%	For. 71%/ Conc. 29%	13.3% DM	13.4% DM	0.9 UFL/kg DM	0.9 UFL/kg DM

Analysis of variance (ANOVA) was applied to milk production using SAS statistical procedures considering as fixed factor diet regime (diet A and diet B) and lactation phase.

## Results and Discussion

The quantity and quality parameters of grain legumes cultivated on farm in 2005-06 are shown in table 2. Considering only the crude protein content, sweet lupin var. Multitalia is the best variety producing 1.607 kg/ha of protein, almost double the field bean var. Vesuvio (CP 819 kg/ha), the less productive one. The protein pea crop varieties, although the CP content is not very high, are very interesting for the production of total CP, due to the good yields. The field bean produced the lower CP total quantity, due to lower yield, compared to others grain legumes. The varieties sown in spring (Pea Hardy and Lupin Luxe) didn't manage to mature properly before the warmth and, except for Lupin Multitalia, their yields were zero.

**Tab. 2: Characteristics of the grain legumes produced in a Tuscan organic farm in 2006.**

Species Variety	GY DM (t/ha)	DM% % DM	CP % DM	FAT % DM	CF % DM	Ash % DM	NDF % DM	ADF % DM	ADL % DM	CP (kg/ha)
F. Vesuv.	3.16	93.65	25.93	0.88	13.77	3.82	30.37	19.86	5.01	819
F. Chiaro	3.49	93.93	27.66	0.76	9.37	3.83	34.58	14.12	2.87	965
P. Class.	5.36	93.75	21.14	1.25	5.16	3.09	30.39	9.73	0.50	1133
P. Hardy a	6.03	93.68	20.32	1.29	1.45	3.10	31.03	11.32	0.10	1225
P. Ideal	5.15	94.53	23.60	1.19	8.01	3.17	30.48	11.82	1.11	1215
P. Hardy s	0.00	93.33	22.41	1.08	10.34	3.62	32.73	18.51	2.03	0
L. Multi.	4.50	95.05	35.72	3.96	15.61	8.68	33.77	26.34	4.42	1607
L. Luxe	0.00	95.05	36.36	5.60	16.66	4.58	27.16	23.23	4.92	0

**Tab. 3: Result of milk productions (diet A, with soya bean and B, with lupin)**

DFR = 306		Treatment		Lact. per.	Treatment x Lactation period			Sig.
		Mean	Sig.	Sig.	0-100 days	100-200 days	>200 days	
Milk kg	Diet A	32.5	***	***	36.7	33.2	30.0	ns
	Diet B	27.8			30.0	28.5	24.6	
Fat %	Diet A	4.1	ns	ns	4.1	4.1	4.0	ns
	Diet B	4.1			4.3	3.9	4.2	
Protein%	Diet A	3.3	**	***	3.0	3.2	3.4	ns
	Diet B	3.1			2.9	3.1	3.4	
SCCx 10 <sup>3</sup> /ml	Diet A	361	ns	ns	503.0	437.6	251.9	ns
	Diet B	267.1			266.5	196.7	362.6	
Urea g/100 ml	Diet A	0.026	ns	ns	0.027	0.025	0.026	ns
	Diet B	0.026			0.027	0.026	0.028	

\* significant for P<0.05 \*\*significant for P<0.01 \*\*\* significant for P<0.01

The results of milk production of the two group fed with different diet are shown in table 3. Although the quantity and quality of milk of the B cow group, fed with bitter lupin, is good, is not the same of the A cow group, fed with soya bean. In particular the alimentary treatment and the lactation period (0-100 days, 100-200 days, >200 days) had a positive influence on the diet A for milk production (+4,7 kg/day) and protein

content (+0,2%), while no influence on fat, somatic cells and urea content was observed. Although the interaction of the two parameters did not show significant differences, we reported the mean value in the table 3 to get an idea of the lactation curve of the two experimental groups. The bitter lupin has never influenced the urea contents in the milk, always at physiological levels in both the experimental groups. It means that it didn't negatively influence the protein metabolism.

## Conclusions

Because the climate (often too dry, too hot and too cold) and soil characteristics (rocky soils), the Mediterranean area normally offers poor pastures and scarce possibilities to produce a sufficient amount of vegetal protein sources to feed dairy cattle (Boyazoglu and Morand, 2000). But, alternative of buying soya bean is feasible in many countries of this area, like in the Central Italy. In fact the production on farm level of field bean, protein pea and sweet lupine provide considerable contributions of nutrient for cattle. In particular, sweet lupine var. Multitalia produced the highest total protein content, while the other non-Italian varieties failed. Protein pea is very interesting for its higher grain yield while field beans may suffer under climatic condition resulting in lower yields. Anyway more research work is needed on the use of local varieties. The introduction of lupine as alternative to soy bean in the formulation of diet in organic dairy cattle nutrition is interesting also in case of bitter lupine. In fact, when mixed with field bean and protein pea, to make it more palatable, the quantity and quality productive levels are slightly lower in comparison with soy bean diet.

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# A discussion of norms for S supply in organic farming based on content in forage and ruminant performance in Norway

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Key words: forage, dairy cattle, deficiency, grassland, sheep

## Abstract

*The content of sulphur (S) in grassland on 27 Norwegian organic farms with dairy or sheep production was investigated in 2001 and 2002. The forage content of S was below the norms (2 g S kg DM<sup>-1</sup>) for both plants and animals in a large proportion of the samples. The average S content in forage at dairy farms was 1.4 g S kg DM<sup>-1</sup> and at sheep farms 1.5 g. Even on grasslands with low plant S content (<1 g S kg DM<sup>-1</sup>), S-fertilization did not increase yields and increased the plants' S content only very slightly. No indications of S deficiency were observed on the dairy farms. For one sheep farm with a forage S content of 1.1 ± 0.1g S kg DM<sup>-1</sup>, brittle and short winter wool was reported.*

## Introduction

Fertilization and mineral supplementation in organic farming systems must be based on the guidelines for organic farming from IFOAM and the set of rules that regulate organic farming practices. The plant and animal requirements for S will depend on growth rate and yield. In organic farming systems, the rather low supply of nitrogen from the soil and diet is an important reason for the low production levels that often are targeted and obtained (e.g. Berry et al. 2002).

If there is a risk that animals are suffering because of too low a mineral supply, or if there is a risk that the production is severely limited, farmers may be allowed to add extra sulphur (S). However, supplementation with any single element may cause new disorders in plants or animals. For example, increased S content in the fodder ration for ruminants may induce secondary copper deficiency in a forage rich diet with a high content of molybdenum (Underwood & Suttle, 1999) and may reduce selenium uptake by both plants (Hopper & Parker, 1999) and ruminants (Ivancic & Weiss, 2001).

Because development of relevant norms demand a lot of resources, extension services often use recommendations developed for conventional agriculture. In case of S, a feed content of 2.0 g S kg DM<sup>-1</sup> for dairy cattle is recommended in Norway (NRC standards, National Research Council, 2001), and the same herbage content for grasses and clover. Because of the high S-content in wool, NRC recommend a S content in feed ration of 1.8 to 2.6 g S kg DM<sup>-1</sup> for young lambs and 1.4 to 1.8 g S kg DM<sup>-1</sup> for mature ewes (Underwood & Suttle, 1999).

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The aim of this paper is to discuss the present recommendations for supply of S to forage plants, dairy cattle and sheep in relation to the S content recorded in forage from Norwegian organic dairy and sheep farms.

## Materials and methods

A survey was carried out on organic sheep (13) and dairy (14) farms in Norway. Samples of standing forage crop were taken from each of three plots in three different grasslands on each of the farms in 2001 and 2002 (Govasmark et al. 2005). On most farms there were two harvests annually, except for on five mountain farms, where only one cut was taken. The botanical composition of the grasslands varied greatly among the farms. The median content of clover was 13 % and 28 % for the first and second harvest, respectively. The corresponding lower - upper quartiles were 5-23 % and 18-44 %. None of the farmers applied any kind of mineral fertilizer to their soils.

There were large variations in feed ration and milk yield among the 14 dairy farms. The fodder ration consisted of 7 to 24 % concentrates (mainly homegrown barley and oats), 20 to 40 % pasture, and the rest silage and hay. The milk yield varied from 3000 to 6300 kg per cow per year, with an average of 4600 kg. The majority of the herds had calving time distributed over a large part of the year. On the sheep farms the main forage in winter was hay. In summer the sheep grazed in mountain areas or other outlying fields. Only small amounts of concentrate before and after lambing were used. Seaweed meals as supplied on four dairy farms contained 2.5-3.5 % S. The rest of the farms did not supply any S beyond S occurring in herbage and cereals.

To investigate whether S fertilization increased S content, yield, and the protein content of the forage, trials were conducted in established grasslands on organic farms; three in 2002, seven in 2004, and five in 2005. In 2002, S was applied in spring as  $\text{MgSO}_4$  at rates of 0, 30 and 60 kg S  $\text{ha}^{-1}$ , and in 2004 and 2005 S was applied in spring as  $\text{CaSO}_4$ ,  $\text{Na}_2\text{SO}_4$  and  $\text{K}_2\text{SO}_4$  at rates of 0, 20 and 40 kg S  $\text{ha}^{-1}$ . In all years herbage samples were taken in mid-June and mid-August at the first and second harvests. Timothy (*Phleum pratense*) and red clover (*Trifolium pratense*) were collected separately on each plot for S and N analysis.

## Results

In the farm survey, the forage S content varied from 0.8 to 3.1 g S kg  $\text{DM}^{-1}$  in the first cut and from 1.0 to 3.1 in the second. Weighted mean values for content of S in forage from dairy and sheep farms were respectively 1.4 and 1.5 g S kg  $\text{DM}^{-1}$ . All forage samples from dairy farms had less than 2.0 g S kg  $\text{DM}^{-1}$  at first cut, and 79% at second cut; 13% and 1% had less than 1.0 g S kg  $\text{DM}^{-1}$  at first cut and second cut, respectively. On the sheep farms, 91% of forage from first and 33% of forage from second cut had less than 2.0 g S kg  $\text{DM}^{-1}$ , and 54 and 9 % had less than 1.4 g S kg  $\text{DM}^{-1}$ . Only two of the total of 110 forage samples collected from sheep farms contained less than 1 g S kg  $\text{DM}^{-1}$ . The S content of oats and barley grown on some of the farms varied from 1.4 to 1.7 g S kg  $\text{DM}^{-1}$ .

In spite of low content of crude protein, the forage N/S ratio was high, and was higher than 12, the recommended value from NRC, in 62 and 70 % of all forage samples from first and second cut, respectively. Neither forage protein nor forage S content had a clear relationship to milk yields. The urea concentration in milk was generally low (3.6 mmol/l).

S fertilization did not increase either the yield or the protein content in the field trials, but had a small but significant effect on forage S content at most sites (Table 1).

**Tab. 1: Yield ( $\text{t ha}^{-1} \text{ yr}^{-1}$ ) and content of sulphur (S) ( $\text{g kg DM}^{-1}$ ) in red clover and timothy after application of 0 and 20  $\text{kg S ha}^{-1} \text{ yr}^{-1}$  as  $\text{CaSO}_4$ ; mean of four fields with two harvests in 2004 and 2005  $\pm$  std dev.**

	First cut			Second cut		
	0	20		0	20	
Kg S $\text{ha}^{-1} \text{ yr}^{-1}$						
DM Yield <sup>a</sup>	5.6 $\pm$ 1.6	5.6 $\pm$ 1.3	n.s.	3.7 $\pm$ 1.4	3.7 $\pm$ 1.3	n.s.
S Timothy <sup>b</sup>	1.0 $\pm$ 0.1	1.1 $\pm$ 0.1	***	1.5 $\pm$ 0.5	1.7 $\pm$ 0.6	*
S Red clover <sup>b</sup>	1.4 $\pm$ 0.2	1.5 $\pm$ 0.2	***	1.2 $\pm$ 0.2	1.3 $\pm$ 0.2	n.s.

<sup>a</sup>n=16, <sup>b</sup>n=8, \* significant for  $P < 0.05$ , \*\*\* significant for  $P < 0.001$

## Discussion

The S content in forage was much lower than recommended for cattle and sheep. Supplementation with concentrates based on barley and oats did not improve the S supply, as indicated by the low S content in grain produced on the farms in this investigation. Thus the S content in the whole fodder rations was low, as seaweed was supplied only on four farms. However, no indications of S deficiency were observed on the dairy farms.

If the supply of N relative to S was too high in the herds studied here, the content of urea in the milk would probably have been considerably higher than recorded, as observed by Qi (1992). Even though 54% of the main harvests (first cut) on the sheep farms contained less S than the lower limit of the recommendations from NRC, no symptoms of deficiency were observed, except on the farm with the lowest S and protein content in the forage. On this farm there were problems with brittle and short winter wool. Lack of symptoms of S-deficiency cannot be caused by the animals using stored S in periods with low S-supply, as sulphur is mainly spent in muscle and the mammary gland, and excess sulphur will be excreted (Underwood & Suttle, 1999). From these observations it may be suggested that the recommendations for S supply are higher than the requirement for dairy cattle and sheep with fodder rations given on these organic farms.

However, the symptoms of S deficiency in ruminants are not specific. S deficiency may result in reduced appetite and digestibility of forage, which is not easy to identify and which may be caused by other factors too (Underwood & Suttle, 1999). The recommendations are also ambiguous. In the British standards (ARC, 1980) the suggested minimum is from 1.0 to 1.5  $\text{g S kg DM}^{-1}$ . The recommendations for S supply to sheep and cattle needs to be critically evaluated in view of the moderate to low intensity levels that are found in organic farming. However, the recommendations may also be too high for conventional agricultural systems.

The lack of response to S application observed in the field trials can be explained by factors other than S limiting plant growth on these farms. However, we are surprised that the yield responses were so low. At some sites the S content in red clover was less than half the level of 2  $\text{g S kg DM}^{-1}$  that is often used as a marginal value for optimal plant growth. We observed similar results for potassium (K) (Øgaard and Hansen, in prep.). Even with low concentrations of K in grassland ( $< 15 \text{ g K kg DM}^{-1}$  in most cases), K fertilization did not increase yields, either alone or in combination with

additional S-supply. N-limited soil-plant-animal systems like those studied here will seldom respond to inputs of other nutrients, as stated by Liebig. The low N availability should be taken into account when extension services are evaluating the need for supplementation of S and other elements in organic farming systems.

Since increased N intensity of farming systems decreases their N efficiency (Bleken et. al, 2005) and increases the N surplus and nitrous oxide emissions (Olesen et. al., 2006), the effects of increased intensity level should be taken in to account in the further development of organic farming systems.

### Conclusions

Except for the symptoms of S-deficiency in wool on one sheep farm, no clear symptoms of S deficiency were observed in the investigated sheep and cattle herds despite S content in roughage that is much lower than what is recommended by the extension service. S fertilization did not increase either the yield or the protein content in the field trials. In most trials, fertilization had a small but significant effect on S content in the herbage

### Acknowledgments

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## **Pisum sativum as alternative protein source in diets for buffalo cows in middle and late stage of lactation**

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Key words: *Bubalus bubalis*, Alternative protein source, Peas, Milk production.

### **Abstract**

*A study was carried out at an organic buffalo farm in order to examine the effect of feeding peas (Pisum sativum L.) as an alternative protein source for buffalo cow diets during middle and late stage of lactation. Two concentrates were formulated to contain, as fed basis, either 350 g/kg of soybean cake (control concentrate, CC) or 450 g/kg of peas (experimental concentrate, ExpC) as the main protein sources. The two concentrates were almost isonitrogenous (on average, crude protein 240 g/kg DM). Twenty buffalo cows were blocked into two groups according to lactation number and previous milk yield and were assigned to one of two dietary treatments from 10° day in milk onwards: control group was offered in the milking parlour 3 kg of CC, while treatment group was offered the same quantity of ExpC. All cows were fed a total mixed ration containing 3 kg of CC. The experimental period was from 100° day in milk onwards. Daily milk yield was not affected by treatment, as well as, milk fat and protein percentages, somatic cell count, urea content, fatty acid composition and clotting properties. Results support the partial substitution of soybean meal with peas in diets for buffalo cows with no negative effects on milk yield and composition.*

### **Introduction**

In the Italian traditional areas of buffalo (*Bubalus bubalis*) breeding (Latina province, Sele Plain and Volturno Plain) there are about 2,000 farms, but only 3 are certified organic. One of the several reasons of this low number is the farmers' concern about the standards required in organic regulation, in particular for feed supply. In the organic farms the protein needs of lactating cows are often supplied by soybean (fed as heat-treated seed or cake) which is, however, agronomically suitable only in limited areas of Italy. By contrast, pea (*Pisum sativum*), besides being better adapted to Mediterranean growth conditions than soybean, has good nutritive value and can be used as protein source for ruminant diet (Khorasani et al., 2001; Froidmont and Bartiaux-Thill, 2004; Masoero et al., 2006, Vander Pol et al., 2008) even in organic livestock systems because have no risk of GMO contamination. The aim of this study was to evaluate the effect of partial replacement of soybean cake with extruded peas in lactating buffalo cow diets on milk production and quality during the second phase

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of lactation. The results concerning the first 100 days of lactation were published elsewhere (Di Francia et al., 2007).

## Materials and methods

The study was carried out on an organic dairy buffalo farm located in the Sele Plain, Campania Region, Southern Italy, in which a commercial compound concentrate containing (as fed basis) 350 g/kg of soybean cake (control concentrate - CC) was used. An experimental concentrate was formulated to contain as the main protein sources 450 g/kg of extruded peas (experimental concentrate -ExpC). The two concentrates were almost isonitrogenous and were organically produced. Twenty multiparous buffalo cows (on average, 604±109 kg of body weight) were blocked by parity (on average, 2.9 ± 1.3 lactations) and milk yield from their previous lactation (on average, 2,116±508 kg) and assigned to one of two dietary treatments from 10° d of lactation onwards: control group was offered twice a day in the milking parlour 1.5 kg of CC, while treatment group was offered the same quantity of ExpC. All cows were fed a standard total mixed ration (TMR) containing 3 kg of CC. Individual milk samples were collected at 2-weeks interval from 100° day in milk onwards and were analysed for chemical composition (Milkoscan 605), urea (CL 10, Eurochem), somatic cell count (SCC; Fossomatic 250). Additional milk samples were taken at 25-day interval and analysed for fatty acid (FA) composition, by using gas chromatography, and clotting properties (Formagraph). The AOAC (1990) methods were used to determine chemical composition of feedstuffs. Mozzarella cheese yield was calculated according Altiero et al. (1989). Data on milk yield and quality underwent analysis of variance for repeated measures (SAS, 1990) with treatment (CC and ExpC) as a non-repeated factor and week of observation and week of observation x treatment as repeated factors. Single cows were the experimental unit.

## Results

ExpC concentrate compared to the CC had similar chemical characteristics (g/kg DM): crude protein 245 vs. 239; NDF 244 vs. 242; ENL 7.8 vs. 7.4 MJ/kg DM). Only soluble protein (SP) content was slightly higher in ExpC (76 vs. 42), reflecting the differences between the two protein sources (115 vs. 60, for extruded peas and soybean cake, respectively). For all variables presented in Tables 1 and 2, the effect of week of observation was always significant, due to the modifications of milk composition as the lactation progressed, whereas no significant effect of the interaction week of observation x treatment was found. Daily milk yield was not affected by treatment, as well as, milk fat, lactose and protein percentages. Moreover, the level of milk urea in treated group was comparable to that of control group. Although an impressive difference in SSC was observed between the two dietary groups, it was not statistically significant. Milk pH was almost identical in the two treatments, as were the clotting properties and the mozzarella cheese yield (Table 1). No differences were observed between the groups for milk FA composition (Table 2).

## Discussion

In dairy cows a number of studies have investigated the effects of the substitution of ration composition, level of peas inclusion and technological treatments. Although the two protein sources differed for SP content, no differences were found for milk yield and milk urea content between the dietary groups.

**Tab. 1: Milk traits, cheese yield and clotting proprieties for the dietary groups**

		Diets		SE
		CC <sup>1</sup>	ExpC <sup>2</sup>	
Milk yield	kg/d	6.4	5.9	0.17
Fat	%	9.5	9.9	0.40
Protein	"	4.7	4.5	0.073
Lactose	"	4.6	4.5	0.05
Somatic cell count		40,813	93,615	18,183
Milk Urea	ml/dl	45.0	40.6	1.20
pH		6.70	6.68	0.037
Mozzarella Cheese yield	(%)	27.2	28.0	0.53
Rennet clotting time	(min)	20.4	19.9	1.25
Curd firming time 20 mm	(min)	1.7	1.7	0.10
Curd firmness 30 min	(mm)	41.1	41.8	2.68

<sup>1</sup> CC control concentrate based on: maize grain, dehydrated whole maize plant, soybean cake (35%), faba bean (4%), dehydrated alfalfa meal, wheat bran, barley, maize gluten meal, sodium bicarbonate, calcium carbonate, dicalcium phosphate, sodium chloride. <sup>2</sup> ExpC Experimental concentrate based on: extruded peas (45%), maize grain, dehydrated whole maize plant, faba bean (4%), dehydrated alfalfa meal, wheat bran, barley, maize gluten meal, soybean cake, sodium bicarbonate, calcium carbonate, dicalcium phosphate, sodium chloride.

**Tab. 2: Fatty acid composition (wt%) of milk for the dietary groups**

	Diets		SE
	CC <sup>1</sup>	ExpC <sup>2</sup>	
Butyric	2.31	2.50	0.15
Caprinic	2.02	2.14	0.12
Capronic	1.30	1.32	0.056
Myristic	11.4	11.2	0.21
Palmitic	34.1	32.6	0.39
Stearic	10.8	12.1	0.21
Oleic	22.7	23.3	0.39
Linoleic	2.59	2.71	0.079
Linolenic	1.07	1.06	0.025
CLA	0.96	0.87	0.04
Total Short Chain FA	8.28	8.58	0.41
Total Medium Chain FA	53.3	51.2	0.59
Total Long Chain FA	38.5	40.2	0.60
Mono Unsaturated FA	25.6	25.7	0.36
Poly Unsaturated FA	3.66	3.78	0.09

soybean with peas (Froidmont and Bartiaux-Thill, 2004; Masoero et al., 2006; Vander Pol et al., 2008), with contradictory results perhaps due to the confounding effects of Probably, the protein solubility and the non structural carbohydrate degradability of the two diets were adequate to satisfy the requirements of buffalo cows and to reduce the loss of N from the rumen. As expected, clotting properties and mozzarella cheese yield were similar between the two dietary treatments, because milk protein and fat contents of the two groups were almost identical. Milk protein and fat percentages, in fact, are the essential factors that affect firming time, curd firmness and cheese yield (Altiero et al., 1989; Martin and Coulon, 1995). Although the fat percentages of two protein sources were very different (15 vs. 100 g/kg DM for peas and soybean cake, respectively) milk FA composition was not affected by dietary treatment, due to the fact that the level of the pea inclusion which was below the threshold to allow changes for FA.

## Conclusions

Peas can partially substitute for soybean meal as the main protein source in diets of buffalo cows in late stage of lactation without adverse effects on production and quality. The lack of negative effects on milk yield makes peas an attractive GMO free protein feed in diet formulation for buffalo cows raised in organic farms.

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## Rearing improvement in organic Maremmana beef production: “in vivo” performance and carcass characteristics.

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Key words: Maremmana breed, Organic beef production, carcass characteristics

### Abstract

*“In vivo” performance and carcass characteristics of Maremmana young bulls and steers were evaluated during a three year extension service program based on the improvement of animal performance and the production of steers. Average slaughter ages were 568, 562 and 642 (P<0.01) days and the average slaughter weights were 494.2, 567.2 and 548.2 kgs (P<0.01) respectively for young bulls in the first and second trial year and steers in the third, with a dressing percentage of 52.3%, 53.6% and 54.82% (P<0.01) respectively. No significant differences were found in carcass conformation and fatness scores which were similar to those found by other authors in the same breed reared in similar conditions.*

### Introduction

The rearing system of Maremmana, one of the most important rustic breeds in Italy, is characterised by early spring calving season and the use of pasture only by suckling cattle from spring to fall, when calves are allocated on feedlot and fed by forage and concentrates until 16–20 months of age, when young bulls are slaughtered. For these reasons Maremmana could be considered the breed that better than others can contribute to the organic beef production in Italy. Nevertheless the lack of specific technical guidelines, more than those in 1804/99 EU Rule, requires specific extension services programs. Aim of the work was to modify feeding management and production system in an organic farm, in order to improve growth curves, slaughtering performance and to evaluate the possibility to rear steers, which are better suited on the organic farm due to their calm temperament, to the pasture, in a three years (2002-2005) extension service experimental project proposed by the Regional Agency for Development and Innovation in Agriculture (ARSIA) of the Tuscany Region.

### Materials and methods

In the first and second year spring born calves (eight and six, respectively) were weaned at the begin of the autumn and allocated in feedlot until slaughtering. In the

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third year calves (seven) were castrated by means of Burdizzo emasculator immediately after weaning, allocated in feedlot and from spring to mid summer managed on pasture until fattening, when they were allocated in feedlot until slaughtering. Weaning weights were 164±25, 215±43 and 165±50 kg, for the first, the second and the third year, respectively, with great differences due to the climate. Weaned calves were given oat hay and oat haylage *ad libitum* until the beginning of fattening period, when they were given *ad libitum* oat hay. During growing period (from weaning to 90 days before slaughter) and during fattening period (last 90 days before slaughter), concentrate was supplemented on the basis of 0,8 kg/100 kg live weight (LW) during the first year and 1 kg/100 kg LW (in order to improve the animal performance) during the second and third years, according to 1804/99 EU rule guidelines (40% of concentrates on annual total dry matter intake). Concentrate was composed by 75% of grounded barley and 25% of grounded field bean during the first two years and during the growing period of the third and by 80% barley and 20% of field bean during the fattening period of the third. Forage chemical characteristics are reported in table 1. From weaning to slaughtering young bulls and steers were weighted every two months to determine the average daily gain (ADG). The slaughter age was influenced by the meat demand by consumers, because of direct selling strategy used by the farm owner. At slaughter, conformation and fatness of carcasses were evaluated according to the SEUROP grid and converted to continuous variables in a 18 and 15 levels, respectively. To evaluate relationship between age and Live Weight, regression analysis was performed using PROC REG of statistical package SAS (SAS, 1999). “*In vivo*” and at slaughter performance data were submitted to analysis of variance by PROC GLM of the same statistical package.

**Tab. 1: Forage chemical characteristics (DM basis)**

Parameter		Forages		
		Oat hay	Oat Haylage	Pasture
Dry Matter	%	88.2	40.2	25.8
Crude Protein	% DM	11.5	11.3	13.6
Ether Extract	“	1.8	2.8	2.6
NDF	“	54.8	53.3	53.4
ADF	“	35.6	34.2	33.8
ADL	“	3.4	3.6	2.2
Ash	“	7.0	8.9	9.5

## Results

The rationalization of rearing system was based in: a) concentrate creep feeding during pre-weaning period; b) increase of concentrate administered during growing and fattening period and c) steers production using pasture. The relationship between age and weight follows a cubic trend (Fig. 1) (Table 2). All curves showed a self-accelerated growth until 370 days of age when growth decelerated until kg 500 LW similarly to those reported by Sargentini (1998) in the same breed. Young bulls reared in the second year showed the lower slaughtering age, the higher slaughtering weight and the higher ADG if compared with first year reared young bulls and steers. The last ones showed the higher slaughter age and the lower ADG (Table 3). Young bulls reared before optimization of rearing system showed the lower slaughtering weight even if slaughter age was similar respect young bulls reared in the second year.

Dressing yield was higher in steers than in young bulls (54.82% vs 53.6% and 52.3%;  $P < 0.01$ ) reared in the second and first year respectively. No significant statistical differences were found in carcass conformation score and fatness score whose values corresponded respectively to R in young bulls and R- in steers, and to 3- and 3 on the basis of SEUROP grids.

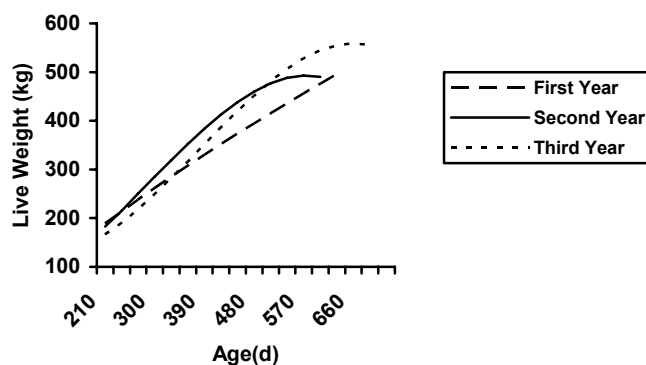


Figure 1: Growth curves of young bulls and steers during the trial.

Tab. 2: Regression equations for growth parameters.

Years	Regression Equations	R <sup>2</sup>	RSD
First	$Y = 3.74 + 0.997x - 0.000427x^2 + 0.000000396x^3$	0.88	47.32
Second	$Y = 88.71 - 0.271x + 0.005273x^2 - 0.00000786x^3$	0.70	75.32
Third	$Y = 167.48 - 0.420x - 0.0035x^2 - 0.0000031x^3$	0.88	47.04

Tab. 3: LS Means for "In Vivo" and Slaughter Performance by year

Parameters		Years			RMSE
		First	Second	Third	
Slaughter age	D	568B	562B	642A	69.48
Slaughter weight	Kg	494B	567.2A	548A	38.54
Average Daily Gain	g/d	947b	982a	924b	92.53
Carcass weight	"	258.8B	320.8A	300.48A	24.17
Dressing yield	%	52.3B	53.6B	54.82A	2.44
Carcass conformation score		7.75	7.75	7.00	1.4
Carcass fatness score		7.50	6.50	6.60	1.6

A, B:  $P < 0.01$ ; a, b:  $P < 0.05$  present study

## Discussion

The slower growth rate observed in steers is mainly due to the different hormonal status. In intact male androgens promote muscular development throughout the increase in nitrogen retention. This anabolic property of androgens, especially testosterone, influences ADG of bulls to increase up to 19% than that of steers (Steen, 1995). In the present study ADG of bulls is 6% higher than that of steers, this difference, even if statistically significant, is quite slight and could be due to different environmental differences among years. Slaughtering ages, slaughtering weights and ADG (Table 3) were similar to those found by Sargentini et al. (1998) in the same breed and Berthiaume et al. (2006) in Angus cross steers fed by 40% barley and 60% grass silage on daily DM intake. Dressing yields were similar to those found by Marino et al. (2005) in Podolian young bulls organically reared. Carcass conformation and fatness scores were respectively similar and higher than those found by Sargentini et al. (2005) in the same breed organically reared.

## Conclusions

If growth curves are considered as a method to evaluate the success of rearing systems, in the present study they are quite similar to those found by other authors. Steers performances on pasture during spring appear interesting, because obtained in typical Mediterranean harsh conditions. Carcass conformation and fattening could be considered interesting and confirms the good adaptation of Maremmana breed to this rearing system.

## Acknowledgments

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# Indigenous sheep breeds in organic livestock production in karst areas of Croatia\*†

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Key words: sheep, indigenous, karst, organic, Croatia

## Abstract

*Organic sheep breeding in Croatia is based on indigenous breeds, which are well adapted to their environment. This practice eliminates most of the problems usually encountered when imported foreign breeds have to be adjusted to the new conditions. Karst areas, encompassing about 50% of Croatian territory, are the natural habitat to eight of nine indigenous sheep breeds. These areas are nearly free from pollution, which makes them ideal for organic production. These facts were the foundations for the onset of the projects "Organic lamb production in Croatia" and "Standardisation of some health parameters of Croatian indigenous sheep breeds". Their goal is to promote and support the development of organic sheep production in Croatian karst areas. In the course of two years, we monitored housing conditions, feeding regime and general health status of animals from five organic flocks. We took blood and faeces samples to determine normal ranges of key physiological and biochemical parameters, since no such previous data existed. They will provide the basis for health monitoring as an aid to veterinarians and sheep breeders in organic production. The development of organic livestock production in the karst areas of Croatia is aimed at accelerating the economic growth of this underdeveloped region by providing a framework for creating a competitive product, while preserving the traditional way of life and protecting the environment.*

## Introduction

Croatian consumers started to show interest in organic products some 15 years ago. At that time organic production was not surveilled, nor was there a proper regulative system introduced. Finally in 2001, Ministry of Agriculture issued the relevant legislative acts, which were in accordance with the IFOAM Basic Standards 2000, and founded the Department for Organic Production. Since then, 446 farms have been registered for organic production on a total of 6.011 hectares, which represents only about 0.5% of agricultural land in Croatia.

For further development of organic production, especially sheep farming, almost ideal conditions are found in Croatian karst areas (Šimpraga et al. 2005). Karst represents a landscape shaped by the mildly acidic water acting on soluble bedrock such as limestone. When plans for farming in karst areas are made, the lack of surface water must be taken in account, since even when rainfall is adequate, the rainwater quickly flows away through the crevices into the ground, sometimes leaving the surface soil parched between rains. Nearly 50% of the Croatian territory can be classified as karst areas, most of which are situated in the Mediterranean region. Most of the land in these areas can be used only for grazing, which makes livestock production the most promising branch of agricultural production in this area (Boyazoglu, 2002). Sheep that

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have been reared there for centuries have adapted to the harsh environment exceptionally well, using the potential of the karst areas to the maximum and providing high-quality products such as meat, milk, leather and wool (Garibović et al., 2006). The number of sheep in karst areas in Croatia kept on 5.781 farms has reached 338.903 in 2006. These figures are still far from more than one million sheep reared in the 19<sup>th</sup> century in Dalmatia only, which at that time represented the highest *per capita* number of sheep in the whole Europe. Previous attempts to increase meat and milk production in karst areas were based on import of foreign breeds suitable for intensive production. All such attempts failed and showed that the specific conditions of karst areas support only the rearing of indigenous breeds which are exceptionally well adapted to their native environment (Mioč et al., 2006).

Taking into account the huge potential of organic breeding in pristine, unpolluted karst areas based on the nine well-adapted Croatian indigenous sheep breeds, we started with the research projects. Their main goal was to establish a network of organic sheep farms in order to stimulate and promote development of organic sheep breeding in Croatian karst areas. Regular checking of health status of the reared animals becomes almost indispensable because organic breeding excludes any kind of preventive treatment, especially anti parasitic. This makes parasite infestations a true challenge in organic sheep production (Rahmann and Seip, 2007). Blood profiling is therefore a well known method for health monitoring (Ingraham and Kappel, 1988). Since none of the parameters for indigenous sheep breeds have been standardized previously, normal physiological values of key haematological and biochemical parameters have been determined in this study.

### **Materials and methods**

The research was conducted on 30 animals from organically reared flock of indigenous Lička pramenka sheep. As control group we used 30 animals from a heard of Merinolandschaf sheep reared under same conditions as Lička pramenka. Samples of blood and faeces were taken every 3 months in a course of two years. The parameters determined included erythrocyte count (RBC), leukocyte count (WBC), haemoglobin (Hb), hematocrit (Hct), red blood cell indices (MCV, MCH, MCHC), Calcium (Ca), Phosphorus (P), Magnesium (Mg), glucose, blood urea nitrogen (BUN), creatinine, aspartate aminotransferase (AST), gama-glutamyl transferase (GGT), serum albumine and total protein concentrations.

Animals were monitored clinically through standard veterinary supervision, which included general health status and determination of haematological and biochemical profiles. Rearing conditions, especially housing and feeding, were supervised in order to comply with the rules of organic production.

### **Results**

The results shown in Tables 1 and 2 provide a sub-range specific for organically bred Lička pramenka sheep. Differences between RBC, WBC and thrombocyte count, Hb concentration, MCV, MCH in Lička pramenka and Merinolandschaf sheep were statistically significant to the level of  $p < 0.01$ .

**Tab. 1: Haematological values (mean±SD) and range for organically bred Lička pramenka are given.**

<b>Parameter</b>	<b>Value (±SD)</b>	<b>Range (min–max)</b>
Hemoglobin (g/l)	97,49±14,65	76–118
Hematocrit (%)	29±4	22.6–36.2
MCV (fl)	31,81±2,11	31.0–38.5
MCH (pg)	10,61±0,68	10.2–12.1
MCHC (g/l)	333,7±14,53	306–356
Erythrocytes (10 <sup>12</sup> /l)	9,23±1,44	6.72–10.34
Thrombocytes (10 <sup>9</sup> /l)	263,05±154,11	30–377
Leukocytes (10 <sup>9</sup> /l)	11,22±3,21	5.1–18.7

**Tab. 2: Biochemical values (mean±SD and range) for organically bred Lička pramenka are given.**

<b>Parameter</b>	<b>Value (±SD)</b>	<b>Range (min–max)</b>
Calcium (mmol/l)	2,59±0,31	2.50–3.11
Phosphorus (mmol/l)	1,74±0,62	0.60–6.01
Magnesium (mmol/l)	1,44±0,23	1.16–1.99
Glucose (mmol/l)	3,38±0,64	2.8–6.2
Urea (mmol/l)	6,05±1,72	3.4–8.4
Creatinine (µmol/l)	128,55±13,46	121–164
AST (U/l)	131,12±26,93	62–183
GGT (U/l)	41,3±15,49	23–44
Serum total protein (g/l)	76,85±6,74	72–120
Serum albumin (g/l)	37,9±5,77	30–49

Differences in Hct were significant to the level of  $p < 0.05$ , while differences in lymphocyte, monocyte, basophil and eosinophil count and MCHC were not significant. Differences in biochemical values – P, BUN, creatinine level and AST activity were significant to the level of  $p < 0.01$ ; Ca, glucose and GGT to  $p < 0.05$ . Mg, total protein and albumin levels were not significantly different.

## Discussion

The use of haematological and biochemical parameters in health monitoring is already well established (Meintjes et al., 2002) but since these values depend on the specific sheep breed and rearing conditions, they have to be determined as a sub-range of the much broader range found in literature (Tibbo et al., 2005). This called for determination of relevant parameters characteristic for each breed under specific conditions of organic production. By combining haematological and biochemical parameters with the results of the coprological examination, we can gain insight into the impact of parasitic invasion on the general status of the animals raised, and also determine the degree of natural resistance and adaptation of indigenous breeds (Matanović et al., 2007). Since parasites are one of the most important limiting factors in organic production, their impact needs to be further investigated for the specific Croatian breeds. Natural resistance of indigenous breeds to parasites is a subsequent research area that is a logical and necessary extension of the present work.

## Conclusions

Upon completion of the research, physiological parameters of indigenous Croatian sheep breeds will have been fully standardised, which will enable their use in health monitoring, especially in organic production. Production which is in compliance with the policies of European Union will ensure a recognizable high-quality organic product ready to be offered on the international market and also promote stricter regulation of sheep rearing thus facilitating the effective eradication of the black market for sheep and lamb products in Croatia. Organic breeding can guarantee increased profit from sheep production in karst areas, while keeping the benefit of traditional production and combining it with the modern approach to veterinary monitoring.

## Acknowledgments

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† All research and other procedures undertaken within this project are in full compliance with Croatian legislative regulating treatment of experimental and other animals, and were reviewed and approved by the relevant Ethics committee.

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# Quality of organically grown protein crops in Norway for livestock concentrates – limited N and S supplementation

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Key words: Camelina, Concentrates, Oilseed crops, Pea, Rape, Turnip rape

## Abstract

*The aim of organic farming husbandry is to be entirely based on an organically produced diet. Shortage of organically produced protein crops for production of concentrates supplying the European market and a contemporary ban on the use of fishmeal for ruminants in the EU have led to an increased need for organically produced feedstuffs for production of concentrates in Norwegian organic husbandry. Pea is the most commonly cultivated protein-rich crop in organic agriculture in Norway. For ruminants, peas have a low bypass protein content compared to common protein supplements, such as rape meal and soybean meal. Other high-protein crops with complementary properties are therefore needed to meet the demand in feed quality for ruminants, pigs and poultry. Oilseed crops, which are rich in both fat and protein, will become of considerable interest if problems related to their cultivation are solved. Currently, our experience with oilseed crops in organic agriculture is limited. A four year research project "Organic protein feed and edible oil from oilseed crops" will serve to improve current knowledge and evaluate the feed quality of organically grown protein crops like rape, turnip rape and camelina. The project will provide knowledge about the rumen degradability of protein, starch and NDF (neutral detergent fibre) and intestine digestibility of protein and starch of organically grown, protein-rich crops necessary for the production of concentrates with an optimal feed quality.*

## Introduction

The content of crude protein is often low in the herbage from an organic ley (Olberg *et al.*, 2005) resulting in insufficient protein content to meet the nutritional demands of for example high productive milking cows. Therefore, feedstuffs with additional protein are normally added to the ration. Husbandry in organic farming should be based entirely on an organically produced diet (Council for The European Union, 1999). An obstacle in the production of concentrates for use in organic farming is that extracted soybean meal, which is the main protein source in conventional concentrates, is not permitted in organic husbandry. This is caused by a general ban of the use of chemical extracts in fodder production ([www.debio.no](http://www.debio.no)). Fish meal has been a vital constituent in concentrates and secured the need for high-quality proteins in organic husbandry. However, precautions to avoid contamination with prions from meat bone meal and high prices have made it important to look for alternatives. Currently, pea is the most commonly cultivated protein-rich crop in organic agriculture in Norway. For ruminants, peas have a low bypass protein content compared to common protein supplements,

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such as rape meal and soybean meal (Corbett, 1997). Other high-protein crops with complementary properties are therefore needed to meet the demand in feed quality for ruminants, pigs and poultry. Oilseed crops, which are rich in both fat and protein, will become of considerable interest if problems related to their cultivation can be solved.

The content of chemical constituents, such as protein, fat, NDF (neutral detergent fibre) and amino acids, varies among crops. In addition, nutritional quality parameters like fatty acid composition and rumen degradability of protein vary much among crops as well. High rumen degradability of protein results in a low AAT-value (amino acids absorbed in the small intestine) and a high PBV-value (Protein balance in the rumen) (Madsen *et al.*, 1995). Turnip rape and rape are rich in unsaturated fatty acids, which restrict the content of oilseeds that can be used in the daily feed ration for ruminants. However, the content of oilseeds in the ration can be increased if fat is removed through squeezing or compression. In addition, expeller cakes produced in that way usually have an increased protein value for ruminants because the heat produced in the treatment reduces the rumen degradability of protein, increasing the AAT-value and reducing the PBV-value of the feed. Moreover, the oilseeds are rich in S-containing amino acids, complementing the amino acids found in peas. Unfortunately, the mentioned crops do also contain elements, which different animal species have different tolerances to (Wollenweber *et al.*, 2002). Camelina or gold-of pleasure (*Camelina sativa* L. Crantz) is another oil-seed crop, which may have considerable interest for organic cropping in northern areas (Alen *et al.*, 1999). It has a low nutrient requirement, no seed dormancy, less problems with insect damage than rape and turnip rape and the seed quality makes it suitable for both edible oil and animal feed (Vollmann *et al.*, 1996).

Experiments with conventionally grown oilseed crops show great differences in protein and fat content according to the N fertilization rate (Rathke *et al.*, 2004; Asare & Scarisbrick, 1995). Currently, our experience with oilseed crops in organic agriculture is limited, and we do not know to what extent limitations in the N supplement will influence the content of crude protein and fat. In addition, N and S application have increased the seed glucosinolate concentration (Asare & Scarisbrick, 1995). Different fertilization strategies may perhaps result in differences in the feed quality. Experiment with long-term cattle manure application to rape increased the total N content and decreased the oil content in the seed (Hao *et al.*, 2004).

Our ongoing project "Organic protein feed and edible oil from oilseed crops" involves the whole production chain for protein feed and edible oils and will obtain knowledge for secure production of high-quality proteins for livestock feeds and edible oil for human consumption in Norwegian organic farming based on oilseed crops. One of the sub-goals in the project is to establish knowledge on the feed quality of organically grown protein crops. The project will provide knowledge about the rumen degradability of protein, starch and NDF and intestine digestibility of protein in organically grown, protein-rich crops in order to plan the production of concentrates for the Norwegian organic husbandry in the future. The project period is 2006 to 2010.

The project is led by the Norwegian Institute for Agricultural and Environmental Research in co-operation with the Norwegian University of Life Science, the Swedish University of Agricultural Sciences, the Norwegian Institute for Land Inventory, the Norwegian Meteorological Institute, Norwegian food research institute - Matforsk and the companies 'Felleskjøpet Fôrutvikling BA', 'TINE produsentrådgivning' and 'Norsk Matraps AB'. This presentation gives an overview of the project and gives some preliminary results from the first year.

## Materials and methods

In the main project, fields with peas, spring sown green manure and barley will be established as pre-crops for turnip rape and camelina in spring 2006, 2007 and 2008 on the organic research area at Research Farm Apelsvoll and at Lanna Research Station, in spring 2007 and 2008. For winter rape and winter turnip rape, fields will be established with a spring sown green manure crop of white clover (*Trifolium repens*), ryegrass (*Lolium* spp.) and phacelia (*Phacelia tanacetifolia*), and barley as pre-crops in the same years. Split-plot experiments with four nitrogen levels (0, 40, 60 and 80 kg ha<sup>-1</sup> in organic fertilizer) on main plots and turnip rape and camelina with and without S (MgSO<sub>4</sub>) on sub-plots will be placed in each pre-crop field with three replications in 2007, 2008 and 2009 at Apelsvoll and at Lanna in 2008 and 2009. Split-plot experiments in winter rape and in winter turnip rape with autumn fertilization (0 and 40 kg N ha<sup>-1</sup>, chicken manure pellets) on main plots and spring fertilization (0, 40, 60 and 80 kg N ha<sup>-1</sup> as chicken manure pellets with and without S) on sub plots will be placed in each pre-crop field in 2006, 2007 and 2008 at Apelsvoll and in 2007 and 2008 at Lanna. Each experiment will have three replicates. At each experimental site, weather data such as air and soil temperature, precipitation and time of snow cover will be recorded. The soil mineral N content for each treatment will be determined in late autumn in the establishing year and after harvest.

Samples of rape, turnip rape, camelina and pea will be sampled from the respective fields and analysed chemically for ash, starch, protein, fibre, NDF (neutral detergent fibre), fat, sugar, the amino acids methionine, lysine, cysteine, tryptophan, threonine and arginine and the minerals Ca, P, Mg and S. Rumen degradability of protein and NDF and intestine digestibility of protein in rape, turnip rape, camelina and pea will be analysed using the nylon bag methods (Madsen *et al.*, 1995). For pea, the rumen degradability and intestine digestibility of starch will also be analysed with nylon bags. Content of fat and protein, rumen degradability and intestine digestibility of protein will be determined in samples from both expeller cake and entire seed for camelina, rape and turnip rape. Glucosinolate concentration will be analyzed in camelina, rape and turnip rape, while tannin concentration will be analyzed in pea. Samples will be analysed according to the methods used by Nordic Feed Evaluation.

## Discussion and results

In Autumn 2006, pea samples (varieties Faust, Integra and Pinochio) from six different farms were analysed chemically for ash, starch, protein, NDF (neutral detergent fibre), fat, fibre, Ca, P and Mg. The results from the analyses were comparable to results from conventional studies but new samples will be analysed in winter 2007 and 2008 until a full evaluation of the results can be performed. In the 2006, rumen degradability of starch, protein and NDF, and intestine digestibility of starch and protein were analysed for varieties of Faust and Pinochio with the nylon bag method (Madsen *et al.*, 1995). The protein degradability in the two samples was lower than estimated in the Norwegian feed table for 2008 but was within normal variation. This was also the case for starch and NDF. The degradability of starch was lower in pea than in oat and barley, which is of special interest concerning high yielding dairy cows. The measurement of intestine digestibility of protein and starch showed unexpectedly high values for the indigestible portion of starch (39% of total) and protein (13% of total). This might be due to the analytical technique used, and will be further investigated. However, lower digestibility of starch than protein is in agreement with studies on conventional peas (Ljøkjel *et al.*, 2003a, b).

We expect a pronounced variation in the quality of protein-rich crops dependent on the cultural measures, soil fertility and climatic conditions. The results from the different quality parameters will be evaluated in comparison to published results and former feeding trials with conventionally grown rape, turnip rape and pea. Quality-parameters of significance for the use of crops in the production of concentrate for ruminants and poultry will be prioritized.

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# Use of grass and red clover silage mixtures for milk production and whole-body N partitioning by dairy cows

Moorby, J.M.<sup>1</sup>, Ellis, N.M., Fisher, W.J., Davies, D.R. & Scollan, N.D.

Key words: dairy cows, grass silage, milk production, nitrogen partitioning, red clover.

## Abstract

Twenty-four multiparous Holstein-Friesian dairy cows in mid lactation were used in a 4×4 Latin square changeover experiment with four 4-week periods to investigate the effect of altering the ratios of red clover (RC) and ryegrass silage (GS) in the forage component of their diet. Ratios (in the dry matter (DM)) were: R0, 0 RC:1 GS; R34, 0.34 RC:0.66 GS; R66, 0.66 RC:0.34 GS; R100, RC 1:0 GS. All cows received ad libitum access to their allocated forage with 4 kg of a standard concentrate per day. Results are presented in order of R0, R34, R66 and R100 respectively. Feed DM intakes (16.7, 17.8, 18.3, 19.0 kg d<sup>-1</sup>, s.e.d. 0.24, P<sub>lin</sub><0.001) and milk yields (25.2, 26.1, 26.5, 26.1 kg d<sup>-1</sup>, s.e.d. 0.47, P<sub>lin</sub><0.05, P<sub>quad</sub><0.05) increased as the proportion of RC in the forage increased. Nitrogen (N) intake and excretion of N in urine and faeces increased (P<0.01) with increasing proportion of RC in the diet, but milk N secretion as a proportion of diet N intake, decreased (P<0.01). It is concluded that the best balance of feed intakes, milk yields and efficiency of utilisation of dietary N was achieved when cows were offered a diet with RC silage as 0.66 of the forage.

## Introduction

Red clover (RC; *Trifolium pratense*) requires no nitrogen (N) fertiliser for growth and is therefore highly suitable for use in organic farming systems. Red clover can be successfully ensiled as bales, and when fed to dairy cows RC silage has been shown to allow higher intakes, leading to higher yields of milk, than grass silage (Dewhurst *et al.*, 2003a; 2003b; Thomas *et al.*, 1985). However, the efficiency of utilisation of RC silage can be low, and for agronomic purposes may be best offered to cows as a mix with another forage such as grass silage. Ryegrass silage is a common forage that is widely used in the UK and other parts of Europe, and offers this potential.

The objectives of this experiment were to investigate the effect of mixing red clover and ryegrass silages at different ratios on feed intake, milk production and whole-body N partitioning in dairy cows.

## Materials and methods

Twenty-four multiparous Holstein-Friesian dairy cows in mid lactation were used in a 4×4 Latin square changeover experiment. Following a covariate period with all cows offered a common diet, cows were allocated to one of six replicate Latin squares on the basis of milk yield recorded shortly before the start of the experiment. Four experimental diets were offered to the cows differing in the ratios (on a dry matter (DM) basis) of grass silage to RC silage: 1) diet RC0: 1 grass:0 RC; 2) diet RC34: 0.66 grass:0.34 RC; 3) diet RC66: 0.34 grass:0.66 RC, and 4) diet RC100: 0 grass:1

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RC. The grass silage was prepared from a first cut perennial ryegrass sward and stored as a large clamp under cover. The red clover silage was a mixture of first and second cut bales and used in a ratio of one bale first cut to one bale second cut.

In each of four 4-week periods, the first 21 days were used for adaptation to diets, and the remaining 7 days were used for measurements. All cows received *ad libitum* access to their allocated forage diets (to allow at least 0.1 of offered feed as refusals), and also received a constant allocation of 4 kg standard dairy concentrate per day. Feed intakes and milk yields were recorded for all cows throughout the experiment.

Feed samples were collected during the measurement week and composited to give one sample per experimental period. A subset of eight of the cows were used for digestibility and whole-body N partitioning measurements during the last 7 days of each experimental period. For these, separate collections of total outputs of faeces and urine were made from all cows during the measurement period. Dry matter, organic matter (OM), N, and neutral detergent fibre (NDF) were determined in feeds and faeces and used to calculate apparent whole-tract digestibilities of these components (intake in feed minus output in faeces divided by intake in feed). The N content of urine was also measured, which enabled the calculation of whole-body N balance (by difference of intakes and total outputs in milk, faeces and urine). Milk fat and protein was measured by commercial near-infrared milk analysis in 4 consecutive samples collected from all animals during the measurement week in each period.

## Results

The concentrations of DM and water-soluble carbohydrates (WSC) decreased, and the concentrations of ammonia-N and fibre fractions increased, as the proportion of RC silage in the diet increased (Tab. 1). Diet CP concentration was similar for all forage mixtures.

**Tab. 1: Mean composition of the silage mixtures offered to dairy cows during the experiment. Values in g kg<sup>-1</sup> DM unless otherwise specified**

	Silage mix				Concentrate
	R0	R34	R66	R100	
Dry matter, g kg <sup>-1</sup>	374	359	338	322	869
Organic matter	894	893	893	894	927
Crude protein	206	205	196	194	210
Ammonia-N	2.00	2.32	2.72	3.06	-
Water-soluble carbohydrates	113	74	49	29	92
pH	3.98	4.17	4.41	4.66	-
Acid detergent fibre	290	317	335	373	143
Neutral detergent fibre	439	459	447	461	222
Ether extract	36	31	27	24	-
Acid detergent ether extract	-	-	-	-	56

**Tab. 2: Effect of altering the forage ratio of grass and red clover silages on feed intakes, diet apparent whole-tract digestibilities, and milk yield and composition of dairy cows**

	Diet				SED	Sig. <sup>1</sup>	
	R0	R34	R66	R100		L	Q
Total DM intake, kg d <sup>-1</sup>	16.7	17.8	18.3	19.0	0.24	***	n.s.
Digestibility, g g <sup>-1</sup> intake							
Dry matter	0.63	0.62	0.59	0.55	0.008	***	*
Organic matter	0.73	0.71	0.68	0.64	0.007	***	*
Nitrogen	0.67	0.69	0.67	0.66	0.010	n.s.	n.s.
Neutral detergent fibre	0.73	0.71	0.68	0.60	0.024	***	n.s.
Milk yield, kg d <sup>-1</sup>	25.2	26.1	26.5	26.1	0.47	*	*
Fat conc., g kg <sup>-1</sup>	38.0	36.7	35.6	35.5	0.99	**	n.s.
Protein conc., g kg <sup>-1</sup>	30.8	30.7	30.6	29.3	0.39	***	*
Fat yield, g d <sup>-1</sup>	955	947	935	923	27.2	n.s.	n.s.
Protein yield, g d <sup>-1</sup>	770	798	810	763	17.1	n.s.	**

<sup>1</sup> Significance: L, linear effect, Q, quadratic effect. There were no significant cubic effects; n.s., not significant; +, P<0.1; \*, P<0.05; \*\*, P<0.01; \*\*\*, P<0.001

**Tab. 3: Effect of altering the forage ratio of grass and red clover silages on N intakes, N outputs, and apparent partitioning of dietary N by dairy cows**

	Diet				SED	Sig. <sup>1</sup>		
	R0	R34	R66	R100		L	Q	C
N intake, g N d <sup>-1</sup>	529	577	552	611	14.0	***	n.s.	**
N output, g N d <sup>-1</sup>								
Faeces	172	181	184	206	6.6	***	n.s.	n.s.
Urine	203	218	232	233	9.0	**	n.s.	n.s.
Milk	117	122	119	118	4.8	n.s.	n.s.	n.s.
N balance	36	57	17	55	12.6	n.s.	n.s.	**
N partition, g out g <sup>-1</sup> in								
Faeces	0.33	0.31	0.33	0.34	0.010	n.s.	n.s.	n.s.
Urine	0.39	0.38	0.42	0.39	0.014	n.s.	n.s.	*
Milk	0.22	0.21	0.22	0.19	0.007	**	n.s.	+

<sup>1</sup> Significance: L, linear effect, Q, quadratic effect, C, cubic effect; n.s., not significant; +, P<0.1; \*, P<0.05; \*\*, P<0.01; \*\*\*, P<0.001

Feed DM intake significantly increased as the proportion of RC in the diet increased (Tab. 2). However, this was associated with a decrease in the digestibility of several diet components (but not of N). Despite this, milk yields were significantly affected by diet with the highest yields coming from cows offered diet R66. Milk fat and protein concentrations all decreased significantly with increasing proportions of RC in the diet.

Intakes and excretion outputs of N increased linearly as the proportion of RC in the diet increased (Tab. 3). There was a significant cubic effect on N balance, with the lowest value for cows offered diet R66. The secretion of milk N expressed as a proportion of dietary N intake significantly decreased as the proportion of RC in the diet increased.

## Discussion

This study investigated the effects of mixing of RC and grass silages, and confirmed earlier findings of the increased intake potential of RC silage (Bertilsson and Murphy, 2003; Dewhurst *et al.*, 2003a; 2003b; Thomas *et al.*, 1985). Increased milk yields as a result of increased DM intakes were also confirmed. However, these were associated with little or no change in yields of milk protein and fat, so that concentrations of milk components decreased with increasing intakes of RC silage. Most responses to changing from grass to RC silage were linear, although mixing the two had some benefits. Milk and protein yields were highest from diet R66, and were slightly lower on pure RC silage (R100). Increased N intakes, coupled with decreased milk N outputs meant that the apparent efficiency of diet N use for milk protein production was lower with high RC diets (Bertilsson and Murphy, 2003).

## Conclusions

Milk output can be improved by feeding dairy cows with RC silage, although at the expense of milk fat and protein concentrations. Maximum milk and milk protein yields were found at a forage mixture of 0.66 RC and 0.34 ryegrass silages.

## Acknowledgments

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# Effects of mixing red clover and maize silages on milk production and whole-body N partitioning in dairy cows

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Key words: dairy cows, maize, milk production, nitrogen partitioning, red clover.

## Abstract

Twenty-four multiparous Holstein-Friesian dairy cows in mid lactation were used in a 3×3 Latin square changeover experiment with three 4-week periods to investigate the effect of altering the ratios of red clover (RC) silage and maize silage in the forage component of their diet. Ratios (in the dry matter (DM)) were: RC10, 0.1 RC:0.9 maize; RC50, 0.5 RC:0.5 maize; RC90, 0.9 RC:0.1 maize. All cows received ad libitum access to their allocated forage with 4 kg of a standard concentrate per day. Whole-body N partitioning and whole-tract diet digestibility measurements were carried out using a subset of cows (n=9). Results are presented in order of RC10, RC50 and RC90 respectively. Feed DM intakes (19.6, 20.5, 19.5 kg DM d<sup>-1</sup>, s.e.d. 0.32, P<0.01) and milk yields (26.1, 27.3, 25.7 kg milk d<sup>-1</sup>, s.e.d. 0.54, P<0.01) were highest on diet RC50. Milk protein concentrations decreased (P<0.001) as forage RC proportion increased, and protein yields were significantly (P<0.01) higher on diet RC50. Urine N excretion was lowest (as a ratio to N intake), and milk N secretion was highest, on diet RC10. It is concluded that milk and protein yields can be improved by feeding RC silage as 1:1 mix with maize silage, but that the efficiency of utilisation of forage N was reduced when diets contained more than 0.1 RC silage.

## Introduction

Red clover (RC; *Trifolium pratense*), requires no nitrogen (N) fertiliser for growth and is therefore an excellent crop for use in organic dairy systems. Red clover can be successfully ensiled as bales, and RC silage has been shown to have a high intake potential, leading to higher yields of milk, than grass silage (Dewhurst *et al.*, 2003a; 2003b; Thomas *et al.*, 1985). However, due to its relatively low energy density, the efficiency of utilisation of RC silage can be low, and is best offered to cows as a mix with another energy-rich forage. Maize silage offers this potential, itself being relatively low in crude protein but high in starch. The objectives of this experiment were to investigate the effect of feeding three mixtures of RC and maize silage on milk yield and composition from dairy cows, and whole-body partitioning of dietary N.

## Materials and methods

Twenty-four multiparous Holstein-Friesian dairy cows in mid lactation were used in a 3 × 3 Latin square changeover experiment. Cows were allocated to one of three replicate Latin squares on the basis of milk yield recorded shortly before the start of the experiment. Three experimental diets were offered to the cows differing in the ratios (on a dry matter (DM) basis) of maize silage to RC silage: 1) diet RC10: 0.9 maize:0.1 RC; 2) diet RC50: 0.5 maize:0.5 RC; 3) diet RC90: 0.1 maize:0.9 RC. The

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maize silage was prepared and stored as a large clamp under cover. The red clover silage was a mixture of first and second cut bales and used in a ratio of two bales first cut to one bale second cut.

In each of three 4-week periods, the first 21 days were used for adaptation to diets, and the remaining 7 days were used for measurements. All cows received *ad libitum* access to their allocated forage diets (to allow at least 0.1 of offered feed as refusals), and also received a constant allocation of 4 kg standard dairy concentrate per day. Feed intakes and milk yields were recorded throughout the experiment.

Feed samples were collected during the measurement week and composited to give one sample per period. During the last 7 days of each experimental period separate collections of total outputs of faeces and urine were also taken from some of the cows (n=9). Apparent whole-tract digestibilities of DM, organic matter (OM), N, and neutral detergent fibre (NDF) were calculated (intake in feed minus output in faeces divided by intake in feed), together with whole-body N balance (by difference of intakes and total outputs of N in milk, faeces and urine). Milk fat and protein was measured by commercial near-infrared milk analysis in 4 consecutive samples taken during the measurement week in each period.

## Results

The experimental forage mixtures differed significantly in their composition as the ratio of maize silage to RC silage varied (Tab. 1), with lowest crude protein (CP) concentrations on the RC10 diet. The dairy concentrate offered to all cows contained 929 g OM kg<sup>-1</sup> DM, 152 g CP kg<sup>-1</sup> DM, 87.6 g water-soluble carbohydrates kg<sup>-1</sup> DM, 215 g NDF kg<sup>-1</sup> DM, and 52.8 g acid hydrolysis ether extract kg<sup>-1</sup> DM.

**Tab. 1: Mean composition of the silage mixtures offered to dairy cows during the experiment. Values in g kg<sup>-1</sup> DM unless otherwise specified**

	Diet			SED	Significance <sup>1</sup>	
	RC10	RC50	RC90		Linear	Quad
Dry matter, g kg <sup>-1</sup>	333	416	514	8.7	***	n.s.
Organic matter	957	933	916	0.71	***	**
Crude protein	103	148	165	5.9	***	+
Water-soluble carbohydrates	18	53	76	8.1	**	n.s.
pH	3.73	4.14	4.57	0.044	***	n.s.
Acid detergent fibre	228	318	360	21.5	**	n.s.
Neutral detergent fibre	410	454	477	16.3	*	n.s.
Ether extract	32.7	22.8	17.0	1.35	***	n.s.

<sup>1</sup> n.s., not significant; +, P<0.1; \*, P<0.05; \*\*, P<0.01; \*\*\*, P<0.001

Total DM intake was highest (P<0.01) on the equal mix silage diet (RC50; Tab. 1), which led to a small increase in daily milk yields. Diet digestibility was significantly effected by treatment, with higher digestibilities of DM and OM with greater proportions of maize in the diet, but with higher NDF digestibilities with lower proportions of maize. Milk fat concentrations and yields were unaffected by treatment, while milk protein concentrations decreased (P<0.001) as the proportion of RC in the diet increased. Milk protein yield was highest (P<0.01) on the RC50 diet. Expressed

in terms of kg DM consumed, milk yield was not significantly affected by dietary treatment, with a grand mean of 1.33 kg milk yielded kg<sup>-1</sup> DM consumed.

Nitrogen intake increased significantly as the proportion of RC in the forage mixture increased (Tab. 3). As N intake increased, the output of N in faeces and urine also increased significantly. However, overall whole-body N balance was not significantly different between treatments. Expressed as a proportion of dietary N intake, faeces N output tended to increase with increased proportion of RC in the silage mixture, and urine N output increased significantly. Milk N output, on the other hand, decreased significantly, so that efficiency of milk protein production was highest on the RC10 diet, which had the lowest CP concentration.

**Tab. 2: Effect of altering the diet ratio of maize and red clover silage on feed DM intakes, diet apparent whole-tract digestibilities, and milk yield and composition by dairy cows**

	Diet			SED	Significance <sup>1</sup>	
	RC10	RC50	RC90		Linear	Quad
Total DM intake, kg d <sup>-1</sup>	19.6	20.5	19.5	0.32	n.s.	**
Digestible DM intake, kg d <sup>-1</sup>	12.1	12.1	11.1	0.19	***	**
Diet digestibility, g g <sup>-1</sup> intake						
Dry matter	0.62	0.59	0.57	0.008	***	n.s.
Organic matter	0.69	0.67	0.66	0.005	***	n.s.
Nitrogen	0.61	0.60	0.58	0.018	+	n.s.
Neutral detergent fibre	0.47	0.56	0.61	0.015	***	+
Milk yield, kg d <sup>-1</sup>	26.1	27.3	25.7	0.54	n.s.	**
Fat conc., g kg <sup>-1</sup>	36.7	37.5	38.9	1.40	n.s.	n.s.
Protein conc., g kg <sup>-1</sup>	30.9	30.6	29.9	0.24	***	n.s.
Fat yield, g d <sup>-1</sup>	941	1020	1000	38.4	n.s.	n.s.
Protein yield, g d <sup>-1</sup>	798	834	775	18.7	n.s.	**

<sup>1</sup> n.s., not significant; +, P<0.1; \*, P<0.05; \*\*, P<0.01; \*\*\*, P<0.001

## Discussion

Red clover silage has been shown to have a high intake potential in dairy cows and to improve milk yields compared to grass silage (Bertilsson and Murphy, 2003; Dewhurst *et al.*, 2003a; 2003b). Compared to lucerne silage, equal yields of milk at reduced levels of intake have been observed (Broderick *et al.*, 2001). The optimum rate of supplementation of RC silage with a high-energy forage such as maize silage is uncertain. In this study, the greatest intakes of DM were observed on the RC50 diet, and despite the fact that digestible DM intakes were not the highest, the yields of milk and milk components were (marginally) highest on this diet. Increasing the proportion of RC silage in the forage mixture led to increased N intakes, but also increased N outputs, so that the most efficient diet in terms of milk N output was the RC10 diet. Increased rates of excretion of N in urine (both in g d<sup>-1</sup> and expressed relative to N intake) as the RC component of the forage mix increased indicates an increased rate of uptake of ammonia from the rumen as the relative availability of energy-yielding nutrients (i.e. starch from the maize silage) decreased. This agrees with previous reports of mixing white clover silage with maize silage (Auldust *et al.*, 1999).

**Tab. 3: Effect of altering the diet ratio of maize and red clover silage on N intakes, N outputs, and apparent partitioning of dietary N in dairy cows**

	Diet			SED	Significance <sup>1</sup>	
	RC10	RC50	RC90		Linear	Quad
N intake, g N d <sup>-1</sup>	366	505	528	16.6	***	**
N output, g N d <sup>-1</sup>						
Faeces	140	201	223	7.2	***	*
Urine	74	120	173	5.7	***	n.s.
Milk	128	145	137	4.8	n.s.	*
N balance	24	39	-5	18.2	n.s.	n.s.
N partition, g out g <sup>-1</sup> in						
Faeces	0.38	0.40	0.42	0.018	+	n.s.
Urine	0.20	0.24	0.33	0.014	***	n.s.
Milk	0.35	0.29	0.27	0.012	***	n.s.

<sup>1</sup> n.s., not significant; +, P<0.1; \*, P<0.05; \*\*, P<0.01; \*\*\*, P<0.001

### Conclusions

It is concluded that milk and milk protein yields can be significantly improved by feeding RC silage as 1:1 mix with maize silage, but that the efficiency of utilisation of forage N was reduced when diets contained more than 0.1 RC silage. However, reduced within-animal efficiency at higher rates of RC silage use would be less of a problem at the whole-farm level if manures are used appropriately as fertilisers, distributing legume-fixed N to other crops.

### Acknowledgments

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## **Animal health, product quality and strategies for organic pork production**

## Strategies for a diversified organic pork production

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Key words: Organic, pigs, pork, breed, male pigs

### Abstract

*Possible reasons for the low market share of organic pork may be heavy price competition with conventional produced pork products combined with no or small distinctive characteristics in appearance and quality, both regarding eating quality (flavour, tenderness) and ethical quality (production methods). The overall aim of this study is to identify strategies for a diversified organic pork production with high credibility and superior eating quality based on pigs foraging in the cropping system, use of a traditional breed and no castration. Preliminary results indicate that the use of a traditional breed, the Danish Black-Spotted pig, might be a way to produce pork, which in appearance differ from conventional pork and at the same time improve the credibility of organic pig production.*

### Introduction

There has been a considerable increase in the consumption of organic pork in Denmark as well as in other European countries the last few years, however, the relative consumption of organic pork is still considerably lower than e.g. organic egg and milk (GfK, 2007). One possible reason for the low market share may be heavy price competition with conventional produced pork products combined with no distinctive characteristics in the organic pork products *per se*. A smaller consumer survey in Denmark (Beck & Søndergård, 2004) indicated that consumers who valued pork products were very price sensitive and not in particular interested in organic products as such. On the other hand, the consumers who were very interested in organic products did not value pork products very much. This calls for a consideration that organic pork should differentiate *per se* from conventional pork, e.g. regarding cuttings and flavour. The low market share may also be due to small distinctive characteristics in the ethical quality of organic pork. In Denmark, the organic pig production of today typically includes production methods, which do not comply particularly well with the principles of organic farming - and thereby probably not with the consumers' expectation to organic pig production: Castration of male pigs, use of specialised high-producing crossbreeds, housing of growing pigs in stables with no access to pasture. None of these characteristics live up to the intentions of organic farming in terms of provision of life conditions with due consideration for the basic aspects of the farm animals' innate behaviour; use of livestock breeds well-suited for local conditions, and creation of a harmonious balance between crop production and animal husbandry (IFOAM, 2000).

The overall objective of this study is to identify strategies for a diversified organic pork production with high credibility and superior eating quality based on pigs foraging in

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the cropping system, use of a traditional breed and no castration. Specific objectives to be studied are how breed affects the performance and pork quality of different "types" of slaughter pigs. Three categories of slaughter pigs are investigated: 1) Entire male pigs slaughtered before sexual maturity, 2) Female pigs slaughtered at more than 100 kg live weight and 3) Sows slaughtered after weaning of the first litter. Three different breed combinations will be compared: The modern crossbred (Landrace x Yorkshire) x Duroc (LYD), the traditional breed Danish Black-Spotted (BS) and the crossbred Danish Black-spotted x Duroc (BSD). In this paper preliminary results will be presented from the first year of the project.

## Materials and methods

The experimental set-up was based on outdoor seasonal production of pigs with farrowings in the spring. 17 gilts (6 LY mated with D, 6 BS mated with BS and 5 BS mated with D) farrowed in April in individual paddocks with clover grass. The piglets were weaned at 10-11 weeks of age in June/July. The piglets stayed in the paddocks with access to the farrowing hut. The first parity sows were slaughtered shortly after weaning and six BS and five LY first parity sows were selected for meat quality assessments. The entire male pigs were slaughtered in July at approximately 40 kg live weight. Seventeen male pigs (one pig from each litter) were selected for meat quality assessments. After removal of the male pigs, three female pigs per litter were chosen to remain in the paddock. These pigs were slaughtered in the beginning of November. Back fat and meat thickness were measured at two points on the carcass with an optical probe (MK equipment). Surface colour with the parameters L\* (lightness), a\* (redness) and b\* (yellowness) was measured on slices of the M. longissimus dorsi using a Minolta Croma Meter CR-300 colorimeter.

## Results

In the following, preliminary results will be presented as numerical differences between breed combinations. The first parity sows' litter sizes, number of weaned piglets and piglet mortalities are presented in Table 1. One BS sow was excluded from the material due to an unusual low litter size of two piglets. In average the BS sows gave birth to 2.2 fewer piglets per litter than LY sows, but weaned only 1.1 less piglets per litter due to a markedly lower piglet mortality rate (21% lower).

**Tab. 1: The litter performance of the first parity sows (BS: Danish Black-Spotted, LY: Landrace x Yorkshire)**

	BS (n = 10)		LY (n = 6)	
	Mean	SD	Mean	SD
Litter size (dead and live born)	9.8	1.1	12.0	2.9
Weaned piglets per litter	8.2	1.8	9.3	1.6
Total piglet mortality, % of born piglets	16.5	15.0	20.8	8.8
Weaning age, days	74	9	72	9

Danish Black-Spotted piglets grew in average 21% slower than LYD piglets (316 g vs. 399 g per day) in the period from a few days after birth to weaning at 10-11 weeks of age. There was a negative effect of castration on daily gain for all three breed combinations and in particular for LYD pigs. Across breed, the daily gain was - in average - 15 % lower for castrated pigs compared to entire male pigs (332 g vs. 390 g per day). For LYD pigs, castrated pigs grew 24% slower than entire males (351 g vs.



459 g per day). The mean weight at weaning was 25 kg, 24 kg and 28 kg for BS, BSD and LYD pigs, respectively.

The first parity sows were slaughtered shortly after weaning at a mean live weight of 115 kg and 173 kg for BS and LY, respectively. The dressing percentage was 69 % for both breeds. The LY sows were leaner than the BS sows (e.g. 14 mm vs. 19 mm back fat and 57 mm vs. 41 mm meat thickness in one of the measuring points). The BS sows scored lower in L\* (48.2 vs. 50.5) and higher in a\* (11.8 vs. 9.6) and b\* (5.2 vs. 4.5), indicating darker meat compared to LY sows.

The entire male pigs were slaughtered at a mean age of 102, 87 and 87 days and a live weight of 39, 38 and 43 kg for BS, BSD and LYD, respectively. The dressing percentages did not differ markedly between breeds (71%, 73% and 73% for BS, BSD and LYD, respectively). There were no big differences in the thickness of the back fat and the meat of the three breed combinations (e.g. 11, 9 and 9 mm back fat and 58, 51 and 55 mm meat thickness in one of the measuring points for BS, BSD and LYD, respectively). Also for entire male pigs, the surface colour differed markedly between the breed combinations as shown in Table 2. The BS scored lower in L\* than BSD and LYD and both BS and BSD scored higher in a\* than LYD. BSD scored higher in b\* than BS and LYD.

**Tab. 2: Surface colour of slices of *M. longissimus dorsi* for entire male pigs (BS: Black-Spotted, BSD: Black-Spotted x Duroc, LYD: (Landrace x Yorkshire) x Duroc)**

	BS (n = 6)		BSD (n = 5)		LYD (n = 6)	
	Mean	SD	Mean	SD	Mean	SD
Minolta L*	49.4	4.8	53.7	2.3	54.0	5.1
Minolta a*	8.1	1.0	7.9	0.4	5.1	1.1
Minolta b*	3.4	1.2	4.3	0.6	2.9	0.8

## Discussion

The use of traditional breeds like the Danish Black-Spotted pig might be a way to produce organic pork products, which in e.g. appearance and flavour differ from conventional products. Preliminary results of this study support this theory as pork from the BS sows and young males was darker compared to pork from the more modern crossbreeds when observing numerical differences. Coming assessments will illuminate whether a difference in sensory profile also exists. In a previous pilot study, the pork from BS pigs was considered as tastier compared to modern crossbreeds (Christiansen, 2005).

Traditional breeds are generally considered as more suited for outdoor production because of their hardiness, less exposure to extreme weather situations and good mother abilities (Edwards, 2004). The results presented in this paper indicate that BS sows have lower piglet mortality, however, whether this is due to improved mother abilities is not known. Behavioural observations before and after farrowing will be included in the second year of the present project. Furthermore, it will be evaluated whether the traditional breed is able to retrieve a larger proportion of their energy need by foraging. This would be of great value in organic pig production based on pigs integrated in the cropping system.

Slaughtering entire male pigs at 40 kg live weight may be a way to improve the animal welfare in organic farming and simultaneously producing organic pork products of a particular appearance and high eating quality. It is common procedure to castrate piglets in organic farming to reduce the production of skatole as well as androstenone and thereby the risk of boar taint. It is, however, well documented that castration is associated with pain for the animal (Prunier et al., 2006) making castration inconsistent with the aim of organic farming in terms of good animal welfare. Castration is further known to reduce the growth rate of the pigs as confirmed in the present study and to reduce feed efficiency. Thus, there are some very important advantages of entire male production. It is expected that slaughtering the pigs at 40 kg live weight as in this study will reduce the risk of boar taint. Skatole concentrations in back fat of the young male pigs will be assessed in the nearest future.

## Conclusions

Danish Black-Spotted first parity sows had lower litter sizes compared to the more modern crossbred Landrace x Yorkshire. However, due to lower piglet mortality, the difference in weaned piglets per litter was only 1.1 piglets. The daily gain of the piglets from castration to weaning differed markedly between breeds. In average, the Black-Spotted piglets grew 21% slower than Landrace x Yorkshire piglets. There was a clear negative effect of castration on daily gain, especially in the Landrace x Yorkshire piglets with 24% higher daily gain in entire males compared to castrated pigs. Both the Black-Spotted sows and the Black-Spotted entire males, which were slaughtered at approximately 40 kg, had higher a\* scores and lower L\* scores indicating darker meat compared to Landrace x Yorkshire crossbreeds. In conclusion, preliminary results indicate that the use of a traditional breed might be a way to produce pork, which in appearance differs from conventional pork and at the same time improve the credibility of organic pig production.

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# Influence of amino acid level and production system on performance, health and behaviour in organic growing pigs

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Key words: lysine, production systems, growing pigs, social interactions, health

## Abstract

*The influence of dietary amino acid levels (recommended, 7% and 14% lower) on performance and carcass quality was studied in organic indoor and outdoor pigs fed ad libitum in a 2-phase feeding system. The outdoor pigs grew faster during phase 2 than the indoor pigs ( $p=0.001$ ), although feed conversion ratio did not differ ( $p=0.358$ ). Dressing percentage was higher for outdoor than for indoor pigs ( $p=0.011$ ) but lean meat content did not differ ( $p=0.904$ ). The results indicate a discrepancy between pigs housed in different production systems rather than between pigs directed to different dietary amino acid levels. This suggests that growing/finishing pigs fed ad libitum can compensate for dietary amino acid levels lower than the current Swedish recommendations without affecting production results.*

*Behaviour was affected by production system and showed that outdoor pigs walked significantly more ( $p=0.012$ ) and tended to be rooting more ( $p=0.098$ ) than indoor pigs. Sniffing, nibbling, pushing ( $p=0.001$  for all) and tail manipulation ( $p=0.002$ ) occurred more often indoors than outdoors. The incidence of pigs seropositive to erysipelas was higher outdoors ( $\chi^2$ -test;  $p=0.001$ ). *Ascaris suum* infections were present in both production systems, whereas *Eimeria* sp only was found among outdoor pigs.*

## Introduction

The regulations for the formulation of organic pig diets limit the number of potential and approved feedstuffs that are rich in protein and have a desirable amino acid profile. In addition, the use of synthetic amino acids is not allowed (EC, 1999; IFOAM, 2002). To compensate for the dietary deficiencies in essential amino acids, a high inclusion level of protein in the organic diet is necessary, resulting in a surplus of dispensable and non-limiting essential amino acids. This can affect production results negatively and increase the losses of nitrogen to the environment. A sufficient total daily intake of protein and amino acids could probably be assured when the voluntary feed intake increases in order to maintain a high daily energy intake, according to Håkansson *et al.* (2000).

Pigs in organic production shall be able to express their natural behaviour for grazing and rooting. Roughages induce satiety and studies have shown that aggressive and harmful behaviours were reduced in roughage or straw enriched environments (Beattie *et al.*, 2000). By increasing the time spent eating, roughages can keep the pigs occupied and reduce stress and aggression.

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The number of incidences of arthritis and arthrosis at slaughter have been higher for pigs raised outdoors, and according to Kugelberg *et al.* (2001) this phenomenon can be linked to erysipelas (*Erysipelothrix rhusiopathiae*). Outdoor production may cause an increased infection risk from parasites e.g. large round worm (*Ascaris suum*), because routine deworming is not practised in organic production systems.

The performed study aimed to investigate the influence of different amino acid levels on performance and carcass quality of organic pigs reared in indoor and outdoor production systems. Further, observations were performed in order to evaluate the pigs' activity behaviour and social interactions and the pathogen load was evaluated.

## Materials and methods

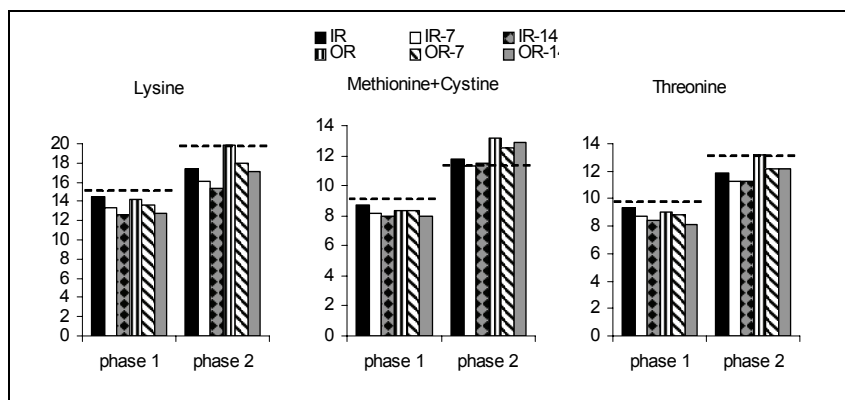
A total of 192 growing/finishing organic pigs (L-YxH) were raised indoors (I) in conventional pens or outdoors (O) on pastures. The indoor pens had a concrete floor, with a slatted floor in the dunging area. The total area was 14.8 m<sup>2</sup>, giving a floor area of 1.1 m<sup>2</sup> per pig. Indoor pigs had no access to outdoor area, but were provided with straw once daily. The outdoor pastures had a total area of not less than 0.3 hectare (375 m<sup>2</sup> per pig) with access to a shelter (1m<sup>2</sup> per pig) with straw bedding. One feeder was placed in the front of each pen and pasture and only one pig could eat at the same time from the feeder. Water nipples were placed over the slatted floor indoors and next to the feeder outdoors. In total there were 12 pens indoors and 12 pastures outdoors and each pen or pasture included eight pigs, four females and four castrates. Piglets were randomly allocated within litter to six treatments (IR, IR-7, IR-14 and OR, OR-7, OR-14), balanced according to sex and live weight. The pigs received diets containing different amino acid levels (lysine, methionine + cystine and threonine), based on standardised ileal digestible (SID, g/MJ ME) values. R was in accordance with the recommendation for growing/finishing pigs in Sweden, R-7 and R-14 contained 7% and 14% lower amino acid levels than the recommendation (Simonsson, 2006; Table 1). The amino acid supply was given as a 2-phase feed and all diets were provided ad libitum. Individual live weight and group average feed consumption were recorded continuously during the experiment and carcass parameters were assessed conventionally at slaughter. At three occasions; 60, 110 and 140 days of age, samples of blood and faeces were collected and active behaviour and social interactions of the pigs were studied.

**Tab. 1: Planned standardised ileal digestible (SID) amino acid supply (g/MJ ME)**

	Weight interval (kg)	Lysine	Methionine+cystine	Threonine
IR + OR	19-60	0,68	0,41	0,44
	61-113	0,58	0,33	0,38
IR-7 + OR-7	19-60	0,63	0,38	0,41
	61-113	0,54	0,31	0,35
IR-14 + OR-14	19-60	0,59	0,35	0,38
	61-113	0,50	0,28	0,33

## Results

Pigs in OR, OR-7 and OR-14 treatments grew faster than IR, IR-7 and IR-14 pigs (1005, 1109 and 1000 vs. 865, 911 and 839 g, respectively;  $p=0.001$ ) during phase 2 as well as during the entire period. Treatment did not affect feed conversion ratio ( $p=0.676$ ), which was on average 41.7 MJ ME/kg weight gain for the entire period. All OR treatments had higher carcass weight and dressing percentage than IR treatments ( $p=0.006$  and  $p=0.011$ , respectively) but lean meat content was similar in all treatments ( $p=0.904$ ) and was on average 57.2%. No interactions between treatment and sex were found. All pigs consumed slightly less standardised ileal digestible amino acids than the Swedish recommended levels (Simonsson, 2006) during phase 1. During phase 2, all pigs except those in treatment OR had lower daily intake of lysine and threonine compared with the recommendations, however methionine and cysteine was around the level recommended or slightly above for all treatments (fig. 1).



**Figure 1: Daily consumption of standardised ileal digestible lysine, methionine+cystine and threonine (g/day) for pigs in different treatments compared to the recommended values (Simonsson, 2006) of daily intake.**

Outdoor pigs walked significantly more ( $p=0.012$ ) and tended to be rooting more ( $p=0.098$ ) than indoor pigs. Social interactions such as sniffing, nibbling, pushing and tail manipulation occurred more often indoors than outdoors ( $p \leq 0.01$  for all). The incidence of pigs seropositive to erysipelas was higher outdoors than indoors (22 vs. 4.6%, respectively;  $\chi^2$ -test;  $p<0.001$ ). *Ascaris suum* infections were present in both production systems, whereas only outdoor pigs were infected with *Eimeria* sp ( $\chi^2$ -test;  $p<0.001$ ).

## Discussion

The results in our study mainly indicate a difference between pigs housed in different production systems (indoor/outdoor) rather than between pigs subjected to different dietary amino acid levels (R/ R-7/ R-14). No significant effect of dietary amino acid level on performance and carcass quality could be observed and consequently, *ad libitum* feeding seems to have ensured a sufficient total daily intake of protein and amino acids even with 7 and 14% lower levels of lysine, methionine + cystine and threonine than the Swedish recommendation (Simonsson, 2006). The lower daily consumption of amino acids compared with the recommendations indicate that they could be too high for organic pigs fed *ad libitum*. Recently, Bertolo et al. (2005)

showed that growing pigs on average had lysine requirements that were 94 % of the current NRC requirements. Walking and rooting occurred more often by outdoor than by indoor pigs in our study and this could be part of an explorative behaviour in accordance with Wood-Gush *et al.* (1990). An outdoor system with pasture seems to allow pigs to be more active and perform more natural behaviours, such as foraging and rooting, than an indoor system and reduce the frequency of aggressive behaviours. The higher incidence of pigs seropositive to erysipelas outdoors indicates a potential need for vaccinations to avoid problems with lameness and deteriorated animal welfare.

## Conclusions

The amino acid level in diets for organic growing/finishing pigs fed *ad libitum* could be reduced, below current Swedish standards for conventionally raised growing/finishing pigs, without any negative effects on performance and carcass quality. Reduced dietary amino acid levels can make it easier to optimize nutritionally sufficient feeds for organically raised pigs with available feed resources. This will also benefit the environment by minimizing the excretion of nitrogen.

## Acknowledgments

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# Effects of a feeding strategy to increase intramuscular fat content of pork under the conditions of organic farming

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Key words: feeding strategy, pork quality, intramuscular fat, on-farm research

## Abstract

*Eating quality of pork is to a high degree influenced by the intramuscular fat (IMF) content. In previous studies under standardized conditions the feeding strategy was identified as a main source of variation for the IMF content in pork. In this study the effect of the implementation of a specific feeding strategy using a high portion of home-grown grain legumes on the IMF content of pork, was assessed under different conditions on German and Austrian farms. Results showed that IMF content ranged on a comparably high level of about 2.2 %. In contradiction to previous results under standardized conditions the factor feeding had no significant influence on the IMF. The feeding effect was overlapped by heterogeneous conditions on the different farms. IMF content showed greater variation between the farms than between groups within each farm.*

## Introduction

The IMF content is the prominent criterion for eating quality of pork, well known for enhancing softness, tenderness and overall liking of pork (Affentranger et al. 1996, Fernandez et al. 1999). The authors consider an IMF content above 2-2.5 % as a minimum level to influence sensory properties. The non-consideration of this trait and the unidirectional selection for lean meat in conventional production resulted in IMF contents averaging clearly below the desirable IMF values. In general, pig producers try to approach maximum rates of lean tissue deposition and carcass values by means of providing diets enriched with limiting amino acids. Results of Sundrum et al. (2000), obtained under standardized conditions, showed that diets based on organic home-grown grain legumes with an unbalanced amino acid supply have the potential to produce pork with an high IMF (> 2.5%) content and a high meat yield without causing excessively fat pigs. The present study was conducted to assess whether the previous results can be transformed into farm practice.

## Materials and methods

A total number of 12 organic pork producers in Germany and Austria were involved. In the fattening period two dietary treatments (control and experimental diet) were used simultaneously on each farm in separate pens with about 20 animals per pen. On each farm one replicate was conducted. The control diets represented the feeding strategy followed on the individual farm while the experimental diet was based on a high portion of home-grown grain legumes that supplied restricted amounts of

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essential amino acids while at the same time increasing the supply with non-essential amino acids. In Germany the same experimental ration containing 47 % grain legumes (lupines and faba beans) was offered on all six farms. In Austria six farm-specific experimental rations, mixed by the respective farmers themselves with about 36 % grain legumes (peas and faba beans) were fed. Each mixture was analyzed by NIRS. The amino acid supply was separately determined by HPLC.

In Germany the genotype used was a crossbreed (Du x Ha) x (DL x DE) while the genotype on Austrian farms was a crossbreed Pi x (DL x DE). Recording of growth performance data started at the beginning of the finishing phase with about 70-80 kg and ended before slaughtering at about 120-130 kg live-weight. Carcass traits were assessed at the abattoir. Individual samples of *Musculus longissimus dorsi* (*M.l.d.*) of 10 pigs per treatment were taken from between the 13<sup>th</sup> and 14<sup>th</sup> rib and frozen at -20 °C before NIRS analysis.

Analysis of variance, estimation of least square means and standard errors were performed using the mixed procedure of the software package SAS 9.1.3 (SAS Institute 2004). Denominator degrees of freedom were approximated by the Kenward-Roger method. Residual were checked for normal (Gaussian) distribution and homogeneity of variance with residual plots by PROC UNIVARIATE and PROC GPLOT in SAS. The dependent variables were analysed by fitting a mixed model using farm, feed and sex as fixed factors: Farm\*feed\*round and farm\*round were considered as random factors (Piepho et al. 2003).

## Results

The experimental diet in Germany was characterized by a wide ratio between Lysin: (Methionine + Cysteine). The control diets showed a great variation in their amino acid ratio, depending on the respective mixture of the farm, but were better balanced than the experimental diet. In Austria the control diets as well as the experimental diets showed a great variation in the considered ratio of amino acids, but the experimental diets in comparison to the control diets tended to have a wider ratio of Lysin: (Methionin + Cysteine).

Performance and carcass traits of control and experimental groups on the examined organic farms in Germany are presented in Table 1. Daily live-weight gain was generally on a high level (above 800 g), but did not differ significantly between control and experimental group. Carcass traits such as lean meat content, fat and meat area showed no significant differences between both groups. IMF content tended to be higher for the experimental group (2.22 %) than for the control group (2.08 %).

**Tab. 1: Mean values and standard deviation of performance and carcass traits of control (CG) and experimental group (EG) on organic farms in Germany**

	Daily weight gain (g)	Lean meat content (%)	Fat area (mm)	Meat area (mm)	Intramuscular fat (%)
CG n = 113	844 ± 154	52.7 ± 4.1	20.0 ± 4.6	58.1 ± 5.0	2.08 ± 0.56
EG n = 115	823 ± 141	52.6 ± 3.2	19.7 ± 3.7	56.3 ± 4.7	2.22 ± 0.55



Performance data and carcass traits for the Austrian farms are presented in Table 2. Daily live-weight gain showed no significant difference between both groups. Lean meat content, fat and meat area were not significantly different between both groups. In Austria, the assessment and calculation of the lean meat content, fat and meat area was based on a different formula than in Germany, making the numbers for both countries being not directly comparable. Similar to the results obtained in Germany, IMF content of the experimental group tended to be higher (2.27 %) than for the control group (2.11 %).

**Tab. 2: Mean values and standard deviation of performance and carcass traits of control (CG) and experimental group (EG) on organic farms in Austria**

	Daily weight gain (g)	Lean meat content (%)	Fat area (mm)	Meat area (mm)	Intramuscular fat (%)
CG n = 60	794 ± 105	56.9 ± 4.0	14.9 ± 5.3	76.9 ± 5.7	2.11 ± 0.6
EG n = 69	732 ± 114	58.0 ± 3.4	13.5 ± 4.6	75.7 ± 5.7	2.27 ± 0.47

Mean values of IMF content (%) of the different farms in Germany and Austria are shown in Table 3. In Germany and in Austria the factor feeding had no significant influence on the IMF. In Germany, the interaction farm\*sex (p = 0,0341) showed the response of IMF on different farms depended on the sex. Especially on one farm (farm 5) castrated male animals showed a significant higher IMF content (2.13 %) than female animals (1.74 %). Mean IMF values showed a high variation between the different farms, with a minimum of 1.88 % (farm 3) and a maximum of 2.36 % (farm 4), respectively.

For Austrian farms the factors farm (p = 0,0027) and sex (p = 0,0176) showed a significant influence on the IMF. Castrated male animals achieved a significantly higher IMF content (2.40 %) as compared to females (2.19 %). The IMF contents varied between the different farms from a minimum of 1.81 % (farm 3) to a maximum of 2.96 % (farm 6).

**Tab. 3: Mean values and standard errors (s<sub>e</sub>) of IMF content (%) on the different farms in Germany and Austria**

	Germany		Austria	
	Mean	s <sub>e</sub>	Mean	s <sub>e</sub>
Farm 1	2.25	0.21	2,29 b	0,12
Farm 2	2.33	0.21	1,85 c	0,11
Farm 3	1.88	0.21	1,81 c	0,12
Farm 4	2.36	0.20	2,46 b	0,11
Farm 5	1.94	0.21	2,40 b	0,15
Farm 6	2.10	0.28	2,96 a	0,14

LSD (5 %) = 0.75; n = 228

LSD (5 %) = 0.17; n = 129

## Discussion and Conclusions

Contrary to the previous results obtained under standardized conditions (Sundrum et al. 2000), different feeding strategies caused no significant differences between control and experimental groups on the IMF content of pork under on-farm conditions. Animals of the experimental groups in Germany and Austria both tended to a higher IMF value without being statistically different from the control groups. The reasons for the discrepancy between the results obtained under standardized or on-farm conditions are multi-factorial. On the one hand the IMF content in the control groups was already on a high level which might be due to the usage of relatively high contents of grain legumes in the control rations. On the other hand the highest IMF values in the previous study (Sundrum and Aragon 2005) were obtained with the feeding strategy beginning in the starting period, while in the study presented here the use of the experimental diet was restricted to the finishing period. The interaction between feeding strategy and IMF was probably overlapped by farm specific factors. In contradiction to the standardized conditions the rations showed great variations and were not consistent in their compositions regarding e.g. crude protein. Feed consumption also varied substantially between both groups in each farm as well as between the different farms. Variations in daily weight gain within the groups resulted in different ages at slaughter which might have an additional effect on the IMF content. An advantage of the used experimental ration was the possibility to supply fattening pigs with a ration containing 100 % organic feed ingredients and thereby meet the future requirements of the EC-Regulation with respect to bought-in feedstuffs. Due to the great variation between individual carcasses it is concluded that there is a need for a direct assessment of IMF content of pork at the abattoir to fulfil the expectations of consumers with regard to a high eating quality of organic pork.

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## Occurrence of intestinal helminths in two organic pig production systems

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Key Words: fattening pigs, organic husbandry, outdoor, pasture rotation, helminths

### Abstract

Organically raised pigs are at particular risk of being infected with pasture borne endoparasites, but the housing and management system may nevertheless have a great impact on transmission. In the present study pasture rotation routines on six pig farms representing two different organic management systems were compared; 1) a mobile system, in which the pigs during the summer were living in huts on pastures that were included in a long-term crop rotation scheme, while they during the winter were stabled with access to a concrete yard; 2) a stationary system, in which the pigs all year round were stabled with access to outdoor pastures in the summer time and a concrete yard in the winter. On one farm per system, the faecal excretion of nematode eggs from the pigs were analysed for a period of 3 years. Furthermore, soil samples were collected on a mobile farm to investigate levels of nematode eggs from fields with different pig/fertilizer history. The results showed that the use of a stationary system did not fulfil the actual recommendations for prevention of nematodes. The infection levels of *A. suum* and *Oesophagostomum* spp were high in the young pigs in both systems. In contrast, *T. suis* egg excretion was steadily very low in the mobile system, while the infection level increased during the observation period in the stationary system. The number of eggs in soil from the fields that had been used as pig pastures until November was larger compared to those used only until September, or that was fertilized by manure.

### Introduction

Organic pig producers may have a variety of different production systems, and the housing and management system may in turn have huge impact on transmission and prevalence of intestinal helminths (Carstensen et al. 2002). Survey studies have revealed that organically raised pigs in general are at particular risk of being infected with pasture borne endoparasites (Roepstorff et al.1992, Carstensen et al. 2003) that may have an effect on animal welfare and production. Thus, organic finishers generally have high levels of milk spots in their livers, caused by migrating larvae of the pig roundworm, *Ascaris suum*. Since the use of prophylactic anthelmintic treatment is not desirable in organic husbandry, precautionary management is crucial (Roepstorff et al. 1992, Carstensen et al. 2003). Nematode eggs are deposited in the faeces but must develop in the outside environment before they become infective, and ingestion of infective eggs is the route of transmission. Ascarids mainly affects young

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animals while adults usually has acquired resistance (Roepstorff, 2003). In a single day one piglet may contaminate the environment with millions of eggs, which potentially survive for many years (Roepstorff, 2003). Although the eggs in general are highly resistant to physical and chemical factors, they may face a high mortality when exposed to prolonged desiccation, heat, UV-light, and/or microfungi. Another important pathogen is the whipworm *Trichuris suis*, which at high worm burdens might cause blood-stained diarrhoea and even death (Roepstorff & Nansen, 1998). *T. suis* has a life cycle very similar to *A. suum*, but *T. suis* seems to be highly associated with outdoor rearing, and this may be the reason why it is much more common in organic herds than in conventional herds (Roepstorff et al. 1992; Carstensen et al. 2003). The nodular worm, *Oesophagostomum* spp., is commonly found in pigs, but unlike both *A. suum* and *T. suis* it is only moderately immunogenic and therefore tends to accumulate with age in older pigs (Roepstorff & Nansen, 1998). *Oesophagostomum* spp. has a high prevalence in some organic herds while a low prevalence in others (Roepstorff et al. 1992; Carstensen et al. 2003), but the underlying reason for this difference is unknown. The aim of this study was to investigate the management in different organic pig production systems in relation to actual recommended nematode prevention routines and to increase the knowledge of the transmission and survival of eggs from pig parasites in the systems. This study is expected to contribute to a better understanding of how to control these infections in a sustainable way.

## Materials and methods

Nematode prevention routines on six pig farms representing two different organic housing and management systems were compared during 2002 - 2004: 1) a mobile system (herds M1-M3) with huts, where the pigs were included in a crop rotation plan during the summer, while the pigs were stabled with access to an outdoor concrete yard in the winter; 2) a stationary system (herds S1-S3) in which pigs were housed all year round with access to outdoor pastures in summer time and a concrete yard during the winter. M1 and M2 raised their own pigs while the other farms bought the weaners, which were raised for slaughter. Most of the piglets were raised in stables during winter and in huts at the pasture during summer. During the three year study, one farm per system, M1 and S1, was chosen for investigation of the faecal excretion of nematode eggs from growers (at age 12 weeks) and fatteners (at age 20 and 23 weeks). On each of these two farms, five groups of 10 randomly selected pigs were examined every year on three occasions from May to November. Information on condemnations at slaughter was also registered. Furthermore, in 2004 soil samples were collected in May and July on one of the mobile farms (M1) to investigate levels of nematode egg contamination on fields included in a crop rotation system and with a different pig/fertilizer history: 1) six fields grazed by pigs, 2) five fields fertilized with pig manure, and 3) one field fertilized with a byproduct from yeast production (BioVinasse) mixed with water from the dunghill. On each occasion four pooled soil samples were collected per field. From May until October/November, pigs in both production systems had access to a pasture with a stocking rate of 84 – 147 m<sup>2</sup>/pig. In the mobile system, the interval for pasture rotation was 3-6 years (between grazings), whereas in the stationary system 1–2 years (Table 1). Unlike the mobile system, the pasture in the stationary system was in general used by consecutive groups of animals and the pigs also had access to a small permanent outdoor area next to the stable. In contrast, most pig groups in the mobile system were let out on a pasture that was totally included in a crop rotation system, and that had been unexposed to grazing pigs for several years.

**Tab. 1: Pasture management routines in six organic pig farms representing two different housing and management systems; 1) a mobile system (M1-M3); 2) a stationary system (S1-S3)**

	M 1	M 2	M 3	S 1	S 2	S 3
Groups/year in the same outdoor area	1	1	1	2	1-2	4
Rotation interval (years between grazings)	3	≥ 3	7	1	1	2
Partly permanent outdoor area	No	No	No	Yes	Yes	Yes
Stocking rate (m <sup>2</sup> /pig)	134	114	147	94	101	84

## Results

The infection levels of *A. suum* and *Oesophagostomum* spp was high already in the young pigs (12 weeks) irrespective of the system used. Approximately 50% of the 12 weeks old pigs were infected with *A. suum* and about 75% with *Oesophagostomum* spp. in both herds. In contrast, the infection level of the whipworm *T. suis* was very low in the mobile system throughout the three year study period, while the infection level tended to increase in the stationary system from the second year.

Eggs of *A. suum* were found in soil samples from all fields of herd M1. However, there was huge variation in the results ranging from a single “dead” egg in one sample, to several eggs in all four samples. Eggs from other nematodes were not found with the exception of *T. suis* that was detected in one sample from a field fertilized by manure. The mean numbers of eggs were reduced from May until July, however there was a large within plot variation. The number of eggs from the fields used as pig pastures until November was larger compared to those used only until September, or fields which were fertilized with manure.

## Discussion

This study shows that the organic pig pastures in the stationary system were much more intensely used compared to those in the mobile system. In the stationary system the rotation intervals of the pastures were short (1-2 years in between grazings) and the pastures were often used by consecutive groups of animals. Also the pigs had access to small permanent outdoor areas. This is contrary to the recommendations for organic pigs, which recommends a rotation scheme including all outdoor areas (Roepstorff et al. 2001). Also, the rotation intervals should be as long as possible and a pasture rotation schedule should be strictly maintained in order to prevent parasite problems (Carstensen et al. 2003). The differences in management routines between the pig raising systems investigated in the present study indicated a higher risk of being exposed to nematodes in the stationary system. However, we were unable to confirm this by faecal examination of the fattening pigs (>12 weeks). On each of the two farms representing the different systems, already about 50% of the 12 weeks old pigs excreted eggs of *A. suum* and about 75% *Oesophagostomum* spp. Thus, the results from the faecal examinations, showed that the piglets had been infected already before they were brought into either of these pig raising systems. For the future, it therefore seems important to also concentrate on the management of the piglets before weaning. In contrast, the occurrence of *T. suis* differed between the two systems investigated herein. The number of whipworms in the mobile system was very low throughout all three years, while the infection level increased in the second

year in the stationary system. Our results conform with the Danish study by Carstensen et al. (2002), where the highest prevalences of whipworms were observed in organic pigs maintained for several consecutive years on permanent outdoor areas. Occasionally, such herds have also had clinical problems associated with *T. suis* (Carstensen et al. 2002) and the authors suggested that this may be due to accumulation of nematode eggs in the soil over the years. Such accumulation may also have taken place in the stationary farm that was investigated in the present study. The investigation of nematode eggs in the fields, revealed that fertilizing with pig manure from the dunghill was enough to cause a low level of *A. suum* contamination. The fields that had been grazed by pigs only at summertime had a low contamination similar to the manure fertilized fields. In contrast, the two fields that had been grazed during both summer and autumn displayed a more than tenfold contamination level compared to the other fields. This difference may partly be caused by the longer period of grazing and thereby more eggs being excreted on the area and partly because eggs excreted during the autumn seem to have a higher survival rate than eggs deposited during the summer (Larsen & Roepstorff, 1999; Kraglund, 1999).

### Conclusions

The use of a stationary system all year round did not fulfil the actual recommendations for rotation of pasture areas. Faecal examination of 15 groups of organic pigs revealed high infection levels of *A. suum* and *Oesophagostomum* spp already in 12 weeks old pigs. The faecal results also indicated an accumulation of eggs from *T. suis* in the stationary system, which points out the need for longer rotation intervals. The results indicated that when autumn grazing is practised, the rotation intervals should be extended compared to only summer grazing.

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## **Multi criteria assessment of livestock systems**



# Organic livestock production - trapped between aroused consumer expectations and limited resources

Sundrum, A.<sup>1</sup>

Key words: standards, inconsistencies, conflict of aims, credibility, change in paradigm

## Abstract

*Literature reviews reveal that the implementation of organic standards have failed to clearly improve status of animal health and welfare on many farms in comparison to conventional production. The a huge variability with respect to this issue between organic farms indicate profound discrepancies between claim and reality of organic livestock farming. Thus, the hypothesis that the implementation of minimum standards will automatically provide benefits for the issue of animal health and welfare has been refuted by farm practice. As a consequence, organic farmers and retailers can no longer stick to the claim that organic products of animal origin are of higher value with respect to the issue of animal health and welfare. Reasons for the limited effects of the organic standards are multi-factorial and assumed to be farm specific in the first place. On the other hand, limited availability of resources such as nutrients, labour time and investments within organic farm systems together with a high pressure on the production costs by retailers make any improvements very difficult. In order to preserve the credibility of organic agriculture and the confidence of the consumers in organic products there is a need for more transparency and for a change in the paradigm from a standard-oriented to an output-oriented approach. Credible information about the specific level of product and process qualities emerged by each farm has to be provided. Simultaneously, a high level of animal health and welfare has to be honoured by premium prices to cover the additional costs and efforts that are needed to improve the current situation.*

## Introduction

Standards are a characteristic feature of organic farming since 1954. The starting point for the standards was the trademark legislation that required clear criteria to identify organically produced goods (Schaumann 2002). Because the variety of production sites and the resulting product properties did not allow the identification to be linked to products in terms of quality that could be described exactly and understood analytically, the production method itself became the identifying criterion. This fundamental principle has been adopted by the EU Commission to harmonise the rules of organic farming and to make all organic systems across EU members subject to minimum standards (EEC Regulation 2092/91). One of the main objectives of the EU Regulation is to protect consumers from unjustified claims and to avoid unfair competition between those who label their products as being organic. Simultaneously, certified standards are closely linked to the expectation that they provide benefits and additional values. Consumers make a whole range of positive inferences from the label 'organic', including a high level of animal health and welfare on organic farms

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(McEachern and Willock 2004). Many consumers directly associate organic farming with enhanced animal health and welfare and conflate organic and animal-friendly products (Harper and Makatouni 2002). A healthy product from a healthy animal is by far the most important reason to buy organic products from animal's origin (Miele and Parisi 2003). There is, however, reason for concern that the expectations of the consumers often are not met by organic livestock farms.

### **Animal health and welfare as a process quality**

Animal health and welfare has different meanings to different people. The attributes included in a concept to assess animal health and welfare primarily depend on who is making the definition. In the literature, there is a great variety of definitions of animal health and welfare, thoroughly discussed by Fraser et al. (1997). Hence, there is no generally accepted definition of animal health and welfare within scientific community. In general, legislators and brand label programmes are using technical indicators which refer to single aspects of housing conditions (e.g. space allowance), to describe different levels of minimum standards in relation to the appropriateness of housing conditions in terms of animal health and welfare. The EU-Regulation (EEC-No. 2092/91) clearly exceeds the minimum standards of conventional livestock production.

On-farm assessments, however, indicate that organic standards do not automatically lead to a high status of animal health and welfare that exceed the level in conventional production (Hovi et al. 2003; O'Mahony et al. 2006; Dietze et al. 2007). The results of these studies showed substantial variation both between and within farm types. Especially, the comparable high rates of mortality and morbidity interfere with the well-being of farm animals. Hence, consumer expectations are not met to an acceptable level. Reasons for the low effects of the organic standards are multi-factorial. Animal health and welfare emerges from complex interactions between farm animals and environment within a farm system. While standards represent only a small aspect with respect to the development of production diseases, the main source of variance is expected to be caused by the farm management (Sundrum et al. 2006).

### **Conflicting areas**

Products with attributes of process quality such as animal health have in common that their unique selling proposition is not directly visible to the consumer. Only additional information will identify the characteristics of the production process of these foods. Perception of consumers is to a high degree influenced by information through media and advertising. However, neither media nor advertising campaigns define their view on animal health and welfare or provide information by which criteria the status is assessed. While different consumers show different preferences and subjective perceptions there is a huge variability of pictures in the 'eyes of the beholder' which makes it very difficult to deal with this issue without clear and reliable information.

On the other hand, organic farming has to deal with a high diversity between regions of Europe with respect to the availability of relevant resources (high quality feedstuffs, labour time, investments etc.), the perception of problems and the expertise to deal with these problems (Sundrum et al. 2006). In order to improve the unsatisfying situation, there is a need for additional efforts on many farms, encompassing among others improvements in feeding conditions (Sundrum et al. 2008), hygiene management and data handling (Dietze et al. 2007), and the implementation of feed back mechanisms to control the complex processes along the production chain. Thus,

previous on-farm assessments indicate the need for a clear increase in labour time to meet the requirements of an appropriate animal health and welfare management.

Whether the additional costs will be compensated for in the long run by an increased productivity due to healthy animals and a reduction in veterinary costs remains an open question. This will depend to a high degree on the farm-specific situation and the development of the organic market and the production costs. As resulting costs of production for most organic farm types are higher than for conventional systems, price premiums are urgently needed to achieve an appropriate income (Offerman and Nieberg 2000). However, prices for organic animal products often do not even cover the previous expenditures need to implement the minimum standards. In addition, those producers who aim for a high level of animal health and welfare by increasing their efforts compete with their products on the same markets as those who widely ignore the issue of animal health and welfare and possibly gain advantages due to a lower cost basis or lower requirements for labour time.

Based on the previous results of on-farm assessments in various countries, retailers and producers can no longer claim to offer products that derive from healthy animals, without being at risk to loose credibility and confidence of consumers. While all organic livestock farmers will have to face the possible consequences deriving from the loss of credibility, those who have already invested a lot in measures to improve animal health and welfare will loose more than those who still work on the basis of derogations and comparable low production costs.

While farmers are responsible in the first place for the well-being of their farm animals, they are very limited in their freedom of decision-making as they possess little financial scope that can be used for improvements. In contrast, consumers are able to select between large ranges of products while the expenditures for food in relation to the total budget of a household have dramatically decreased during the last decades. On the other hand, the interests of retailers to increase turnover rates by offering organic food with comparable low prices contradicts with the possibilities of the farmers to investigate in substantial improvements of animal health and welfare.

For organic livestock production, consumers' interests and expectations are very important as they are closely linked to their willingness to pay premium prices being an essential precondition to cover the higher productions costs in comparison to conventional production. Therefore, it is of essential importance for organic farming to clarify on how to cover consumers' interests, to ensure consumer confidence and to avoid misleading labelling. The organic movement is challenged to ensure that its credibility and the confidence of the consumers does not get lost in the gap between claim and reality.

## **Conclusions**

By arousing and/or not contradicting consumer expectations in relation to a high level of animal health and welfare in organic livestock production, retailers and producers of organic food are facing the risk to become victims of their own announcements. The current framework conditions of the food market contribute to a situation in which the existing potential for a high level of animal health and welfare in organic livestock production is not fully realised and the further development of quality production is hampered by contradicting expectations and perceptions. From an overriding perspective there is reason to conclude that the lack of clear objectives and threshold values concerning an acceptable status of animal health and welfare as well as the lack of control mechanisms within and outside the farm system contribute to the high

variation in relation to animal health and welfare in organic livestock production. As organic standards so far have not worked properly to ensure a high status of health and welfare there is no clue that they will work in the future. It can be assumed that clearly increased feed prices and a high pressure on market prices for organic products will prevent farmers to invest efforts and money in measures which are very uncertain with respect to their profitability. To prevent the loss of credibility, organic farmers and retailers are obliged to take the burden of proof. Consequently, there is a need for a change in the paradigm from a standard oriented to a result and output oriented approach. Reliable monitoring systems for assessing the animals' health and welfare status are urgently required to accommodate societal concerns and market demands. Retailers should urge the producers to establish a regular monitoring system for animal health data, for example records of all incidences of treatment, mortality and morbidity rates, slaughterhouse data of fattening animals, and somatic cell counts of dairy cows. Producers failing to meet certain health standards in the longer term should face consequences. Simultaneously, retailers have to make sure that a high level of animal health and welfare will be honoured by adequate premium prices to cover the additional costs needed to ensure a process quality which is closely linked to the credibility of organic farming.

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# Is automatic milking acceptable in organic dairy farming? Quantification of sustainability indicators

Oudshoorn, F.W.<sup>1</sup> & de Boer, I.J.M.<sup>2</sup>

Key words: organic dairy, automatic milking system, sustainability indicator, milk quality

## Abstract

*The objective of this research, was to quantify sustainability indicators of organic dairy farms using Automatic Milking Systems (AMS), and a comparative group of organic dairy farms using conventional milking systems (CMS). Milk yield per cow was higher for AMS farms but did not result in higher net return to management. Nitrogen surplus per ha of available land was higher for AMS farms, Animal health was unaffected by AMS use, as also most milk quality aspects; somatic cell count, clostridium spores and urea. Acid degree value (ADV), measured as free fatty acids (FFA) in the milk, was higher in milk from AMS users. Labour time was decreased by almost 50% for AMS users, to 2.3 min/cow/day. It could be concluded from quantification of selected indicators on economy, environment, cow health, milk quality, and labour time, that the organic dairy farms using AMS, in spite of the substantial decrease in grazing time, show potential for a sustainable development.*

## Introduction

The use of Automatic Milking Systems (AMS) has been increasing vastly the last few years in organic dairy production in Denmark. At the end of 2005, 9% of the 480 organic herds were using AMS. This is not surprising as organic farmers have been known to be innovative, both in system approach and technology. New technology can however provoke skepticism (Meskens and Mathijs, 2002) not at least when organic markets are based on trust and integrity for product quality and production process (Torjusen et al.2004.). A rising concern was registered among stakeholders involved in the production, addressing some sustainability issues of automatic milking (Oudshoorn et al. 2007). A survey was made of literature on AMS use (Oudshoorn & de Boer, 2005), considering possible conflicts with the organic view on sustainability and these were analyzed using focus groups with stakeholders. However no data was available for only organic AMS use so theoretical extrapolation was conducted. The issues of concern comprised economic profitability, increasing eutrophication potentials, caused by too high stocking density close to the barn, milk quality and the problems of pasturing (grazing and eating fresh herbage) the herd sufficiently (Oudshoorn et al. 2007). An accepted method for validation of these issues of concern comprises (Mollenhorst and de Boer, 2006) identification and quantification of indicators. The objective of the work was to acknowledge if the identified theoretical

concerns were correct, by quantifying indicators for these issues and validating them using CMS farmers and legislative thresholds as reference.

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## Materials and methods

To validate selected sustainability indicators we chose to compare values of 9 organic AMS farms with 9 farms using conventional milking systems (CMS) for the year 2005. To make comparison possible, interdependent factors were avoided, like farms size and race. The issues of concern addressing sustainability were economic performance or profitability of the farm, on-farm eutrophication and biodiversity, labor, animal welfare including health, and milk quality aspects. For each of these issues we selected a set of sustainability indicators (SI's). We followed the definition of Bell and Morse (2003) who stated that an indicator should be an operational representation of a property, quality or characteristic of a system. Economic profitability was measured by quantifying financial result (i.e., gross income minus fixed and variable costs) and specifying some selected account items. Eutrophication was measured by quantifying N & P balances at farm gate and in specific fields used for grazing and mowing. Biodiversity was quantified by registering the amount of species in the selected fields. In addition the average field size was registered as field borders often give space to more diversity. Labor was registered as the average time used on tasks concerning dairy cows. Animal welfare and health were registered by selecting health indicators especially related to grazing, such as claw problems, mastitis, and reproduction, as well as the total amount of treatments (treatments per cow per year). Milk quality aspects concerning use of AMS were in the survey identified to the amount of free fatty acids (FFA), hygiene indicators and somatic cell count (SCC). Grazing itself was registered as well as direct influence on fat % and Urea content.

All results were tested for normal distribution and for variance and significant differences for the factor investigated (ANOVA).

## Results and discussion

**Tab. 1: Quantification of some general characteristic parameters, as average of 9 farms in each of the two groups: farmers with automatic milking systems (AMS) and farmers with conventional milking systems (CMS). Standard deviation in brackets.**

Parameter	Dimension	AMS		CMS		
Dairy cows	<i>amount</i>	114	(34)	118	(38)	ns
Total area	<i>ha</i>	149	(63)	116	(57)	ns
Stocking rate	<i>LU ha<sup>-1</sup></i>	1.28	(0.32)	1.65	(0.68)	ns
Area available for grazing	<i>ha cow<sup>-1</sup></i>	0.29	(0.14)	0.25	(0.11)	ns

As a result of the partly structured selection of farms, the average herd size of AMS and CMS farms was the same (Table 1.). Stocking rate for CMS farms seems a bit higher, but due to large internal variation no statistically significant differences were found. Clearly the farms using AMS had higher milk yields than their organic colleagues using conventional systems (Table 2) but their profitability, shown as financial result, was not better. Surprisingly, as most economic assessment of AMS based on non organic farming systems show inferior economic performance for AMS compared to CMS farms (Meijering et al. 2004).

**Tab. 2: Sustainability indicators for economic performance, eutrophication, milk quality and animal welfare and health. Average of 9 farms in each of the two groups: farmers with automatic Milking systems (AMS) and farmers with conventional milking systems (CMS). Standard deviation in brackets.**

Indicator	Dimension	AMS		CMS		
Milk yield, delivered	$ECM\ cow^{-1}$	8539	(557)	7302	(880)	**
Financial result	€ x 1000	161	(54)	123	(69)	ns
Surplus N at farm level	$kg\ N\ ha^{-1}$	110	(29)	66	(40)	*
Surplus P at farm level	$kg\ P\ ha^{-1}$	8.8	(6.6)	3.4	(8.7)	ns
Surplus N grazing pasture	$kg\ N\ ha^{-1}$	92	(82)	166	(60)	*
Surplus N mowing pasture	$kg\ N\ ha^{-1}$	148	(79)	53	(80)	*
Average field size	Ha	5	(1.1)	5.3	(3.8)	ns
Plant species <sup>1)</sup> "graze"	amount	5.4	(1.3)	5.6	(2.1)	ns
Plant species "mow"	amount	3.4	(2)	2.4	(1.1)	ns
Labor used	$min\ cow^{-1}$	3	(1.2)	5.3	(1.2)	**
Sum vet. treatm. Summ. <sup>2)</sup>	<i>pr. cow</i>	0.48	(0.24)	0.33	(0.23)	ns
Sum vet. treatm. Wint.	<i>pr. cow</i>	0.40	(0.09)	0.32	(0.21)	ns
Culling rate	%	37	(6)	32	(5)	*
Grass uptake pasture	$kg\ dm\ a^{-1}$	5.1	(1.6)	6.9	(2.2)	ns
Grazing time	$hr\ y^{-1}$	968	(198)	2083	(788)	**
Somatic Cell Count	$10^3\ ml^{-1}$	219	(67)	226	(65)	ns
Clostridium spores summer	$10^3\ l^{-1}$	411	(661)	244	(108)	ns
Free Fatty Acids	$meq\ l^{-1}$	0.78	(0.16)	0.49	(0.11)	**
Applied concentrates	$Kg\ LU^{-1}$	7.28	(1.6)	6.25	(1.7)	ns
N balance import-export	$kg\ N\ ha^{-1}$	8.00	(21)	-48.00	(66)	*
Available N for fertilizing	$kg\ N\ ha^{-1}$	135.00	(26)	117.00	(48)	ns

\*P value < 0.05 \*\* P-value < 0.001 <sup>1)</sup>Plant species: grass species counted as one.

<sup>2)</sup>Sum vet treatm. summ.: the number of veterinary treatments per cow during the selected summer months (summer= Apr.-Sept.)

Surplus Nitrogen at farm level was higher on AMS farms, but in debt analysis showed that this was mainly due to larger export of farm manure by the CMS farms. The amount of concentrates used to accomplish the higher yield on AMS farms was not significant. The surplus N for grazing pastures on AMS farms was lower than for CMS farms. Explainable because the area available for grazing was the same for both groups, but the cows were outside grazing much longer for the CMS farms (Table 1 & 2). The increased time cows on AMS farms were inside resulted in higher amounts of manure collected, which could be applied on mowing fields and cash crops. No difference of biodiversity indicators was found between AMS users and CMS users. Labor time used for AMS users was dramatically lower, giving the farmer more time

for other tasks, like observing the herd for possible sickness. In addition the flexibility of the labour day is larger (Meskens and Mathijs, 2002). Concerning animal health parameters, no significant differences could be registered between the two groups. It was however found that the culling rate for AMS users had a tendency to be higher. It has been reported in literature that the use of AMS provokes the culling, as some cows simply are not suitable for automatic milking (Østergaard et al. 2002). Milk quality is of major concern. Corresponding to other literature, no differences were found in SCC or Clostridium spores. However, the Free Fatty Acid (FFA) concentration in AMS milk was higher, a notorious disadvantage of AMS milking, mainly due to the higher frequency of milking (2.3 – 2.7 times per 24 hours). The absolute value of the FFA concentration is still low, in comparison to FFA values for non organic systems with AMS (Rasmussen et al. 2006).

## Conclusions

Few of the selected sustainability indicators proved to be different for organic dairy farms using AMS, compared with farms using CMS. There was large variance between the farms of each group, however the production level was higher for the AMS farms. Higher feeding levels were registered for AMS farms. Animal health was unaffected by AMS use, as also milk quality aspects; somatic cell count, clostridium spores. Total grazing time per cow per year was less for AMS farms, and the free fatty acid value for AMS milk higher. However, these values were not alarming and thus organic dairy farms using AMS, show potential for a sustainable development.

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# Environmental Impacts and Economic Differences in grassland based Organic Dairy Farms in Germany – Modelling the Extremes

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Key words: Organic, dairy, LCA, Economic return, Farm model

## Abstract

*Differences in environmental impact and economic returns between intensive and low-input organic dairy production are investigated using two simplified model farms with different amounts of concentrates being fed. In four scenarios, ecological and economic effects of restricting the more intensive farm management practice beyond the existing regulations of organic farming are analysed. In the initial situation, the intensive farm has a financial advantage of about 600.00 € per ha compared with the low-input farm, while the environmental risks caused by its production system are higher in several Life Cycle Assessment (LCA) categories. We showed for the model case that limiting livestock density and using regional grown concentrates bring about considerable improvements in LCA results, while restricting the amount of concentrates used does not. These three scenarios result in economic deterioration for the intensive farm. A fourth scenario increasing the share of pasture in daily dry matter intake (DMI) to a minimum of 50% during the grazing season has positive effects environmentally as well as economically.*

## Introduction

The spectrum of production systems in organic dairy farming in Germany ranges from traditional grass-based feeding systems with milk yields of about 6000 kg or less to herds fed with large amounts of concentrates yielding up to 9000 kg milk per cow and year. More intensive strategies are often justified economically, while the price paid in view of a possible aggravation of ecological impact is not accounted for. Then again, economic implications need to be considered when discussing more severe restrictions to farming practice meant for improving environmental performance. We investigated the interrelation between economic and ecological returns using two model farm types. These model farms are assumed to be perfect twins in every aspect but dairy management practice. In the initial situation, the feeding strategy was modelled extremely low-input (0.2 t DM of concentrates per cow and year, 6000 l milk yield) for one farm and extremely intensive (2 t DM of concentrates, 9000 l milk yield) for the other. The more intensive farm is adapted to four different scenarios describing restrictions that may be imposed in order to decrease environmental burdens and that are already fulfilled by the low-input farm in the present situation. We calculated the ecological changes obtained through these impositions and the resulting economic effects for the intensive farm.

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## Materials and methods

The model assumptions were derived from analyses of 36 German organic dairy farms carried out between 1999 and 2007 (Deittert et al. 2008). Both farms are supposed to be grassland farms situated in one of the hilly regions in Mid-Western Germany. Both have a farmed area of 100 ha, on which 100 (intensive) or 80 (low-input) cows plus young cattle are kept respectively. Both farms have simplified farm geometry with the farm buildings being situated in the middle of a square farm area. Thus, the total of the farm area could theoretically be used for pasture. The low-input farmer practices a pasture based regime in summer and relies primarily on grass silage in winter, while in intensive system only 1 kg dry matter (DM) per day are taken in as pasture in the initial situation. The concentrates available in the scenarios are wheat and rapeseed oil cake assumed to be produced within an average distance of 100 km. In addition, imported soybean residues are used as cake and pulp. Milk yield and feeding intensity are assumed to be directly related through the energy and protein contents of the rations (GfE 2001), daily dry matter intake (DMI) is estimated according to Schwarz et al. (1996). One quarter of the herd is replaced per year in the low-input farm, while the intensive farm has a replacement rate of 40%. The cost of a heifer is the same in both models.

As the model farms are equal in every respect but number of cows, feeding system, replacement rate and milk yield, the difference in economic outcome per cow and per kg milk is calculated as the balance of the returns from milk and replaced cows on the one hand and the costs for replacement, fodder and concentrates on the other hand.

To study the environmental impacts, we did a LCA of both farms based on the methodology developed by Haas et al. (2000). The calculation of energy use comprises fodder production, provision of fuel and machinery, and production, processing and transportation of concentrates. The calculation of the climate impact - measured in CO<sub>2</sub> equivalents emitted per milk unit - comprises the CO<sub>2</sub> emissions caused by energy consumption, the CH<sub>4</sub> - emissions from ruminants and excrements and the N<sub>2</sub>O emissions from excrements and fields. Results are related to one milk unit. In the evaluation of animal welfare the positive effect of pasturing and a ruminant adapted ration is taken into account. The N supply, calculated per hectares, is an indirect indicator for the potential biodiversity of the grasslands. For details of the methods applied see Müller-Lindenlauf (2008).

Besides the initial situation we considered the following scenarios:

Limitation of livestock density to 1.4 LU per ha of farm area

Restriction of the amount of concentrates used to a minimum of 20% of daily DMI

Increase of the share of pasture to a minimum of 50% of daily DMI during the grazing season

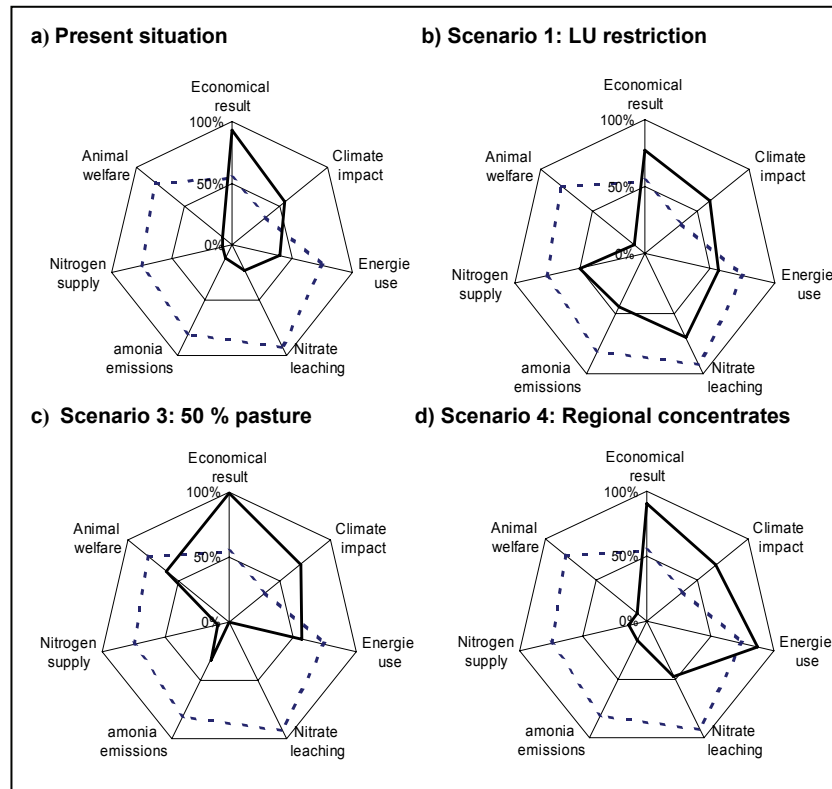
Replacement of imported feedstuff by regional wheat and rapeseed cake.

The requirements of these scenarios are already fulfilled by the low-input farm in the initial situation.

## Results and Discussion

In the initial situation, the low-input farmer has a financial disadvantage of 600.00 € per ha based on actual prices for milk and feedstuff. Rising prices for concentrates diminish this disadvantage, but doubling the concentrate price would be necessary to

equalize economic return of the model farms. As for the environmental effects, the low-input farm resulted in higher positive environmental impacts compared with the intensive farm in all categories except for emissions of CO<sub>2</sub> equivalents per kg milk (Fig 1 (a)). Since a reduction of greenhouse gas emissions is considered to be obtainable mainly by reducing the fibre content of the ration - i.e. intensification - we did not focus on this category further.



**Figure 1: Economic return and environmental impacts of the intensive farming model in the present situation and under three scenarios in comparison with the extensive model farm. - - Extensive Farm, — Intensive farm; Best results are displayed on the boundary, worst in the center. (Scenario 2 not shown because it did not lead to environmental enhancement). Climate impact, energy use and economic result: calculated per kg milk. Nitrate leaching, ammonia emissions and nitrogen supply: calculated per hectare. Animal welfare: rating value.**

Energy use efficiency is considerably lower for the intensive farm and nitrate leaching potential and emission of ammonia are higher. The restricted pasturing is assumed to have a negative effect on animal welfare and the high N supply might cause negative effects on the biodiversity of the grasslands. The imposition of a livestock density of

1.4 LU per ha reduces the risk of nitrate leaching by 50% and also diminishes ammonia emissions (Fig 1 (b)). At the same time, the financial advantage of the intensive farm is reduced to 350.00 € per ha. If the concentrate is calculated to be 20% of DMI, this advantage would decrease further to 150.00 € per ha, while the environmental effects remain essentially unchanged. Imposing a minimum of 50% of pasture in daily summer DMI (scenario 3) does not only lead to improved energy efficiency, but also slightly enlarges the intensive farmer's financial benefit compared with the initial scenario. In addition, animal welfare would be enhanced. However, a prolonged grazing time for the intensively fed cows may lead to a higher risk of nitrate leaching through excrements.

A confinement to regional feedstuff would primarily improve the energy efficiency, while the financial effect observed would be small (scenario 4).

It has to be pointed out, however, that the described results do not apply to farms situated on arable land. In contrast to grassland, negative environmental effects of intensified feeding strategies are less distinct in these cases, because the import of nutrients into the farm either does not occur or can be compensated by an export of other farm products.

## Conclusions

Our results show that restriction of livestock density, confinement to regional feedstuff and the use of pasture based feeding strategies are measures for reducing environmental risks caused by milk production on grassland farms. At the same time restriction of livestock density implies severe economic deterioration for the farmer of about 250.00 € per ha in the model case while for regionalization of feedstuff purchased and enhanced use of pasture the economic effects were comparatively small.

## Acknowledgements

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# Impact of the drought on the fodder self-sufficiency of organic and conventional highland dairy farms

Boisdon, I.<sup>1</sup> & Capitaine, M.<sup>2</sup>

Key words: fodder self-sufficiency, drought, highland dairy farm

## Abstract

*Eight highland dairy farms in the French Massif Central (4 organic and 4 conventional) were surveyed from 2000 to 2005 to understand the forage system functioning and the specificities of organic farms. During this period two important droughts occurred, which highly affected the fodder self-sufficiency of the organic farms, having consequences on more than a year of production. The conventional farms were less affected than the organic ones, and the farmers developed varied strategies including a reduction of the LU and the use of more maize. To maintain the stability of the milk production, organic farms had to increase the reliance on external fodder resources. The lack of security forage stores can explain the sensitivity of these farms and their incapacity to recover a good level of self-sufficiency.*

## Introduction

The general context of global climate change and the more frequent occurrence of severe summer drought (high temperatures, low rainfall) in the last years (Itier & Seguin, 2007) bring the farm sensitivity to the climate accident up to date. When a drought occurs, with low rainfall at the highest herbage growth period, the grassland based systems are very impacted. The farmers have to manage at the same time the livestock pasture and the building-up of winter stores, with a lack of fodder.

The adaptation strategies of the farms will be different following their possibilities of fodder and concentrate purchase, growing forage crops or changing the grazing management (Lemaire & Pflimlin, 2007). It is therefore interesting to investigate witch strategies organic farmers have developed to adapt their systems to the drought. In this article we will not study their adaptability to a new climate, but we will valuate the sensitivity to the drought of organic highland dairy farms and study their capacity to recover a high level of fodder self-sufficiency by comparison with conventional farms.

## Materials and methods

This study is based on 4 organic dairy farms (O1 to O4) and 4 conventional (C1 to C4), located in the highland granitic area of the French Massif Central (800 to 1000 m), on sandy-loam soils. Organic and conventional farms are neighbours, in similar soil and climate conditions, which allows us to compare their technical performances. These farms were surveyed since 2000 and for a long-term period, so their functioning is very well known. The technical and economical data were collected and analysed every year (Charroin *et al.*, 2005).

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The main culture is grassland (table 1). Cereals are cultivated on average 9% of the useable farm area for the livestock consumption. The milk production rests on a grazing period of 150 days without supplementation and a grass-based winter diet. The milk production per fodder area is lower in the organic farms (3400 L ha<sup>-1</sup> vs 4800 L ha<sup>-1</sup>), due to lower herbage yield in organic in relation with the fertilization levels (Bouscary, 2006 ; Capitaine *et al.*, 2007). The conventional farms have a more intensive milk production than the organic ones, with + 1100 L per cow. The organic farms are more specialised with 67% vs 53% of dairy cows per livestock unit.

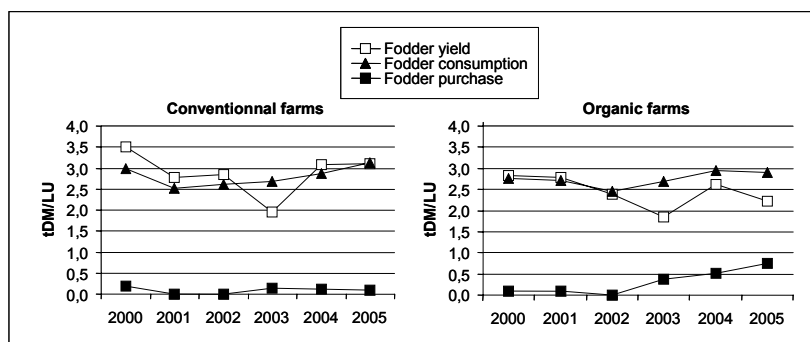
**Tab. 1: Characteristics of the two groups of farms (average 2000-2005)**

	Organic farms	Conventional farms
Useable farm area (ha)	53,0	59,2
% of grassland	88	87
% of cereals	12	7
Stocking rate (LU ha <sup>-1</sup> )	1,02	1,19
Dairy cow LU <sup>-1</sup> (%)	67	53
Milk per cow (L)	5 100	6 300
Milk per fodder area (L/ha)	3 400	4 800

During the 2000 to 2005 period, two years were affected by an important drought : 2003 and 2005. The indicator we used to valuate the sensitivity to the drought is the fodder self-sufficiency: ratio between the fodder produced on the farm and the total fodder consumption of the year, in tonnes of dry matter. In the following figures, the fodder yield is assessed with the information given by the farmers (for example number of hay bales and hectares cut). The fodder consumption doesn't take in account the grass consumption during the grazing period. It only concerns the forage supplies and is calculated with the farming accounts: Fodder consumption = stock beginning + fodder harvested + fodder purchased – fodder sold – stock end.

## Results and Discussion

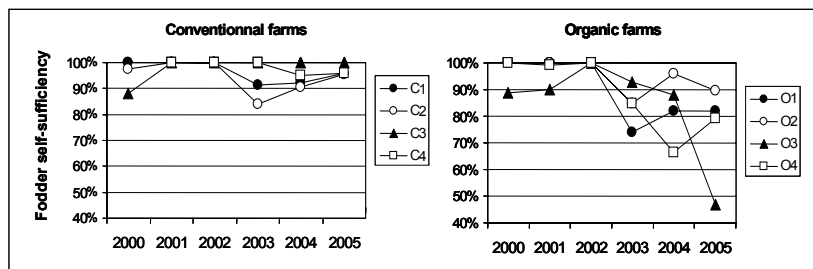
The main objective of the farmers was to maintain the milk production even in years of drought. They have therefore chosen to use the fodders supplies and then to buy some forage (figure1) and also concentrates to feed their cows.



**Figure 1: Evolution of fodder yield, consumption and purchase**

From the year 2000 to 2002, the fodder purchase are nil or very low for the both systems. Only the conventional farms are able to maintain sufficient feed reserves, with a fodder yield surplus of 0,25 to 0,50 tDM LU<sup>-1</sup> above fodder consumption. In 2003 the fodder yields fell down in both groups of farms (-1 tDM LU<sup>-1</sup> and -36% in the conventional farms and -0,5 tDM LU<sup>-1</sup> and -31% in the organic farms). The fodder consumption increased with the distribution of fodder during the grazing period. Only the organic farms had to purchase some fodder (0,5 tDM LU<sup>-1</sup> and 14% of the consumption). In 2004, the levels of fodder yield were good again, but with still inferior to the needs in the organic farms. The second drought of 2005 did only affect the organic farms, with a new decrease of the fodder yield (-17%) and an increase of the fodder purchase (26% of the consumption).

In all farms the fodder self sufficiency (figure 2) was good before 2003 (almost always over 90%). The herd requirements were satisfied with the forage yields. In 2003 the conventional farms were affected with a loss of average 6% of self-sufficiency. Two farms were less affected (C3 and C4), but for C4 the fodder self-sufficiency has reduced in 2004: the fodder supplies were used in 2003 but not renewed in 2004, and the effect of the drought was deferred. The conventional farmers highly increased the concentrate use to maintain the milk production (+54% of concentrates in g L<sup>-1</sup>). The organic farms were more sensitive with a decrease of the fodder self sufficiency from 7 to 41%, but they did not increase the use of concentrates during this first drought.



**Figure 2: Evolution of the fodder self-sufficiency**

In 2005, the conventional farms were not affected by the drought, and most of them had a better fodder self-sufficiency in 2005 than in 2004. Since 2003, they have developed various strategies to adapt their fodder need to the resources:

- decrease of the number of dairy cows, with an intensification of the milk production and use of more concentrates (C3 and C4)
- increase of the area of fodder maize, to increase the fodder stores (C2 and C3),
- stop of a fattening unit (heifers or beef steer) previously existing on the farm (C1 and C3),
- stop of fodder selling (C4).

For the organic farms, the situation of 2005 is very different. None of them was able to recover a good fodder self-sufficiency, in spite of a decrease of the number of cows since 2002 (average -13%). For two of them there is a new fall of this indicator. The situations are highly different between farms:

- O1 and O2 had a similar evolution, but not at the same level of self-sufficiency. O1 was more affected by the drought because of a lower security fodder stores and a higher level production (milk per cow, milk per fodder area).

- the O3 farm reaches the self-sufficiency only 1 year out of 5 (in 2002), and for the other years the average is 90%. This farm is in a period of decline, the farmer is near to the retirement and wants to reduce his workload.
- O4 suffered the most from the drought of 2003, with an effect on the years 2003 and 2004. In 2005, the fodder self-sufficiency has improved, thanks to the reduction of the fodder consumption and the milk per cow, but is still above 80%.

In organic as in conventional, we observed an intensification of the production level between 2000 and 2005 (+9% of milk per cow) with a greater use of concentrates (+20% of concentrates in  $\text{g L}^{-1}$ ), even if this is not relevant in an economical point of view. The organic farms had less possibilities to reduce their fodder needs (they had no secondary unit) or to increase their fodder supplies (they did not grow maize), and the impact of the drought was therefore higher for them.

The analysis of the year 2006 will give us new indications on the ductility of the fodder self-sufficiency.

## Conclusions

In highland situations, the organic farms have less possibilities to maintain their fodder self-sufficiency, in addition with their lower capacity to create fodder stocks. It leads them to a higher sensitivity to the climatic extremes. It is therefore relevant to study the strategic adaptations suitable for the organic farms to improve their self-sufficiency.

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# Comparison of Organic and Conventional Beef-Suckler Farms in Germany

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Key words: Beef cows, Beef production, Germany, System comparison

## Abstract

*This study aims to compare conventional and organic farms with beef-suckler herds. Addresses were collected mainly by contacting breeding associations and farmers' magazines. 216 questionnaires were evaluated (34.1% of them organic). Beef-suckler production in Germany is an extensive production system (small farms, small herd sizes, high percentage of grassland, low soil points, etc.). 39% of farms had to fulfil special regulations for extensive grassland production and 43% carried out landscape conservation measures. Farmers specialize in beef-suckler production. 60% of them are part-time farmers. Beef production amounts to two thirds of their agricultural income. Most farmers keep only beef cattle on the farms. Other farm animals are kept in small stock sizes. This study has found only a few differences between conventional and organic farms. Organic farmers more often keep breeds of low intensity but more of them use direct marketing channels. On organic farms cows more frequently stay outside all year. Animal performances were the same in both production systems.*

## Introduction

In 2005, 4,163,600 dairy cows and 648,400 beef cows were kept in Germany. 4.29% of farmers worked according to organic guidelines on 4.74% of the cultivated land. However, 18.35% of all beef cows in Germany were kept on organic farms (RIPPIN & HAMM 2006). Beef cows formed the largest group of all farm animals. On 45% of 920 organic farms, beef-suckler cows were kept, which again means that they present the largest group (Hörning et al. 2004). Rahmann et al. (2004) found similar results. This study intends to find out how conventional and organic beef-suckler farms differ.

## Materials and methods

Addresses of beef-suckler farms were collected mainly by contacting breeding associations and farmers' magazines. Roughly 650 questionnaires were sent out. 216 of them were sent back and were used for this examination. 34.2% of farms that returned completed questionnaires worked according to organic guidelines. SPSS statistical package (12.0) including Mann-Whitney-U-Test for non-parametric data was used.

## Results and discussion

Average farm sizes and numbers of beef cows were relatively small (median 35 ha, 15 cows). Overall, beef-suckler production seems to be an extensive production system. Farms had a high grassland percentage (on average 80.9%, median 99.6%). Stocking density was relatively low (on average 0.57 cows per ha, median 0.50). In general, soil quality was low (on average 38.6 soil points, median 35.0). 38.9% of farmers had to

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meet special regulations with regard to extensive grassland production and 43.2% of them carried out nature conservation measures. All parameters mentioned above apply to both production systems.

On the farms studied, beef production was the most important part of their business. Other farm animals were kept on a relatively small number of farms (30 farms kept horses, 23 had laying hens, 22 fattening pigs, 15 sheep or goats, 8 geese, 7 dairy cows, 6 sows, 4 each had ducks and turkeys, 3 broilers). Also, average stock numbers were small (e.g. median 3 horses, 12 fattening pigs, 10 sheep or goats, 30 laying hens, 20 geese). This study found only a few differences between organic and conventional farms. On average, 60% were part-time farmers. Beef-suckler production amounted to 64.3% of their income from agriculture (median 70.0%). 42.3% of the farmers had kept dairy cows before they started with beef-suckler production. In spite of small herd sizes, farmers specialized in beef-suckler production.

Production types (> 60% of animals sold per year) were similar on organic and conventional farms. 19.7% of farmers focussed on the production of calves, which were sold to other farms for beef production at weaning age (median roughly 8 months). On 6.7% of farms, calves were slaughtered at a median age of 10 months (for baby beef). 24.9% of farms produced animals for beef production (bulls, heifers), which were slaughtered at a median age of 20 months. And 11.9% of farmers produced animals for pedigree breeding. Finally, 36.8% of farmers combined various types of production.

Calving time was the same in both production systems. However, on conventional farms, the calving season lasted longer (5.0 vs. 3.5 months). 164 farms kept one breed, 26 farms had two and 13 farms had three breeds. The main breeds found were Angus (on 41 farms), Charolais (n = 33), Simmental (n = 27), Hereford (n = 22) and Scottish Highland (n = 20). Organic farmers more often kept extensive breeds such as Galloway or Scottish Highland (26.2 vs. 16.5%) and less often intensive breeds such as Simmental or Charolais (13.8% vs. 34.6%). Semi-intensive breeds like Angus or Hereford were kept on 42.5% vs. 55.4% of farms.

More often than their conventional counterparts, organic farmers quoted breeding goals like robustness or quiet temperament while conventional farmers frequently referred to size of the animals and genetic hornlessness. Most farmers kept breeding bulls (median 1 bull per farm). Both production systems used the same share of artificial insemination (AI). Only 60 farmers in total used AI and only 16 of them used it for all their cows. The percentage of cows on the farms, which were artificially inseminated, did not differ.

145 farms provided details of feed components for beef cows. 74.5% of farms named grass silage, 73.8% hay, 26.9% straw, 11.7% maize silage and only 13.1% concentrates (cereals). On 22 farms, beef cows were only fed grass silage and on 16 only hay. Only 37 farmers mentioned feed rations. However, because many farmers fed only 2 components, calculating the average of components appeared meaningless. Amounts of concentrates for fattening animals were the same in both production systems. Organic farmers more often kept cows outside all year (43.9% vs. 29.7%) and conventional farmers more frequently owned more than one housing system for their animals (32.8% vs. 19.7%). The type of production did not have any influence on the percentages of management procedures such as pregnancy diagnoses, birth control, vaccinations, claw care, housing of sick animals, castration age, herd management computer programmes, feed analyses or body condition

scores. Performance parameters were the same for conventional and organic farms (Table 1).

**Tab. 1: Comparison of health and performance parameters (average, median, 5 and 95% percentiles)**

	Conventional				Organic			
	Mean	Mdn	5%	95%	Mean	Mdn	5%	95%
Age of cows (years)	7.1	6.5	4.0	12.0	7.3	7.0	5.0	11.7
Culling of cows (%)	15.7	16.1	8.3	25.7	14.7	14.3	8.6	20.0
Age at 1st calving (months)	29.4	30.0	24	36	28.3	27.0	24	36
Calving rate (% of cows)	96.6	99.5	90	100	95.3	98.0	80	100
Calving interval (days)	367.2	365	332	400	361.5	365	319.5	386.8
Calf losses (%)	5.7	5.0	0	15.0	5.3	5.0	0	10.1
Vet costs (€ per cow / year)	32.7	25.0	0	103.2	27.5	25.0	0.42	67.5

The average daily gain was roughly calculated by using marketing age (months) and final body weight (kg). More farmers provided data for slaughter than for live weights. Daily gains were higher for males than for females and also higher for weaners than for beef animals (Table 2). Daily gains increased with breed intensity (e.g. bulls of extensive breeds achieved a median of 305 g related to slaughter weight, semi-intensive breeds 562 g, intensive breeds 712 g). Due to small sample sizes (different breed intensities) a comparison between production systems does not seem enlightening.

**Tab. 2: Daily weight gain (g) (number of farms, average, median, 5% and 95%)**

	Live weight					Slaughter weight				
	n	Mean	Mdn	5%	95%	n	Mean	Mdn	5%	95%
Weaner (male)	46	1299	1356	507	1848	-				
Weaner (female)	33	1139	1230	314	1578	-				
Bulls	57	1032	1035	470	1541	87	570	593	237	813
Bulls	30	776	779	279	1308	46	404	411	161	659

Compared to conventional farmers, organic farmers more often used direct marketing channels, e.g. butchers' shops or restaurants., and less often slaughterhouses. However, organic farmers were able to sell only 56.6% of their animals as organic products.

### **Conclusions**

Compared to other farmers and production branches, such as dairy cows, pigs or poultry, most farmers specialized in beef-suckler production, which they performed at relatively low intensity. Other studies found similar results with regard to organic or conventional beef-suckler farms in Germany (Balliet 1993, Buchwald 1994, Tenhagen et al. 1998, Hörning et al. 2004, Loibl 2004, Rahmann et al. 2004, Roffeis et al. 2006). Because beef-suckler production in Germany is a production system with generally low intensity (stocking density, amount of concentrates, etc.), conventional farms could easily be converted into organic ones. Conventional and organic beef-suckler farms did not differ much when it came to key characteristics or production performances. Therefore, organic farmers could have some difficulty in highlighting the advantages of their production system and in finding justifications for higher product prices. Perhaps this could explain why many organic beef producers have not been able to sell all their animals as organic produce.

### **Acknowledgments**

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## **Agripolicy: Institutions and implementations**

# Toward Regionalized Models of Organic Food Production and Marketing in the US: The Case of Michigan (USA)

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Key words: midwest organic model, organic marketing portfolios, small-scale organic family farm, fresh produce wholesalers and brokers

## Abstract

*This paper outlines some of the key features of a Midwest organic model that could provide the foundation for a regionalized organic strategy in the US. Based on the results of several recent and on-going studies of organic fruit and vegetable production and marketing in Michigan, the paper looks specifically at the profile of Midwest organic farming, the diversified marketing strategies and portfolios of Midwest organic farmers, and the challenges and opportunities identified by wholesalers and brokers for sourcing organic produce from small family farms. Two approaches to assure the viability of the Midwest organic model are introduced.*

## Introduction

Just under 10 years ago, the landmark Upper Midwest Organic Marketing Project signaled the need for more regionalized strategies in the US to encourage and preserve organic farming and marketing by small- and moderate-sized, independent and entrepreneurial family farms. The project specifically called for a more "holistic perspective" that would consider the "regional organic production, processing, distribution and retail infrastructure" needed to encourage organic bean, grain and dairy farming (Dobbs, 2000: 127). For Dobbs and his colleagues, such a perspective could inform strategies and policies designed to protect Midwestern organic family farms from pressures to integrate production, processing and distribution, and thereby from becoming more like the conventional or industrialized organic farming model typically found in California (see Guthman, 2004).

Despite the recent scholarly and popular attention to local and localized food systems, no comparable assessments of organic fruit and vegetable production and marketing in the US Midwest are available. Drawing upon the results from several recent and on-going studies of organic fruit and vegetable production and marketing in Michigan (USA), this paper outlines some of the key features of a "Midwest organic model" that could provide the foundation for one regionalized organic strategy in the US.

The development of such a strategy for expanding organic production and marketing in the upper Midwest and Great Lakes states will need to be based upon a better understanding of the following: the profile of organic farming in the Midwest: the diversified marketing strategies and portfolios of organic farmers; and, the challenges

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and opportunities identified by wholesalers and brokers for sourcing organic produce from smaller scale family farmers.

### Materials and methods

This paper draws largely upon two surveys of organic production and marketing in Michigan: the 2006 Michigan survey of the 267 organic growers and processors certified by one of the nine certifying agencies registered with the State of Michigan (Bingen, 2007); and, on-going interviews with Michigan organic fruit and vegetable farmers about their marketing strategies, as well as interviews with 112 fresh fruit and vegetable wholesalers and brokers (intermediaries) related to buying and selling organic produce in Michigan and the Midwest. These data are complemented by insights from two years of informal discussions with both organic and conventional farmers about organic production and marketing constraints and opportunities, and the data available from the US Department of Agriculture, Economic Research Service (USDA/ERS) surveys of organic agriculture in the US from 1992 through 2005. (An organic farm census has never been undertaken in Michigan or the US).

### Results

Organic Farming Profile. From 1997 through 2005, the USDA/ERS reported a 63 percent increase in the number of certified organic farmland acres in the US. In 2005, just over 8,000 US farmers had 4 million acres in certified organic production. Michigan certified organic farmland grew by 166 percent from 1997 through 2005. Based on 2005 data from the USDA/ERS, 205 certified Michigan farms represented 45,500 certified organic acres, or only .4 percent of the state's total farmland and one percent of the US total certified organic farmland acres (Bingen, 2007). Moreover, the state's organic farms are relatively small, but differ in size by type of farming (Table 1). Other states in the Midwest and around the Great Lakes report a similar profile of smaller scale organic farms (Kreider, 2004; Miller, 2006; Minn. Dept. of Ag., 2006). Data collected by the USDA, Economic Research Service also show comparable patterns of diversified organic production across the Great Lakes states (USDA, 2007).

**Tab. 1: Farm size of Michigan organic farms by farm type**

Farm Type	Average Acres		Median Acres		Range (acres)	
	Farm	Certified Cultivated	Farm	Certified Cultivated	Farm	Certified Cultivated
All Farms	260	237	135	110	1-2400	0.5 - 2200
Fruit & Vegetable	117	85	41	40	2-1500	0.5-600
Bean & Grain	360	340	200	186	25-2400	25-2200

Source: Bingen, 2007

Diversified Marketing Strategies and Portfolios. Each year Michigan's fruit and vegetable farmers may produce for, and sell into a mix of direct consumer (CSAs, farmers markets, farm stands), direct retail (restaurants, small grocery and health food stores) and even some wholesale markets. While most of the state's bean/grain organic farmers concentrate on wholesale markets, many of them have started to



diversify into vegetables and value-added products, and are moving into more direct sales (Bingen, 2007). Wisconsin's organic farmers rely upon a similar mixed marketing portfolio (Miller, 2006).

Organic farmers regularly modify their marketing portfolios and only a few fresh produce farmers specifically define their marketing strategy prior to planting. Most of them rely upon networking with other farmers to identify buyers or markets. Personal relationships, not written contracts, tend to govern their interactions with retailers, restaurants and wholesalers. Given the importance of direct marketing in their portfolios, a growing number of these farmers are deregistering, or foregoing certification.

**Wholesalers and Brokers.** Thirty percent of the fresh fruit and vegetable wholesalers and brokers (intermediaries) doing business in Michigan currently handle organic produce, and 42 percent are considering entry into the organic produce market. Of these two groups, almost one-half are interested in buying Michigan organically grown produce. Organic Valley (CROPP) continues to explore ways for sourcing fresh organic produce from Michigan. But in response to various kinds of marketing pressures and publicity in the popular media, Whole Foods is the only major grocery chain that has started to purchase selected fresh produce from some small, family farms in the region.

Wholesalers and brokers identify several constraints on expanding their supply of organic produce from Michigan and the Midwest. Currently, they rely heavily on long-standing personal relationships with their suppliers (often in California), and thus look for a regular supply from Michigan and the Midwest that meets standards in order to change their current network of suppliers.

From the perspective of these buyers, several production challenges tied to the agro-ecologies of the Midwest threaten the ability of the region's farmers to meet these supply conditions. The short and variable growing season jeopardizes a regular supply, and pest and disease pressures may compromise the appearance of some produce. Finally, the continued easy and relatively inexpensive availability of fresh organic produce from California trumps the interest of most intermediaries in sourcing local and organic produce from Midwestern farms.

At the same time, many of Michigan's larger scale conventional fruit and vegetable farmers who produce for various types of processing or wholesale markets, and who could respond to wholesaler and broker supply needs, express little interest in transitioning even some part of their production into organic. Despite the increased global threats of cheap imported fresh produce to their production and marketing strategies, these farmers still do not accept organic as a viable alternative that could maintain or even enhance their livelihoods.

## **Discussion**

The diversified, flexible production and marketing strategies of Midwestern organic farms represent a key feature of their viability and livelihoods. Yet these same strategies create constraints for intermediaries and larger retail grocers. Some fresh produce wholesalers and brokers would like to overcome these constraints by helping to create some type of collective marketing arrangements among small organic farmers. In order for such arrangements to work, farmers who have deregistered would need to (re)certify and many would need to find ways to accommodate their currently independent production and marketing styles to the longer-term planning

requirements of the wholesale market. The current, yet limited, successes of some farms in working with restaurants, smaller wholesalers and grocers like Whole Foods, suggests that the creation of a viable Midwest organic model might be possible.

## Conclusions

Unlike the California "paradox" in which organic farming has "replicated what it set out to oppose" (Guthman, 2004, 3), the Midwest organic model remains grounded in a small-scale family farm ideal and agrarian populism. As reflected in the evolving and diversified production and marketing portfolios, family decision making and shared responsibilities from production through marketing continue to be critical defining features of each farm's viability.

Two approaches might help to overcome current constraints on the viability of this model. Both would involve proactive national and state government policies (cf. Smith, 2004). One step addresses the problem of deregistering by using the "criteria for variation" approach to adapt organic standards to local realities without compromising guaranteed standards (Courville, 2006). A second invites state governments to host roundtables for intermediaries and organic farmers to learn how dialogue can provide a foundation for creating successful collaborative and mutually-beneficial marketing relationships to protect and enhance organic farming in the Midwest.

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# Institutions and Policy Development for Organic Agriculture in Western Balkan Countries: a Cross-Country Analysis

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Key words: Western Balkans, organic support policy

## Abstract

*This paper uses a comparative qualitative approach to study the dynamic of institutional changes occurring in the organic movement, State agricultural institutions and policies, and in the organic supply chain, in six Western Balkan countries. It shows that the 'Michelsen path' (Michelsen et al., 2001) is identifiable in these countries, but in a different sequence. Additionally, a number of common trends are identified in the organic sector of the countries studied, leading to a converging trajectory in institutions and policy development for organic agriculture.*

## Introduction

In the EU context, experiences of member states in relation the evolution of the organic sector and the institutional and policy developments have been examined in a theoretical framework developed by Michelsen (1997). This examines changes in three main elements of the institutional setting (farming representatives; state agricultural institutions and policies; and the food market) which interact individually and collectively to influence farmers' decisions to convert to organic agriculture. Michelsen and colleagues subsequently identified a seven-step path, leading to successful growth of the organic sector, consisting of four initial steps essential for the establishment of the organic sector, and three complementary steps facilitating further development. Michelsen *et al.*'s (2001) description, with the extension proposed by Moschitz *et al.* (2004) is summarised in Table 1 – part A. In the context of current pre-accession Europeanization processes undertaken by Western Balkan Countries<sup>3</sup> in agricultural and rural development (including organic agriculture), this paper compares development of institutions and policy for organic agriculture, providing insights into country- and region-specific variations in development, and draws conclusions on future prospects and action which could facilitate further development.

## Materials and methods

The method of comparative case-study analysis (Stake, 2006) has been adopted to combine quantitative and qualitative information. This included desk analysis of over 100 official documents, participant observation, recordings of semi-structured interviews with 49 key informants in WBC and of national workshops. Qualitative material has been analysed using two separate coding stages, and triangulation between the different information sources.

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<sup>3</sup> Albania, Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, and Serbia: within the text, these are abbreviated to AL, BiH, HV, MK, MNE, and SRB, respectively. Collectively, Western Balkan Countries are abbreviated to WBC.

## Results

On the basis of the research findings, a revised sequence of the 'Michelsen path' has been developed, taking into account common features, specificities and emerging development trajectories of the organic sector in WBC (Table 1 – part B).

**Tab. 1: WBC sequence of Michelsen *et al.*'s (2001) path**

part A: Michelsen <i>et al.</i> 's (2001) path	part B: WBC sequence
Step 1: organic movement	Step 2: political recognition
Step 2: political recognition	Step 3: payment support
Step 3: payment support	Step 1: organic movement together with
Step 4: non competitive relationship	Step 5: organic food market
Step 5: organic food market	Step 4: non competitive relationship
Step 6: committed institutional setting	together with Step 7: issue of conflict
Step 7: issue of conflict (Moschitz <i>et al.</i> 2004)	(Moschitz <i>et al.</i> 2004)
	Step 6: committed institutional setting

Relatively small national organic movements in WBC are struggling to develop a clear identity. In most WBC, foreign donors and NGOs have played a major recent role in diffusing organic principles and practice, and helped shape national organic movements and structures. Many local NGOs were also fundamental to early growth. While usually connected to foreign agencies and cooperation projects, leadership came from scientists, extensionists, and consultants with long-standing commitment to organic ideals. These key individuals often work in mainstream agricultural institutions and, crucially, have developed interaction with newly created state organic agriculture structures. Thus, unlike organic pioneers elsewhere in Europe, organic organisations are not isolated from mainstream government institutions. Also, though pioneer farmers made seminal contributions to organic development, and active and committed producers are increasingly engaged in the decision-making, the movements themselves are not yet farmer-led. Sustainability of activities is of widespread concern, given reliance on external projects, and competition for project funding is predominant. This results in overlapping activities, confusion of roles, and ineffective coordination mechanisms.

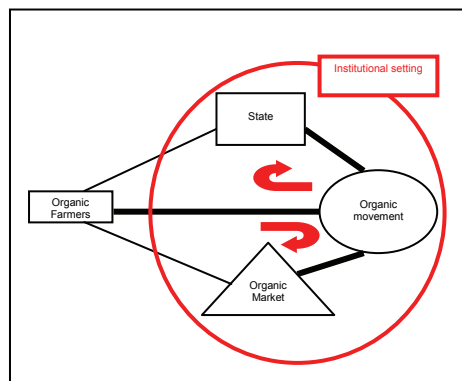
Step 1 (establishment of a formalised organic community) of the 'Michelsen path' is thus not yet fully completed. The revised sequence begins with steps 2 (political recognition) and 3 (introduction of financial support), followed by steps 1 and 4 (development of a functioning market). Different organic movement development dynamics can be identified. In some countries (HV and SRB as well as in Slovenia), parallel pioneer initiatives started, as social movements, before the wars in the 1990s; these conflicts affected their subsequent development (in HV and SRB). This strand continues, and coexists with recent developments from 2000 onwards, throughout WBC, in which organic farming plays a more functional role, linked to foreign donors' agendas and requirements of EU integration processes. The latter is regularly reported as an accelerating factor: in some countries, adoption of state regulation for organic agriculture was more pivotal in establishing the sector than external support or market development initiatives.

Recently, ministerial units dealing with organic farming have been established; financial support (either project-based and/or area payments) has been introduced;

national organic logos have been created (in HV, MK, MNE); and National Action Plans have been drafted (in AL and MK). Such action is not always well established and resourced, but on balance, this regulatory institutional framework represents a significant step in building organic sector identity, role and legitimacy.

WBC governments appear to favour market development objectives, improving agricultural competitiveness and export opportunities, more than land management benefits; few links between organic agriculture and the management of protected areas have been exploited. Yet, apart from some export successes involving a limited range of products, markets for organic products is still mostly underdeveloped, and exhibit significant cross-country variation. Supply chains require improved structure and organisation, certified organic production is limited, organic processing units and technologies are inadequate, and consumers are ill-informed and confused.

Concern with market development is not exclusive to governments, but is shared by local NGOs, and also foreign donors. National organic movements play an important bridging role between producers and market actors, and in the private sector new local companies marketing organic products are keen to interact with existing movement structures and contribute to the growth of the sector as a whole. Interaction between national movements and the market provide an essential, mutually reinforcing impetus for organic sector development. Hence, the WBC-adapted sequence of the 'Michelsen path' gives greater importance to step 5 (development of a functioning market): it moves upward and is placed after step 1 (organic movement development and formalisation). In WBC, national organic movements link organic producers to both state and market, even though both of these are now developing direct interrelations with organic producers: the state through financial support, the market through individual contracts (Fig. 1).



**Figure 1: Interrelationship between organic farmers and the institutional setting in WBC**

In contrast, relationships between organic farming and mainstream agriculture are virtually nonexistent: if contacts are reported, conflict (ideally leading to *creative conflict*) does not exist. The sectors' modest size, and limited recognition of organic agriculture in extension and research institutions, seems to prevent it from being perceived as a competing system. Also, organic agriculture is seen as one among several supported diversification options, in a period of significant agricultural restructuring in the WBC, mainly induced by Europeanization. Therefore, concluding the analysis on the revised 'Michelsen path', the combined complementary steps 7

(creation of an issue of conflict) and 4 (establishment of a non-competitive interrelations with mainstream agriculture) and ultimate step 6 (establishment of a committed institutional setting) have not yet occurred in WBC.

## Conclusions

Analysis of development of the organic sectors in WBC suggests that certain actions could support and accelerate essential steps, and help initiate complementary steps on the 'Michelsen path'.

*First*, organic agriculture appears to have been institutionalised from the start, but often without awareness of its multi-faceted potential to meet evolving societal needs. Its recently established state structures, undergoing important learning processes, are not yet sufficient to plan and act for a sustainable development of the national organic sector, even though organic stakeholders expect much more than compliance with EU *acquis communautaire* in terms of establish promotion, coordination, and networking to develop the national sector. A clear identification and division of roles and responsibilities of all public and private actors with an interest in organic agriculture is required. *Second*, national organic movements need to go beyond lobbying to *i)* improve managerial skills; *ii)* strengthen internal cohesion, especially between members and leadership; and *iii)* consolidate their identity, broadening their appeal to a wider potential set of stakeholders. *Third*, important official platforms for dialogue and negotiation (developing National Action Plans for organic agriculture, and drafting and implementation of Agriculture and Rural Development Plans) should engage extensively with institutions and private actors, including those in mainstream agriculture, if integrated and coherent development of the sector is to be assured. *Fourth*, alongside the state, the organic movement and the market, local authorities and regional cooperation agents can play an important role in future development of organic agriculture in WBC. In short term, local authorities can implement support policies complementary to the state intervention, and, with ongoing decentralisation, they should prepare in the longer term to act as increasingly important players in the national and regional organic arena. Regional cooperation initiatives can provide assistance and experience exchange opportunities to the national organic movements; also, in connection with the needs and schedule of Europeanization process, they can design and realise flexible support programmes for capacity building of organic institutions and organisations in WBC.

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# Impact of agricultural liberalisation on the relative importance of price premiums for the profitability of organic farming

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Key words: agricultural liberalisation, price premiums, relative profitability

## Abstract

*In the literature, impressive evidences can be found with respect to the importance of price premiums for the absolute and relative profitability of organic farms. However, depending on the agricultural support framework, the relative economic importance of price premiums varies considerably. Model results presented in this paper suggest that the relative importance is likely to decline, if producer prices decline substantially and more support payments are transferred directly to farmers as envisaged in the framework of currently discussed liberalisation reforms in Switzerland or the EU.*

## Introduction

Price premiums are a way of compensating for lower yields and therefore contribute significantly to the financial performance of organic farms. They have been identified by several authors as an important factor affecting the absolute and relative profitability of organic farms (Freyer *et al.*, 2001; Nieberg, 2001; Darnhofer *et al.*, 2003). The relative economic importance of price premiums may however vary considerably, depending on the agricultural support framework. In general, the importance of price premiums is lower, if farmers receive their income mainly from direct payments and vice versa. This can be observed for example, if one compares the financial performance of organic and non-organic valley and mountain farms in Switzerland (ART, 2007).

In view of the recent agricultural policy changes in most European countries (liberalisation of agricultural markets, decoupling of price support from income support, increased public expenditures for rural development services) it is hypothesized that the relative economic importance of price premiums decreases in Europe the more agricultural markets are liberalised. The aim of this contribution is to present and discuss some modelling results on this issue. Switzerland has been chosen as an example for this investigation, since the pressure to liberalise agricultural markets and direct income transfers to farmers are particularly high in this country.

## Approach

The model analysis was carried out with the sector-consistent farm group model CH-FARMIS (Sanders *et al.*, 2008). It is a comparative static, process analytical, non-linear programming model that allows a separate assessment of the impacts of policy changes on organic and non-organic farming in Switzerland. The agricultural sector is represented by thirty farm groups, which can be characterised by their farming

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system, farm type and geographic location. Book keeping data from the Swiss FADN was used as a primary source for the model. By applying farm-specific weighting factors, farm data were aggregated to sector accounts. Agricultural production is represented by 29 crop activities and 15 livestock activities. The factor allocation and production of each farm group is optimised by maximising farm income under policy and management restrictions. The restrictions cover the area of land and labour use, livestock feeding, fertiliser balance, rearing of young stock, allocation of direct payments and requirements with respect to the organic production system. A positive mathematical programming approach (PMP) was used to calibrate the production activities in the base year to observed activity levels.

Three different policy scenarios were defined that reflect the currently discussed liberalisation policies in Switzerland: AP 2011, WTO liberalisation and EU agricultural free trade. In Table 1, the assumed changes in prices and direct payment rates are briefly summarized.

**Tab. 1: Assumed changes (%) in prices and direct payments rates**

Area	Changes in prices and direct payment rates <sup>1</sup>				
	Basyr <sup>2</sup>	Reference	AP2011	WTOLIB	EULIB
Prices for crop products	100	90	78	73	46
Prices for livestock products	100	94	88	82	53
Prices for variable inputs	100	98	97	96	74
Prices for fixed inputs	100	105	105	105	98
Direct payments	100	100	120	120	120

<sup>1</sup> Average values of commodity and input groups

<sup>2</sup> 2001

In order to study the impact of different price levels on the financial performance, producer prices of organic farms were additionally varied in each scenario. Based on the projected price level, organic producer prices were increased linearly by up to +15% for all products and decreased linearly by -15% for livestock products and -40% for crop products. A decrease by -15/-40% approximately represents a situation where organic farms receive no price premiums. The prices for non-organic farms were not changed.

## Results

According to the results shown in Table 2, agricultural incomes increase when organic farms receive higher prices, while the opposite is true when prices decrease. Furthermore, the results indicate that the impact of prices on agricultural incomes is greater for the AP 2011 than for the EULIB scenario. Income figures range from CHF 60,900 to CHF 43,200 under the AP 2011 scenario and from CHF 56,700 to CHF 40,900 under the WTOLIB scenario. A smaller variation can be observed under the EULIB scenario (CHF 50,200 to CHF 38,200). If organic farms receive no price premiums, agricultural income would be approximately CHF 5,500 to CHF 7,500 less than projected.



**Tab. 2: Agricultural income of organic farms at varying price levels for organic products**

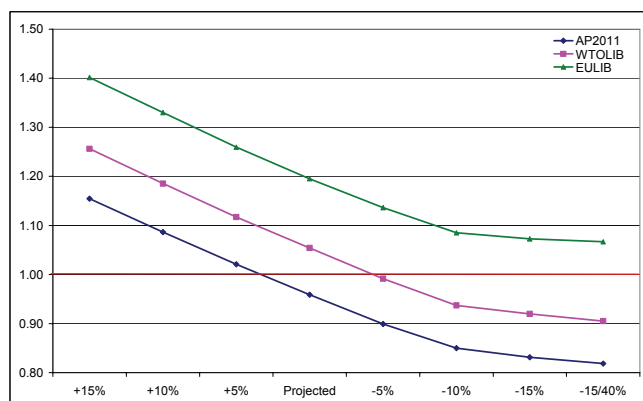
Price level	Organic farms					
	AP2011	WTOLIB	EULIB	AP2011	WTOLIB	EULIB
	<i>Agricultural income (kCHF)</i>			<i>Changes to projected income (%)</i>		
+15%	60.9	56.7	50.2	20	19	17
+10%	57.3	53.5	47.7	13	12	11
+5%	53.9	50.4	45.1	6	6	5
Projected	50.6	47.6	42.8	0	0	0
-5%	47.5	44.8	40.7	-6	-6	-5
-10%	44.9	42.3	38.9	-11	-11	-9
-15%	43.9	41.5	38.4	-13	-13	-10
-15/40%	43.2	40.9	38.2	-15	-14	-11

Source: Own calculations based on FADN data from ART

These results are also reflected in Figure 1, which illustrates the impact of different pricing levels for organic products on the relative profitability of organic farms: the higher the price, the higher the relative profitability.

More specifically, the results of the price sensitivity analysis suggest that - under all three liberalisation scenarios - organic farms are, on average, more profitable than non-organic farms when prices for organic products increase by 5%. Under the EULIB scenario, organic farms achieve higher agricultural incomes on average than non-organic farms, even if they obtain no price premiums.

The ordinate shows the ratio of the profitability of organic farms to the profitability of non-organic farms. The red line indicates the relative performance level at which organic and non-organic farm type groups achieve the same profitability. The progression of the three curves in Figure 1 suggests a linear relationship between price and relative profitability when prices for organic products vary between +15% and -10%. Beyond -10%, prices have a declining impact on relative profitability. This response can be observed under all three liberalisation scenarios.



## **Figure 1: Relative profitability of organic farms at varying price levels for organic products**

### **Discussion and Conclusion**

The model results suggest that the relative importance of price premiums for the profitability of organic farming could decline under more liberalised market conditions. Surprisingly, Swiss organic farms would on average achieve a higher profitability compared to non-organic farms even if they would not obtain price premiums. On the other hand, it can be expected that this may not be true for all farm types. In view of the greater importance of commodity sales for profitability, this might be for example the case for organic valley farms and organic arable farms. If producer prices decline, other income sources such as direct payments and non-agricultural activities become relatively more important for the absolute and relative profitability of organic farms. Though the relative profitability could increase, the viability of farm households would be threatened, if lower prices result in a substantially lower farm income. Quantitative model have the advantage that they are able to account for complex structures and interrelations of the agricultural sector. For this reason, they may provide a valuable basis for policy discussions. However, it is important to note that the outcomes of quantitative models are closely related to the assumptions made. Consequently, such models are not employed to predict the future but rather to identify the impact of different driving forces under certain conditions.

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# Potential implementation problems of the EU OAP: a failure mode and effects analysis

Vairo, D. & Zanolli, R.<sup>1</sup>

Key words: Organic Action Plan, implementation problems, indicators, synergies, conflicts.

## Abstract

*Since 2001, the EU Commission has followed principles of good governance (EC, 2001). One of the five principles of good governance is participation in the formulation of policies and their implementation. The aim of this paper is to provide a first evaluation of the EU Organic Action Plan (OAP) and the Organic action plan evaluation toolbox (ORGAPET) combining the knowledge of researchers from different countries (AND, CH, CZ, DE, DK, IT, NL, SI, UK) with external expertise (Advisory Committee, EU Commission).*

## Introduction

In June 2004 the EU Commission delineated the European Action Plan for Organic Food and Farming (EC, 2004). The resulting European Action Plan for Organic Food and Farming did not originally accompany any specific policy measures, or a budget for specific policy goals. It resulted however, in the much-discussed revision of EC Regulation 2092/91. The revision process itself has been criticised with regard to insufficient stakeholder involvement (Eichert et al., 2006).

The aim of this paper is to provide a first evaluation of the EU Organic Action Plan (OAP) and the Organic action plan evaluation toolbox (ORGAPET)<sup>2</sup>. This has been done in two steps: the first step will provide a policy analysis of the EU OAP in order to identify the potential risks and problems associated to its implementation and assess the quality of the main indicators from the ORGAP evaluation toolbox (ORGAPET). The second step will develop strategies aimed at resolving the potential conflicts and exploiting the synergies in order to facilitate implementation of the EU OAP at national level.

## Materials and methods

Concerning the first step, in order to provide an early assessment of potential risks and problems associated with specific policy-relevant areas, we used an adapted version of (process) Failure Mode & Effect Analysis (FMEA) (McAndrew & Sullivan, 1993) combining the knowledge of researchers from different countries (AND, CH, CZ, DE, DK, IT, NL, SI, UK) (Core Team) with external expertise (Advisory Committee, EU Commission) named Support Team.

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<sup>2</sup> The ORGAP evaluation toolbox (ORGAPET) is a collection of different evaluation tools, including participative techniques, quantitative assessments and methods to identify relevant indicators, which could be used selectively to meet the needs of a particular assessment of national or EU action plans (Lampkin et al., 2006).

The first task in FMEA is to identify and rank the most relevant problem areas of the EU OAP implementation. The core team used a special laddering questionnaire to elicit what can go wrong (list of problems) and to define the logical cause-effect structure of the problem, by identifying all possible causes of each problem. This has been done using the Means-End Chain model (Reynolds and Gutman, 1988). A cognitive map has been created, in order to visually identify links between causes and effects. Based on the results of the laddering exercises, in the second task a specific questionnaire has been submitted to the core and the support team: using 10-points Likert-type scales, for each failure mode (composed by a cause and an effect), the team has estimated the severity/seriousness (cost/impact) of the "failure", how likely is that each potential "failure" will happen (occurrence) and the likelihood of detecting the "failure" using ORGAPET indicators<sup>1</sup>. Once all experts have filled in the questionnaire, a Risk Priority Number (RPN) is calculated based on the product of: Detection X Severity X Probability of Occurrence. RPN will enable ranking of the most important problem areas for which the indicators provided in the toolbox may perform insufficiently. The minimum expected RPN is 1 and maximum 1000.

Concerning the second step, a policy and coherence analysis of synergies and conflicts between various actions of the EU Organic Action Plan has been performed by means of a matrix of cross impacts as specified in the MEANS framework (EC, 1999). The effects of synergies or conflicts have been rated with the help of the core team with 2 electronic consultation rounds<sup>2</sup>. After validation of these ratings, the calculation of the "synthetic" coefficient of synergies<sup>3</sup> has been performed, in order to evaluate the overall level of synergy/conflict between the EU OAP.

## Results and discussion

Once the failure-modes have been defined, the core and support team have evaluated, for each cause and effect, the list of main indicators from the ORGAP evaluation toolbox (ORGAPET). The scope of this task was to verify if the main indicators of the ORGAP toolbox were able to cope with the logical cause-effect structure of the problems concerning the implementation of organic agriculture policy.

The approach to the classification of indicators used in this work is an adaptation of that used in the MEANS framework. Table 1 reports the failure modes and the relative mean RPNs. A quick inspection reveals that no single failure mode is particularly risky, since the maximum mean value is 210 while theoretical maximum is 1000.

<sup>1</sup> The scale range from 1 to 10, whereas 1 refers to No effect (severity), Nearly impossible (probability of occurrence), Almost Certain Detection (detection probability) and 10, respectively refers to Extremely Severe, Extremely High, Absolute Uncertainty.

<sup>2</sup> The evaluation team compared pairs of actions to identify any synergy which may exist. When some kind of synergy seemed possible, a value on the following scale was chosen corresponding to the size of the effect. 2 : for a particularly strong effect of synergy; 1: for a weaker effect of synergy; -1: the same scale applied to negative synergy (conflict); -2 : the same scale applied to negative synergy (conflict)

<sup>3</sup> Cs+ and Cs- calculate the synthetic coefficients of positive and negative synergy for each EU OAP action. Total average Coef Cs+ and Cs- have been calculated as the average synthetic coefficients for each EU OAP measure considering all experts:  $\mu$

$$C_{s+} = \frac{\text{Sum of positive scores}}{(\text{Number of positive scores}) * 2}$$

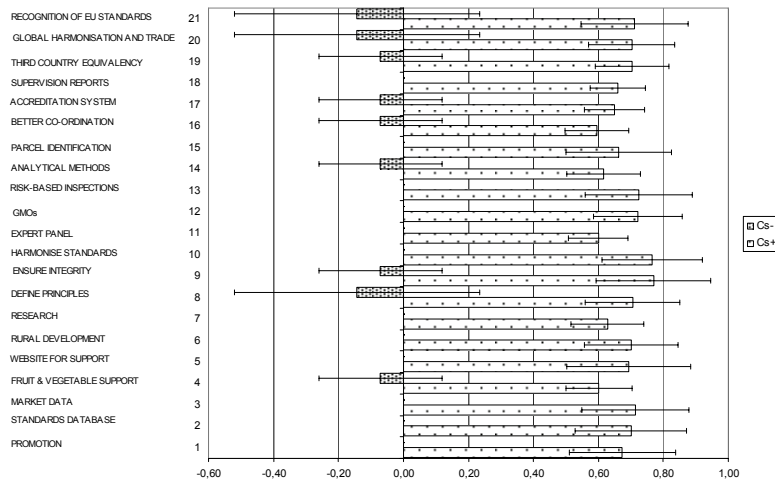
$$C_{s-} = \frac{\text{Sum of negative scores}}{(\text{Number of negative scores}) * 2}$$

**Tab. 1: The failure modes and RPNs**

Cause	Effects	MEAN	STANDARD DEVIATION
Lack of stakeholder involvement	Lack of capacity building	210,0	137,5
Inadequate information and promotion campaigns	Lack of knowledge/awareness on OF	162,8	84,1
Lack of information	Lack of political interest to support OF	159,4	86,9
Weak lobbying for OF	No mandatory implementation of AP	146,6	84,6
Research not enough developed	Lack of importance given to OF	133,1	90,1
Conventional interests against organic lobby	Lack of financial resources	132,2	81,5
Different priorities among MS	General implementation problems	130,8	84,4
Different interests between EU and MS	Inadequate rules/procedures	130,1	82,6

RPNs include information about the probability of detection of the failure modes by the proposed indicators. The detection mean values (non shown for conciseness) range from 3,5 (High probability of detection to moderately high chance of detection) to 4,8 (moderately high chance of detection to moderate chance of detection) which indicate that in general – for the selected failure-modes – the ORGAPET indicators may perform sufficiently.

Figure 1 illustrates the result of the policy and coherence analysis of the EU OAP. Synergies between measures largely prevail while the opinions on conflicting actions are not shared by members of the team, as is shown by the higher standard error bars.



**Figure 1: Synergy/conflict between EU OAP measures**

The analysis suggests that Actions 9 and 10 are essential for the success of the EU OAP, given their synergetic effects. They in addition enter into synergy with many other actions. Interesting is also Action 13 with an high coefficient of synergy and number of measures with which has interactions.

By contrast, Action 4 appears a stand-alone measure, since it enters into synergy with an average of 3 actions only. Action 16 is somewhat peculiar, since it has a fairly weak coefficient of synergy (0.59) but which enters into synergy with many other actions (68). In this case Action 16 has a weak potential for synergy although having numerous interactions, since these are individually weak. In addition Action 16 combines positive and negative effects of synergy, even if the conflict seems to be very weak.

## Conclusions

ORGAPET and its indicators appear as a good base for the detection of many problems regarding implementation of organic agriculture policy. The probability of detecting failure mode by ORGAPET toolbox is moderately high which means that the list of main indicators are able to face with the logical cause-effect structure of the problems. Clearly, indicators should probably be improved in order to explain in a more precise way what are the information included. This because in some cases the indicators seem to be unrealistic or just not available. Concerning synergies and conflicts among actions, there is a substantially agreement on synergies among experts concerning each specific action. On the other hand, it is clear that there is no agreement on conflicts among experts on each specific actions.

## Acknowledgments

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## Public support for organic food and Production, Promotion and Action Plans in Spain

González, V.<sup>1</sup> & Moreno, J.L.<sup>2</sup>

### Abstract

*Organic farming has received very limited public support in Spain in the past. This was used for promotion and supporting partly a semi-public control. The Andalusian Organic Action Plan (OAP) formulated in 2001 was the first broader policy supporting Organic farming in Spain. After this initiative the Spanish Central Ministry for Agriculture, Food and Fisheries (MAPA) has also presented a National Organic Action Plan in 2003, before the approval of the EU Organic Food and Farming Action Plan by the European Council in 2004. In the last years several regions in Spain have announced or approved OAP's, currently in progress in different regions. This paper is presenting and analysing all this Regional and national Organic Action Plans and other organic support policies, stakeholders participation, conflicts and synergies with National and EU Action Plans and evaluation indicators, contributing to the ORGAP<sup>3</sup> project. Finally the paper is discussing the potential use of some evaluation tools (ORGAPET) proposed by the ORGAP.*

### Introduction

Organic Food and Farming sector in Spain has received a very low public support in the past, compared with other European Union (EU). In the beginning of the 90's support was concentrated in creating the legal framework and indirect support to build up a semi-public of control systems in the 17<sup>th</sup> regions, in which stakeholders are represented and voted each four year. From 1996 until 2000, the agrienviromental schemes of the CAP were applied in many regions to support farmers to convert the farm. Some support was also given for promotion to facilitate the participation of the organic sector in national and international Fairs (p. e. Biofach).

Organic food and farming support has been substantially increased in the last ten years. Andalusia (2002-2006), has started the first Organic Action Plan (OAP) in Spain. The *Spanish Central Ministry for Agriculture, Food and Fisheries* (MAPA) has published a 3 years State OAP in 2003, but this never was put in force. In February 2007 a new State OAP Plan 2007-2010) has been presented. At Regional level, several OAP has been approved (Asturias, Baskenland, Castilla-La Mancha, Extremadura or Madrid). In Catalunya preliminary tasks are being developed to launch an Organic Action Plan. But, few instruments of monitoring or evaluation of this OAP are planned. Only in the State Spanish OAP, some indicators have been established for this purpose.

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<sup>3</sup> ORGAP Project means European Union Organic Action Plan: Development of impact evaluation tools (<http://www.orgap.org>)

## Material and methods

Documents of the different OAP at National and Regional level in Spain have been consulted and analysed. Direct interviews in organic events and electronic consultation have been undertaken with Spanish organic stakeholders. All this information has been cross-checked with results of the ORGAP/ORGAPET reports.

## Results

### 1. State Organic Action Plan (OAP)

In 2004 the MAPA organised an informal round of meetings with the organic representatives and in 2005 a National stakeholder Seminar, to discuss specific guidelines to development of Organic Food and Farming in Spain. The 3 Main topics selected were later taken into the State OAP (2007-2010). The final purpose of the this OAP was to contribute to develop the organic sector in Spain with a set of specific actions in all the organic production, processing, marketing and distribution and consumption chains and also in education and research areas.

The specific aims of the State OAP were structured in 3 main objectives: a) to promote the development of Organic Farming, in particular the primary sector, with education, research, inputs regulation, and rural development tools use and recognition of organic Farming specificities; b) to improve the knowledge and to promote the consumption and marketing of organic products, as it's the most relevant challenge in Spain, mainly stimulating the internal demand thought and adequate information for consumers, accompanied of the improvement of marketing structures of the products; c) to improve institutional collaboration, management of resources for the organic sector, contributing to a better coordination, improving communication and the collaboration between all private and public sector agents involved in organic sector. Indicators for monitoring and evaluation were defined.

**Tab. 1: Monitoring impacts indicators of the MAPA Organic Action Plan**

Indicator	Sources
Number of organic stakeholders operators	MAPA - CCAA
Surface of organic Farming	MAPA - CCAA
Surface of organic farmers with agrienvironmental support	MAPA - CCAA
Expenses and number of research projects in organic farming	INIA MEC
Education and training events in organic Farming by MAPA	MAPA
Studies and dissemination Publisher in organic Farming	MAPA
Number of books publications on consumption of organic products	MAPA - CCAA
Economic value/volume of the national market of organic products	MAPA - CCAA
Declared Economic value/volume of sales data & adhoc export studies	MAPA - CCAA
Public expenditures of the MAPA for organic production	MAPA
No questions discussed in the Sectorial Conference	MAPA
No. meetings, seminars, journeys, courses done with the sector in several regions	MAPA

Source: MAPA, 2007. <http://www.mapa.es/notas/documentos>

A national Organic Promotion Campaign (2006-2008), launched by the MAPA in November 2006 (slogan "Cultura-Lógica, Agricultura Ecológica, es cultura, es de lógica", with the topics "Environmental and sustainability aspects to stimulate new generations and also nutritional, health and quality aspects of organic products", with a budget of 2,32 millions of €, co-financed by the European Union, targeted to families and other market actors, teacher's education and consumer associations, belongs



also to this State OAP.. The Campaign was concentrated in "Organic weeks", in the Regions with local and regional sector, expecting a multiplying effect.

#### **State Support for Organic Production**

There was no support for organic farming before the EU Agrienvironmental support from the CAP (Reg. CEE 2078/92). This came in force in Spain late than in other EU countries: in 1997 no aids for organic farmers was given in Catalonia and Galicia and it was established in Asturias and Madrid<sup>1</sup>. The organic farming payments are different by crop and region. In most cases, this payment is lower than in other European member states. For organic olive tree farmers in Andalusia receive only the half payment of the farmers in Tuscany (Italy). The farmers receive around 350 €/Ha.

In period 2001-2005, the number of farmers with animals receiving these aids was 3 times more and the numbers of crops organic farmers has increased a 39% more. The total number of supported farmers was increased from 7,696 (2001), to 11.293 (2005) 47% more. During the period 2000-2006 organic production was a priority aim in the Rural Development Programme in Spain, but in the new Programme 2007-2013 the organic farming is not included as a horizontal measure at National level

#### **State Support for Research**

Organic research in Spain has started, with some isolated projects initiated by individual's researchers working in public research centres, most of them SEAE members. The National Plan for Scientific Research, Development and Technology Innovation (PNIDIT, 2004-2007), has supported organic projects (19 organic research project involving 26 research groups in 13 regions, dealing with 18 different thematic). Other 43 research projects, involving 22 research groups and 2 more regions, on low input and environmental friendly agriculture practices, were also financed. Currently there is no specific National Organic Farming Research Programme. At National level the Education and Sciences Ministry (MEC) has announced the creation of the Centre for Organic Research in Plasencia (Extremadura), in the year 2008. At regional level the Andalusian OAP, created a specific Programme for organic research (1.800.000 €) for small project (max. 120.000 €). From 110 proposals, 24 were approved. A regional public Centre for organic education, research and rural development (CIFAED) was created in Santa Fe, Granada (Andalusia). Also the Instituto Andaluz de Investigación y Formación Agraria, Pesquera, Alimentaria (IFAPA), has assumed some tasks in organic research. In Valencia Region an estimation of 0,3 million € per year small innovation and experimental organic projects, are given. In Catalunya and Balearian Islands a Network "Agrocomed" has been supported involving 9 research groups from 5 public Universities and 3 public Research centres, since 2003.

#### **Regional Organic Action Plans**

Seven regions have developed OAP in Spain. **Andalusia** has finished the first OAP (2002-2006), with a budget of 33.6 millions of €. About 65 % was devoted to support production conversion, 9% was for Research, 8.6 % for improving processing of organic produce, 6 % to support organic consumption. The rest (7.4 %) was for different measures supporting in training education system, organic certification and organic sector better coordination. The plan has supported 45 projects 2.8 millions €. A second OAP (2007-2013) has been launched. **Madrid** Region launched a regional OAP (2005-2007) investing 3 millions of €. **Castilla-La Mancha** has o launched an OAP (2007-2011) investing 44 millions of €. In **Extremadura** Regional Government

has also announced an Organic Action Plan for this year. In the Mediterranean also **Catalunya** has published the "White book of organic farming", in close cooperation with organic sector experts to develop an OAP. In the Nord of Spain, **Baskenland** Parliament has approved this year a Regional Law with some measures to promote organic food and farming to achieve 20 % of surface in organic farming in 2020. **Asturias** has also presented a Regional Organic Action Plan (2007-2009) investing 14,7 millions of €.

## Conclusions

A low support has been devoted in Spain to organic food and farming development from public money, mostly to support organic production, indirect support of control bodies to involve stakeholders and isolated promotion actions like fairs.

Currently, 30 % of the Spanish regions have approved OAP. There is not much coordination between this plans and measures and the State OAP. As OAP are policy instruments, it's used as such by different Governments with several purposes, not as a technical tool. Most of the Regional OAP has been discussed with stakeholders, but some of them have been developed in a desk exercise by Regional Administrations Synergies and conflicts with the State OAP and EU OAP can appear but this has not been identified. SEAE has initiated a process to discuss on this topic.

No impact indicators have been defined except in the State OAP. Consequently no impacts can be measured. The State OAP indicators are more related to results.

Only an assessment of the Andalusian OAP has been published as the rest are still in progress. In this case, a general very positive influence of OAP has been shown.

After stakeholders and experts consulted, the ORGAP Project developed tools to evaluate OAP's (ORGAPET), can be easily adapted and use in the regional OAP. But it's still necessary to differentiate between the potential users, so that relevant information to each category can be found more easily. A separation between theory discussions from practical instructions is needed. This help to evaluate very precisely OAPs and agriculture policies to support organic farming. All they considered this evaluation toolbox very useful, as each stakeholder (public and private) can choose the appropriated tools for their one analyse.

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# Development of criteria und procedures for the evaluation of the European Action Plan of Organic Food and Farming

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Key words: action plan, organic agriculture, evaluation toolbox

## Abstract

*Within the EU funded project ORGAP a toolbox for the evaluation of the European as well as national action plans for organic food and farming has been developed ([www.orgap.org](http://www.orgap.org)). This toolbox was based on a comparative analysis of national action plans in eight countries (CH, UK, DE, IT, DK, SI, CZ, NL, ES), a meta-evaluation of existing evaluations of national action plans, workshops with national stakeholders and a European Advisory Committee, interviews with experts. Furthermore synergies and conflicts between national and the European Action Plan were identified.*

## Introduction

The European Commission released in June 2004 the European Action Plan for Organic Food and Farming (EJOAP). In May 2005 the EU funded 3-year research project with the acronym ORGAP started. In the project 10 partners from 9 countries (CH, UK, DE, IT, DK, SI, CZ, NL, ES) participated, as well as the European umbrella organisation of the Organic Agricultural Movements (IFOAM EU Regional group), ensuring a broad stakeholder consultation process and dissemination all over Europe.

## Materials and methods

The overall objective of this project was to give scientific support to the implementation of the EJOAP by the development of an evaluation toolbox. Firstly the toolbox was tested on a selected number of ongoing national action plans (desk research, interviews with experts). Synergies and conflict areas between national and EJOAP targets were identified. Finally a policy analysis and recommendations were made.

## Results

First a comparative documentation about the status quo of eight national or regional action plans for organic agriculture was made (Stolz, Stolze and Schmid, 2006).

### *Differences in national organic action plans*

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The case study action plans vary with regard to the elaboration process, targets, objectives and the emphasis of measures on certain areas. This is due to quite different political and socio-economic framework conditions for organic farming in these countries. The organic action plans of Andalusia, Czech Republic, Slovenia and Denmark address a very broad portfolio of areas and measures. In contrast to this the Dutch, Italian and English action plans give high priority to measures targeted at market development and consumer information. The German Federal Organic Farming Scheme has a clear focus on measures related to public information. The comparison revealed that the weaknesses identified in the status quo analyses have only partly been translated to the targets and measures included in the action plan documents. This is on the one side a result of the national priority and budget setting and on the other side on the interdependency between EU policies and national policies

#### ***Meta evaluation of evaluations of national organic action plans***

For the development of an evaluation toolbox one important step was to get an insight into already conducted evaluation studies in the field of organic action plans in Europe via meta-evaluations from DE and DK and NL and partly from England/UK. The resulting report contributed to a methodological learning process, helped to optimize the ORGAPET toolbox and provided information on the content level about the success and failure of Organic Action plans in general. It showed that it is on the one hand important to build-up on *specific tailored evaluation standards and indicators*, which can measure the programs specific characteristics. On the other hand it seems to be important, when preparing a suchlike evaluation study, to rely as well on a set of commonly accepted *general evaluation standards*. (Eichert and Dabbert, 2007).

#### ***ORGAPET development***

The development of the Organic Action Plan Evaluation Toolbox (ORGAPET) was a central part of the ORGAP project. It has been elaborated in an iterative process with several versions regularly updated and further developed. ORGAPET has been developed as a web-based toolbox, with links between the different elements designed to make navigation easy. The structure for ORGAPET consists of four main sections: Section A covers background/contextual documents on organic action plans, organic farming policy, stakeholder involvement and evaluation principles and procedures. Section B deals with evaluation methods relating to action plan development and implementation processes, including conflicts and synergies, coherence, implementation failure risk and stakeholder engagement. Section C is about evaluation methods relating to action plan outputs, effects on the organic sector and impacts on public policy goals and Section D is about approaches to synthesising overall conclusions including interpretation issues relating to cause and effect relationships, interactions between elements and likely developments in the absence of the action plans or specific action points. Each section is sub-divided into a number of specific topics, with an overview document providing a guide to key issues and possible solutions, and a series of annexes providing illustrative examples, specific methodological details or useful data sources. A manual will be developed to provide an accessible guide to action plan development, evaluation and the use of ORGAPET. Furthermore it should be a tool for stakeholder involvement in future action plan development and implementation processes at national and regional level as well as EU level (Lampkin, 2007).

#### ***ORGAPET testing and assessment by stakeholders and evaluation experts***

An extensive testing process of an intermediate version of ORGAPET in all ORGAP EU member states showed that stakeholders and experts view ORGAPET as a useful tool. Suggestions for structural and general changes from the experts were taken into account for the revision of ORGAPET (Dabbert and Eichert, 2006).

#### ***Focus group discussions on the national implementation of the EU Organic Action Plan***

Focus group discussions with stakeholders were held between November 2006 and February 2007 in 8 EU member states (Andalusia-ES, CZ, DE, DK, England-UK, IT, NL, SI.). The intention was to identify how national stakeholders perceived the EUOAP and its interplay with national policies in terms of conflict and synergy, and which strategies they would suggest in coping with implementation problems. It was not possible to discuss all aspects of the EUOAP. One topic common to all discussions was the proposal for a revised regulation on organic production, covering several recommendations of the EUOA, which is expected to be implemented by all EU member states by 2009. In addition six focus groups discussed the recommendation aiming for a more transparent European market for organic food. Instead in Italy and England they preferred to discuss the issue of funding organic food and farming policy through rural development plans i.e. as part of the general agricultural policy. The comparison of the outcome showed that only the focus groups of CZ and SI found the EUOAP important and had positive expectations to it. In the Danish group expectations to the EUOAP were positive but the EUOAP was considered insignificant. In DE, EN and IT expectations were neutral and the EUOAP was considered insufficient; in Spain (Andalusia) the EUOAP was considered insufficient and expectations negative. Only two problems appeared in most focus groups: the lack of sufficient statistical data as basis for market transparency and the GMO suggested threshold level in organic produce, where there was a common agreement that a threshold should be very low if it was to be allowed at all. All other issues were specific to the national context, suggesting that implementation problems are specific to each EU member state. The main conclusion from the analysis done here is thus that successful implementation in any member state is a matter of the balance between positive and negative aspects of all three main dimensions of implementation: willingness, capability and comprehension. These balances are unique to each member state and within each dimension. The main expectation is that more weight to positive aspects on all three dimensions will lead to more successful implementation. Furthermore the analysis showed the major importance of the conflict between the organic food and farming sector on the one hand and various threats against it from the socio-economic context, from the ideas behind the EUOAP and from its unintended impacts. (Michelsen & Tyrol Beck, 2007; Zanolli & Vairo, 2008).

#### **Discussion**

One of the main focus areas in the project was to develop a core set of appropriate indicators for ORGAPET, which then can be adapted to specific action plan evaluations. The testing showed that major problems are the data availability and limited resources for data collection, which limits the number of indicators.

Another focus area was how to measure the effectiveness and the direct effects of the policy separate from the general performance of the organic sector. What is the impact of exogenous events and how can these be addressed in an evaluation? As conclusion, it is important to focus on the performance of the measures against

indicators. This does provide an overall picture on the impact of the OAP on the organic farming sector or the wider bio-physical, social and economic environment.

The third major focus was stakeholder involvement in the elaboration of action plans, which was the main topic regarding the revision process of Regulation (EEC) 2092/91 in 2006 and 2007. When looking at examples of the way in which stakeholder interests have been taken into account in national action plans, it is interesting that the approach chosen in some countries was quite differing, ranging from a broad participatory approach to a very top-down approach with a small expert group. Some made good experiences with a broad involvement not only of the organic but also the conventional sector (as in DK) or with stronger focus on market actors as in NL (Dabbert and Eichert, 2006).

### **Conclusions - what are the lessons to be learnt?**

When planning a new or revising an existing action plan it is recommended to study first the different approaches of other action plans (e.g. market-driven versus policy-driven). When a participatory approach is chosen, then stakeholders should be involved in different phases of a policy development (agenda setting, policy formulation, decision-making, implementation, evaluation). Furthermore the experiences within in the project showed that focus group discussions may be used to gain information from the organic food and farming sector itself, while less involved outsiders should be approached in a different way, e.g. by individual interviews after data had been collected from members of the organic food and farming sector in order to ask the outsider for comments to the main arguments of the organic sector.

For the evaluation of organic action plans it is important not only to follow a general accepted evaluation standard but also to elaborate and build-up specific, tailored indicators (standards) adequate to the national action plan; here ORGAPET provides both a procedure for selection as well as examples. Furthermore it is important to differentiate clearly between depiction of facts and areas more open for interpretation through the inclusion of stakeholder (e.g. by a stakeholder reflexion workshop as in DE evaluation) and to ensure sufficient data availability and resources for data search.

### **Acknowledgments**

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## Understanding the organic consumer



## Understanding the Organic Consumer through Narratives: an International Comparison

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Key words: European organic consumer analysis

### Abstract

*Consumer narratives drawing on life history, events and influences are used to explain evolving consumer behaviour with regard to purchasing and consumption of organic products. Triangulated qualitative interviews, involving 54 principal participants in major and average sized cities in Denmark, the UK and Italy form the empirical basis of the study, combined with shopping trip observation and supplementary interviews. The research uses Gardner's (2004) concept of 'change of mind' as a starting point for analysis. While cultural and geographical contexts vary across countries, a key finding is that consumer behaviour co-evolves with market development. The study concludes that potential future marketing strategies must distinguish carefully between strongly committed and occasional consumers of organic products.*

### Introduction

The development of the organic market in Europe has been rapid, but consumption of organic products remains relatively small as a share of overall food purchases (Dimitri and Oberholtzer, 2005; IFOAM, 2006), and may either be close to saturation or capable of more growth. Midmore et al. (2005) review the literature on consumer attitudes to organic food. However, little is currently known about the development of these attitudes over time, and understanding the likely development of future patterns of demand for organic products is difficult to achieve using conventional methods.

In this paper we report initial results of part of the QLIF project<sup>4</sup> (WP1.2.2) investigating reported buying behaviour of organic and other consumers. Our focus on narratives that describe the development of buying habits allows us to identify and extrapolate potential trends with reference to future demand. We describe in-depth interviews and direct ethnographic observation which allow us to explore Gardner's (2004) concept of a 'changing minds'. His approach suggests that when someone undergoes a change of mind, this process usually involves concepts, stories, theories and skills. Our analysis identifies these elements in consumer narratives, helping to obtain deeper knowledge and understanding of consumption patterns. Gardner distinguishes seven 'levers' that may influence a change of mind: reasons (assessment of relevant factors), research (procurement of relevant data), resonance (the affective component), re-descriptions (mutually reinforcing images of what will

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result from the change), resources and rewards (perceived cost-benefit relationship), *real world events* (in households, markets, etc.), and *resistances* (to change). Dick and Basu (1994) have explored product loyalty, as repeated patronage, and identified three indicators of loyalty: the likelihood that the consumer will search for alternatives, resistance to counter-persuasion, and word-of-mouth recommendation to others. Their contribution has also inspired our design and analysis.

### **Materials and methods**

The reported buying behaviour of organic consumers and its dynamics have been investigated using a comparative analysis of qualitative interview data collected in Denmark, Great Britain, and Italy. The study design called for the collection of a broad range of ethnographic data in each country, in the form of detailed case studies of principal participants with varying degrees of commitment to purchasing organic food products. The major focus, biographical accounts of trajectories of food purchases and food consumption in the household, details events that have influenced decisions. Validation of core interviews comes from use of triangulating perspectives. Each case includes an additional interview with a close family member or friend. Accompanied shopping trips were undertaken and video-recorded, and some shopkeepers were also interviewed.

Participants, all of whom were mainly or jointly responsible for shopping and food preparation in their household, were recruited on the basis of a purposive quota sample. The sample in each country included three subgroups: 'regular', occasional' and non-users of organic food products. Half were from a large city (the capital in the UK and Denmark, Turin in Italy) and half from an average size city. At least two cases in each national sample were drawn from households comprising singles, young couples without children, families with younger children, and older couples, whose children no longer lived at home. A minimum inclusion of male participants was also imposed.

Semi-structured question guides were prepared for the interviews and shopping trip. Questions to the principal interviewee covered life history events and how these had influenced shopping and meal preparation; the first encounter with organic foods; probing why organic foods are bought, and whether there have been any changes in motivation. Following the shopping trip, participants were asked to explain their choices and also to discuss their substitution strategies if sought for products had not been available. Shopkeeper and 'significant other' interviews were designed to assess and complement the primary qualitative material. Interviews were recorded, transcribed, coded, and analysed using interpretive procedures.

### **Results**

Clear variations emerge from comparison between the three countries. Italian consumers, in a context of rather more recent industrialisation and urbanisation, give strong approval to traditional meals and cooking, with the influence of childhood meals and grandparents' cooking styles strongly favoured. In contrast, the traditional Danish meal of meat, potatoes, brown gravy and cooked vegetables is referred to by participants as a means of positioning themselves as traditional or modern consumers. Regular consumers of organic food in Denmark generally reject this tradition as being unhealthy, dull, and boring. Organic food, combined with cosmopolitan cookery, is seen as providing interest as well as health, wellbeing and

environmental responsibility. In Italy, organic consumers place more emphasis on intrinsic food quality cues than do non-users, who see food preparation as the main driver of meal quality. In the UK, vegetarianism appears among regular organic consumers as natural and wholesome, corresponding to desires to be in tune with the earth and to follow patterns of nature. While regular consumers in Denmark have confidence in the organic foods available in some supermarkets, British regular consumers tend to be more suspicious of supermarkets in general. In Italy, regular consumers use a range of outlets to seek preferred products, sometimes opting for uncertified but trusted locally produced items such as cheeses, fruit and vegetables. A tendency to frequent a range of outlets, including specialty stores, is found among regular consumers in all three countries.

Almost universally, the initial encounter with organic food is not recalled in any detail. For most regular users, it has become an integral part of their lifestyle, a change of mind and habits characterised by a gradual evolution alongside increasing market availability. In terms of lifecycle, as young adults form new households, new food habits form, including experimentation with international cuisines.

For some few Danish and UK participants, life-events influencing organic choice include childbirth. Contrastingly in Italy, while changes in household composition are reflected in patterns of shopping, eating and cooking habits, they are not seen as significant for regular users, but as confirming attitudes towards healthy and quality food. Health problems trigger changes in the food habits of some households. Couple households involve reciprocal influences, sometimes with partners dominant in food sourcing and preparation taking the lead and influencing choices. Increased income also allows greater access to organic purchasing, such that the transition to financial independence is an important point for changes in food consumption.

Observation of shopping trips provided opportunities to discuss loyalty and substitution strategies. Some UK committed consumers try to buy only organic foods, while partially committed seek priority products such as organic meat and dairy products. However, narratives in most cases suggest that convenience drives the strategies adopted. Regular Danish organic consumers can be divided into the thrifty (seeking value for money) and quality orientated (deliberately choosing particular supermarkets or specialty shops). Some of the former describe how practical constraints play a role in substitution strategies while shopping, particularly with reference to saving time. In Italy, regular users' loyalty is mainly influenced by availability, and substitution mainly regards fruit and vegetables, which are often purchased from local, conventional sources. The gradual changes of mind with respect to organic foods that emerges from the narratives of regular consumers, regard tendencies to assess organic food from the viewpoint of such values as health and environmental sustainability. A concern with animal welfare and other ethical issues is also stressed by many British and Danish consumers. While some regular users are prepared to expend considerable time and effort to obtain the products they want, the extent to which purchases are actually made appears to be strongly dependent upon the availability of products and satisfaction with quality characteristics, as perceived and experienced.

## **Discussion**

Our expectation was that the development of a mindset that is positively oriented towards organic food products would lead to changes in shopping habits. While the value-based and experience-based rewards associated with organic products are central to this mindset, it is clear that real world events in the marketplace have

strongly influenced habit-formation. One pattern which emerges strongly in the UK, and reflected elsewhere, is that the purchasing pattern of many regular users far exceeds the threshold we had established for recruitment to this subgroup. It is also clear that this subgroup is strongly motivated by value-based rewards with reference to environmental and ethical issues. Commitment in other subgroups is weaker or absent, and strongly influenced by a need to obtain value for money. It also appears that, as consumer awareness and markets co-evolve, behaviour changes across all phases of the lifecycle. Some life cycle events do underlie changing food habits, but more often they reinforce decisions that have been taken on considered reflection about food, health and the environment. Mindsets with reference to organic food tend to change gradually, without abrupt 'moments of enlightenment'.

## **Conclusions**

Comparative analysis of national findings is currently in progress. It is however already clear that far from being niche products, organic foods have become ubiquitous, and are interwoven into a variety of consumer lifestyles. It would seem likely that differentiated distribution and marketing strategies are called for that can meet the needs of highly committed organic consumers, but at the same time address scope for growth among the partially committed. There is evidence that the value-based rewards associated with organic foods are particularly important to the former subgroup, while experience-based rewards with reference to quality are important to both regular and occasional users. Price differences between conventional and organic products are perceived as having been reduced over time and wider ranges of product categories are currently demanded. Major barriers to increasing demand appear to affect the supply side, rather than consumers. A strategy focused on the development and supply of standard products, produced at relatively low prices, to discount and other retailers might appeal to those who regularly buy organic products and who exhibit a strongly thrifty orientation in their shopping habits. Yet this would fail to meet the demands of dedicated regular users, and perhaps also some other regular users.

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# Consumers willingness to pay for Fair trade and organic products

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Key words: Fair trade. Organic products. Labels. Taste. Image. Experimental method. Willingness to Pay

## Abstract

*More and more products are now both "organic and fair trade" but little is known about consumers perception of these double labels. In this article, we examine the importance of the "organic" and "fair trade" labels in the consumers' buying decisions and the effect on the perception of the taste of the product by the consumers in the valuation of these labels. We also propose a consumers' typology according to their degree of valuation of these labels, and analyze the motivations of their behaviour.*

*Three consumers' clusters were identified according to their reactions to the "organic and fair trade" label - the first cluster represents the people insensitive to the label's presence, and contained nearly one half of the sample; for a second cluster, the "organic and fair trade" labels' influence on the improving image of the products was positive and important; finally, for the third cluster, the valuation of the "organic and fair trade" label was determined by the product's taste.*

## Introduction

Previous studies underline the increasing interest attached by the consumers to environmental and social criteria in the choice of products, and more precisely the growing interest attached to organic and fair trade products (Tallontire and Blowfield, 2001, Codron et al. 2006, Sirieix, 2008). Indeed, organic agriculture has been developing steadily over the last fifteen years (Sahota, 2007); Fair trade, for its part, has known an exponential growth over the last few years (FLO, 2007). More and more products are now both "organic and fair trade" but little is known about consumers perception of these double labels (Codron et al., 2006)

This article thus addresses the theoretical question of the link between environmental and social concerns, and the practical question of the interest of a double label "organic and fair trade".

## Materials and methods

Our methodological process associates two approaches: experimentation and survey.

The aim of the economic experimentation is to reveal the consumer's willingness to pay (WTP) for quality or for quality's criteria by recreating a context close to the real situations of buying and consuming. We used BDM bidding (Noussair and Ruffieux,

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2004), which motivates the subjects to reveal their preferences honestly for a given quality of product through their willingness to pay.

As part of the BDM bidding, each subject submits a buying offer in terms of price for a product proposed for the sale by the experimenter. Then the experimenter draws lots for a sale price in a layout of prices defined beforehand. Each subject having submitted an offer superior or equal to the randomly selected sale price receives the product and pays the equal amount to the randomly selected price and benefits of the difference between his offer and the sale price (the randomly selected price). However, subjects having proposed a buying price inferior to the randomly selected sale price receive nothing, nor do they make any payment.

The aim of the experimental study being to observe the real behaviour of the consumers, it was necessary to implement the study to products available on the market. The choice of chocolate was motivated by the fact that this product gave us the opportunity of disposing of a variety of chocolate bars with the organic and fair trade labels.

Four chocolate bars available on the market were chosen within a variety of 8 chocolates (4 with the organic and fair trade labels, and 4 without labels) after a tasting pre-test on the basis of two criteria: the hedonistic characteristics and the price level of the product.

We constituted a sample of 102 people (72 women and 30 men) who buy chocolate, selected in a random way in Montpellier (France) and its surroundings by telephone and in an organic shop (Biocoop) by an announcement.

13 sessions were organized in strictly identical conditions. Each session contained three stages:

Stage 1: Blind tasting of the four chocolate bars, prior to bidding for a set of 5 bars of each chocolate.

Stage 2: Evaluation based on a reconstituted packing of four chocolate bars ( 1 neither organic nor fair trade, 1 only organic, 1 only fair trade, and 1 both organic and fair trade), prior to bidding for a set of 5 bars of each chocolate.

Stage 3: Observation and tasting of the four chocolate bars, prior to bidding for a set of 5 bars of each chocolate.

In most cases, experimental studies focus only on the direct, observable results of the bidding and on the "revealed preferences". To complete this information, we also asked each subject taking part in the experimental study to answer a questionnaire about the motivations of his/her consumption of organic and fair trade products. This questionnaire was established on the basis of a previous qualitative study which had identified those motivations (Tagbata and Sirieix, 2003).

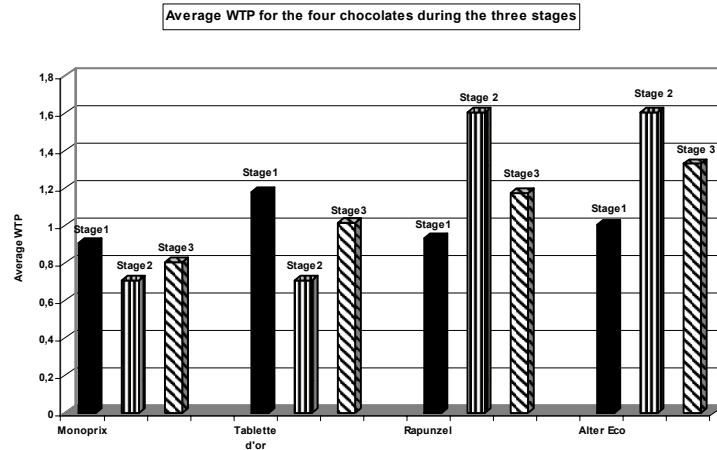
## **Results**

First, we analyse the distribution and the variation of the hedonistic notes and of the willingness to pay for each chocolate during the different stages in order to assess the impact of the "organic" and "fair trade" labels on the perception of the quality and on the valuation of the chocolates. Then, we identify the different segments of consumers according to the degree of valuation of the organic and fair trade labels, and for each

segment we analyse the importance of the different motivations that underlay the positive valuation of these labels.

Results show that blindly, the two “organic and fair trade” chocolates are not the most appreciated, but that they have the highest WTP when the labels are shown.

Between stage 1 (blind test) and stage 3, the organic and fair trade chocolates have known on average an increase of their hedonic notes and of the WTP contrary to the chocolates nor organic, neither fair trade. In stage 2, the WTP was revealed solely on the basis of the information visible on the product label, the chocolate both organic and fair trade collected on average the highest offering (1.61 euros), and the standard chocolate the lowest offer (0.70 euros). However, in stage 3 where in addition to the information, the chocolates are tasted, the offers for organic and fair trade chocolates are inferior to stage 2.



More precisely, three consumers' clusters were identified according to their reactions to the “organic and fair trade” label: the first cluster represents the people insensitive to the label's presence (nearly one half of the sample), for a second cluster, the “organic and fair trade” labels' influence on the improving image of the products is positive and important; finally, for the third cluster, the positive valuation of the “organic and fair trade” label is determined by the product's taste.

## Discussion

Three consumers' profiles reacting differently to the “organic and “fair trade” labels have been identified. Contrary to the results obtained from most opinion polls, which supposed that ethical values were of the utmost importance in consumers' choices, our results show that nearly one half of the consumers of our sample are insensitive to the presence of “organic” and “fair trade” labels on a product. For these consumers, the price appears as the first criterion on which the choice of the products is based while the ethical arguments associated with the “organic” and “fair trade” labels are pushed into the background, behind other criteria like the taste and health issues.

However, the survey showed that for two other segments of consumers, these labels have a positive impact on the perception of the quality of the products which is materialized by a valuation of these labels corresponding to 20-30% of the product price. The organic and fair trade label thus enhances the valuation of the products. Nevertheless, the consumers' sensitivity to this label varies a lot. If the majority of consumers have the same profile as the majority of our sample, they will not be ready to pay more for organic and fair trade products, and the markets for these two types of products must not be overestimated.

Moreover, we have also demonstrated that, although the existence of a substantial WTP for the "organic and "fair trade" labels is principally linked to environmental and social concerns, some consumers condition the valuation of these criteria by the intrinsic characteristics of the product. From this result, we highlight the interaction that may exist between the perceived quality of the product and the labels in improving the image of the product.

In other respects, the WTP with tasting is lower than the WTP declared on the sole basis of the labels, which reveals a gap between the expected quality and the experienced quality. Therefore, efforts on the improving of the quality of the organic and fair trade products must be maintained.

Finally, the joint application of the environmental and social labels on the same product induces a subadditivity of the WTP compared to the willingness to pay for the two dimensions considered separately. Some consumers even prefer an organic chocolate to an organic and fair trade chocolate. Therefore, the double labelling does not have to be systematic.

Before these results could be generalised, they should be checked on representative samples in several countries.

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# The US Organic Food Shopper

Zepeda, L.<sup>1</sup>

Key words: consumer attitudes, profiles; organic food

## Abstract

*Survey data from a random sample of US food shoppers is analyzed to identify significant factors in organic food demand. Qualitative data is also collected to explore motivations, perceptions and knowledge of both organic and conventional food shoppers. Results indicate that shopping venue, food knowledge, and food beliefs are key to organic food demand. Qualitative investigations indicate some scepticism towards organic labels by both organic and conventional shoppers. Not all organic shoppers viewed the increasing availability of organic foods through conventional venues and brands positively. These shoppers perceive commercialization to run counter to creating a local food system. In addition, perceptions of organic food shoppers were diverse, often conflicting, and sometimes quite negative.*

## Introduction

The US represents roughly 43% of global organic food sales (Organic Consumers Association 2007, Organic Monitor 2006). Organic food sales in the US represent 3% of US food sales (Organic Consumers Association 2007), but have been growing at a rate of 20% *per annum* since 1990 (Klonsky and Green 2005). Availability in conventional grocery stores accounts for half of all sales. In addition, well-known brands are introducing or acquiring organic products and even featuring organic versions of existing products. Who are they selling to?

Most studies of US organic food shoppers focus on demographic characteristics. Many have been limited to a metropolitan area and the samples are non-random. This study utilizes data from a national survey of food shoppers. In addition to demographic variables, the analysis includes data on attitudes, beliefs, group affiliations and other behaviours. The conceptual framework is motivated by Lancaster's (1966) attribute model, Weinstein's (1988) precaution adoption process, and Guagnano, Stern and Dietz's (1995) attitude-behaviour-context model. The data are utilized in statistical models to identify characteristics associated with organic food shoppers. In addition to the quantitative analysis, qualitative analysis was used to determine perceptions, motivations, and rationale shopping behaviour. The overall objective is to identify characteristics of US organic food shoppers.

## Materials and methods

The findings for this study are based on a random sample of US adult food shoppers conducted in the fall of 2003. Both a telephone (response rate 47.7%) and mail (29.1% response rate) survey were implemented (n=956). A focus group study was used to identify and refine relevant survey questions as well as to understand consumer knowledge and perceptions about organic foods (Zepeda, Chang and

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Leviten-Reid 2006). The survey data was analyzed in a probit model to identify characteristics of organic food shoppers (Zepeda and Li 2007). A switching regression model was estimated to examine how the decision to buy organic foods affected overall food expenditures (Li, Zepeda and Gould 2007). In-depth, structured interviews were conducted to investigate some of the more unusual findings and to develop a conceptual model of organic food shopping behaviour (Zepeda and Deal 2007).

The framework for the statistical analysis builds on the microeconomic model of consumer demand and theories of consumer psychology. Lancaster's (1966) concept that consumers demand a product's attributes rather than the product itself is relevant, implying consumer demand for organic production methods. Weinstein's (1988) precaution adoption model was developed to explain consumer behaviour and hazards. It provides insights into how and why some consumers are motivated to demand organic foods. He posits that there are ordered stages that consumers must pass through before acting. Weinstein's five stages can be applied to organic food demand: awareness or knowledge of organic food, personal relevance, intention to buy, opportunity, and purchase. Different factors may influence each stage.

Guagnano, Stern and Dietz (1995) provide further insights about why consumers take conservation measures. The crux of their attitude-behaviour-context model is that context is crucial for consumers' behaviours to be consistent with their attitudes. In the case of organic food, such factors as the ease of access (e.g. within or between stores) therefore may be more important to the purchase decision than professed attitudes about organic foods.

## **Results**

Statistical analysis estimated using the 2003 survey data revealed the significant variables in the demand for organic foods were: shopping venue (context), food beliefs, and food knowledge (attitudes) (Zepeda and Li 2007). Income was not found to be significant. Of the demographic variables, only age (negatively) and education (positively) were statistically significant to purchase of organic foods. Although income and education are generally correlated, the findings do not represent an artefact of multicollinearity; when education was omitted from this model, income was still not found to be significant. Curiously, the lack of religious affiliation had a large, significant impact on the probability of buying organic foods. Lack of religious affiliation was not correlated with income either.

The focus group study revealed a degree of scepticism regarding organic food labels by both organic and conventional Caucasian shoppers. The study involved 43 participants in four focus groups (two conventional and two organic shoppers), it was recorded and transcribed; see Zepeda, Chang, Leviten-Reid (2006) for more details. African-American shoppers (none were regular organic food shoppers) were less familiar with the US Department of Agriculture (USDA) organic label, but also had more confidence in it. This seemed to stem from a greater confidence in federal agencies such as the USDA, as well as greater use of labels when purchasing foods. Overall, the focus groups and interviews yielded diverse if not conflicting stereotypes of who ate organic foods: hippies, yuppies, or "soccer moms" (affluent housewives).

Both the focus group study and the in-depth interviews (Zepeda and Deal 2007) revealed mixed feelings regarding the increasing penetration of organic foods in conventional grocery stores and brands. Some welcomed the increased availability and lower prices. Others felt that organic production methods were less important than

what they perceived as building a local food system. They viewed the increasing involvement of large food retailers and brands in organic foods very negatively. These people often characterised themselves as being interested in organics foods, then becoming concerned about whether foods were produced by small, local farmers. Among both conventional and organic shoppers, local foods were viewed positively.

## Discussion

In the focus group study, some conventional Caucasian shoppers viewed organic foods very negatively, characterising them as a, "rip off," and disparaging organic food shoppers as "hippies" or "yuppies." This perception of organic food shoppers was investigated in a study involving in-depth interviews (Zepeda and Deal 2007). Both conventional and organic food shoppers characterised organic food shoppers as hippies and yuppies, though organic food shoppers tended to characterise the stereotype as a transition from hippy to yuppie. Both organic and conventional food shoppers associated organic foods with higher income households, some characterising organic shoppers as a "suburban soccer mom." The characterisation of organic shoppers as affluent housewives, whose children play what is viewed in the US as an elitist sport, refers to seeming concern about what one's children ate, but implies that class-consciousness or conspicuous consumption are the real motivation.

Since the survey data reveal that there is no relationship between income and organic food purchase, the perception that organic shoppers are high-income undoubtedly stems from the fact that in the US organic foods generally (but not always) are more expensive than conventional foods. However, few US households buy many organic items, and the survey data reveals that there is no significant difference in the level of *per capita* food expenditures between organic and conventional shoppers. Therefore, organic food purchasers are not buying organic foods at the expense of other household expenditures. So while organic shoppers may pay more for the few organic items they buy, they must be spending less on other types of foods.

In-depth interviews were also used to investigate another finding from the statistical models, the large significant relationship between organic food purchase and lack of religious affiliation. Perhaps it should not be surprising that a religion variable would be significant in a US study; religion plays a central role for many in the US. Neither organic nor conventional shoppers initially saw a direct relationship, but when told that the survey data showed there was a correlation, several explanations were offered. Organic food shoppers felt that a person who was a freethinker towards religion would likely be freethinking towards other things, like food. Conventional shoppers offered other perspectives. One was that those who were not involved in religious activities had more time to concern themselves with things like how their food was produced. Still another was that technologies like pesticides were gifts from God and therefore could not be inherently harmful. Another belief was that cause and effect were dependent upon God's will, therefore conventional food buyers need not concern themselves with what one ate because God will take care of them.

Interviews with organic shoppers, particularly among those who preferred local over organic foods revealed not just commitment but activism in creating a local food system. It was clear that food choices were an important part of their identities. Many referred to farmers they purchased from in almost parental terms, "they take care of me," and like-minded people as part of a community they were creating. This might explain the negative attitudes towards "corporate organic;" they view it as undermining their vision of their food system that connects food buyers to food producers.

## Conclusions

Focus groups and interviews of US shoppers reveal diverse if not conflicting perceptions of who shops for organic foods. They are characterised as hippies, yuppies, or soccer moms in a disparaging way. However, survey data reveals that income is not related to organic food purchase and food expenditures are not higher among organic food shoppers. It also reveals that lack of religious affiliation is significantly correlated with organic food purchase in the US. Shoppers were surprised at this relationship, but provided explanations, ranging from theological, to time allocation, to desire for an alternative community. Overall, the qualitative and quantitative data indicate that the demographics are poor predictors of US organic shoppers, while attitudes, norms, values, and context are the key predictors.

## Acknowledgments

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# The EU health claims regulation and its impact on the marketing of organic food

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Key words: health claims, consumer behaviour, marketing, communication strategy

## Abstract

*The so-called EU health claims regulation changes the legal framework for all health-related statements on food and in advertising. As health reasons are a major motive for purchasing organic food, organic market actors have to consider the opportunities and threats posed by the new regulation. This contribution discusses the relationship between the organic attribute and the health claim attribute on the basis of a literature review and expert interviews. We argued that there is no scientific basis for depicting organic products as 'healthy as such'. The use of health claims for and on organic food can be problematic as well as promotive. Whether health claims are favourable or not depends, among other things, on product characteristics, the target consumer group and the future use of claims on competing conventional products.*

## Introduction

The regulation (EC) No 1924/2006 on nutrition and health claims made on foods, called health claims regulation, applies to all nutrition- and health-related claims on food packages, in food advertising, and even trade-marks. Its aims are, first, an EU-wide harmonisation in the handling of claims, and second, protection of consumers from misguidance with regard to the 'healthiness' of products. A health claim is defined as 'any claim that states, suggests or implies that a relationship exists between a food category, a food or one of its constituents and health' (EU 2007). It should be noted that important details of the regulation have yet to be worked out by the European Food Safety Authority (EFSA) and the EU jurisdiction. Between 2007, when the regulation came into effect, and full implementation around 2010, businesses operating in the food market will have to adjust to several major changes that the regulation will impose. The regulation is, in essence, an inversion of the current approach: from now on claims will be prohibited unless explicitly allowed. It also demands that decisions about the healthiness of products conform to 'nutrient profiles' - certain favourable nutritional requirements that have to be defined by the EFSA.

The organic movement supports the objective of enabling consumers to choose healthy food: health is, after all, one of its principles, along with balanced ecology, fairness, and care (IFOAM 2007, p. 1ff.). There are several indications that organically grown food can be healthier than conventional food (a review: Vijver, Huber 2007, or as examples: Brandt et al. 2006; Mitchell et al. 2007). Furthermore, consumers choose organic products mainly and increasingly because they think they are healthier (Calverley, Wier 2002). In order to maintain further market growth, it is therefore of particular importance to secure the current general perception that organic products are healthy. On-package communications and advertisements for organic products

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have already made more or less explicit reference to health or health-related well-being for some time. With the EU health claim regulation coming into force, the question is whether the regulation is (un)favourable for organic food products and to what extent organic market actors are aware of and prepared for the challenges and threats. This paper structures the discussion by means of three main questions and identifies possible future paths of development and strategies for businesses operating in the organic market.

## Materials and methods

Secondary research in the form of a literature review was conducted, tackling: 1) the requirements of the regulation in comparison to the present legal environment; 2) positions taken by organic market actors and experts; and 3) the assessment of the regulation's future impact by market experts or pressure groups. In addition to the literature review, primary research was carried out in the form of semi-structured telephone interviews with market actors. Three food products, spaghetti, strawberry yoghurt, and fruit muesli, were selected as examples in these interviews because products in these categories already carry or are most likely to carry health claims in the future. Fifteen articles belonging to eleven processors and retailers were chosen, and the people responsible for marketing these articles were contacted. Five of the experts interviewed in July 2007 worked for German organic processors and two for a big German retailer. The interview-study does not constitute a representative sample. The interviewees were asked whether they were keeping close track of developments regarding the new regulation and how they assessed its impact on their own marketing activities, the wider competitive environment, and consumers' attitudes and buying behaviour. The interviews were recorded digitally and transcribed. In the following, quotations from the interviews are written in italics.

## Results

The relationship between organic products and health claims can be discussed in terms of three strategic questions. Each question asks whether a certain level of relationship is possible, starting with the nearest possible relationship.

**1. Are organic products always healthier, and does this constitute a health claim 'as such'?** There are many indications that organic products are healthier than their non-organic counterparts in several ways. Nevertheless, this does not apply to all food categories. Even if there is scientific support for claiming that a certain food category is healthier when grown or produced organically, it is not guaranteed that every single product unit has the same beneficial effect on health, as required by the regulation. The reason is that organic standards are process-, but not product-oriented. Organic products therefore cannot be labelled with a health claim solely because they are organic.

**2. Is it beneficial to add a health claim to organic products: Would consumers react positively to this combination?** With organic standards on the one hand and the health claims regulation on the other, organic producers face two conflicting concepts. Organic products stand for a holistic approach to, among other aims, health (IFOAM 2007, p. 2). The regulation, in contrast, allows only claims for single substances and their specific impact on health, as e.g. in so-called functional foods. Since the typical organic consumer *'is sometimes more sceptical'* (towards claims), a health claim according to the health claims regulation on an organic food product

might be viewed with suspicion, and the consumer might well reject the product. Nevertheless, the contrary is also arguable. First, the health claim could be regarded as solely exemplifying the overall perception of healthiness. Second, a health claim on an organic product might be more credible with the background of a positive perception of the organic sector and its products. Third, the regulation allows claims for 'natural' substances. This suits the image of organic products: *'An organic consumer would assess a product which is e.g. high in omega-3-fatty-acid by means of a natural process positively and buy it'*. A certain percentage of today's organic consumers might not in fact perceive the combination as contradictory. Several of the experts interviewed stated, for example, that *'today, the target group "organic consumer" is no longer homogenous'*. A distinction ought to be made between *'the original, real organic consumer'*, in other words, the *'organic consumer of the past'*, and the *'conventional consumer, the lifestyle-consumer'* of organic food. The experts associate these two groups with the distribution channels *'specialised organic shops'* vs. *'conventional food retailer'*. The *'conventional'* organic consumers not only perceive health claims as not contradictory, they even tend to appreciate such products and are used to the combination of different additional benefits and trends in the food market. Therefore, adding health claims to organic products might or might not be seen positively by the consumer. Lastly, it is also a question of the product category. One expert argued that the best way to choose which products should carry claims would be to judge from the amount of questions asked on service hotlines regarding their nutritional value, and stated that more questions are asked if a product is already perceived as being healthy.

### **3. Can the use of health claims on conventional products hamper the market development of organic products due to conventional products being perceived as healthier?**

The most important motive for purchasing organic products in Europe is health (Midmore et al. 2005). So-called functional food products, which by definition encompass all products carrying a health claim, make use of the same motive. It is arguable that consumers might regard organic or conventional functional food as being equally desirable as healthy products. An increased use of health claims on conventional products might therefore represent competition for organic products. This is more probable *'where organic processors compete with the conventional, thus in conventional retail shops'*. Organic processors might want to make a distinction from functional foods by communicating their holistic approach, but the regulation does not permit claims about general health benefits alone. Such a claim has to be accompanied by a single substance claim. This could be the reason that several experts stated, for example, that *'here, the regulation indeed is restrictive and does not permit us to communicate the benefit as we would like to do'*. The costly substantiation of single substance claims, in turn, will largely be accessible to big multinational companies with enough resources to finance research. On the other hand, a sharp handling of the regulation might restrict and reduce the excessive use of health-related statements in the conventional food market, allowing for the few remaining claims to be perceived as more credible. Experts remarked that the requirement for scientific substantiation might increase the credibility of claims, and that it is important not to exaggerate the use of claims, but to choose *'the right dosage'*. The impact that health claims for conventional products have on organic products' sales is therefore dependent on the future application of the regulation in practice and the reactions of competing operators in the market.

In total, there is no general answer to the question of whether the regulation will have a positive or negative impact on the organic market and marketing activities taking place in it. The result of the survey reflects the fact that the organic sector itself is

heterogeneous. It is not surprising then that because of the heterogeneity of the organic market and the open questions regarding the future details of the regulation, the standpoints of the experts interviewed have also been heterogeneous. In addition, several interviewees were quite ambivalent towards the regulation. On the one hand, they tended to regard its impact on their marketing activities as negative; on the other hand, they expected to gain new consumers through the use of claims on their products.

Several factors determining the impact the regulation and health claims will have on the organic sector have been identified: 1) origin of the substance in question (natural versus artificial/added); 2) credibility of the processor/trade mark or the organic sector as a whole; 3) perceived healthiness of the product category; 4) distribution channel in question (associated with the existence of competing conventional products and type of consumer); 5) consumer characteristics; 6) future reactions of competitors (organic as well as conventional); and 7) future handling of the regulation by EU authorities and the legal practice.

## Conclusions

Organic market actors should pay close attention to the legal development and that of the market trends in reaction to the regulation. A tailored decision about possible adaptations of one's marketing strategy should be taken for every product in the product range in question. This decision might take into account the factors identified in this survey. It is noteworthy that although some of the interviewees' companies sell products on which the on-package communication will probably have to be changed in order to meet the requirements of the regulation, they tended to express the view that there is neither the wish nor the need to change claims on their products. This might lead us to conclude that, at present, the organic sector might not have dealt sufficiently with the regulation and the requirements and opportunities linked with it.

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# Consumers and their impact on food and farming systems in North America and Germany – Examples relating to GMO issues

Pick, D.<sup>1</sup>

Key words: Organic Consumers, rural development, Biodiversity, Genetic Engineering, Labelling of Ge-food, feed and seeds.

## Abstract

*Consumers in North America and Germany tried in different ways to impact their regional farmers, supermarkets, regional as well as national politicians, food related laws as well as food based land use systems in order to be able to continue consuming ge-free foods and to get sufficient information on all levels of the food chain enabling them to do so. As much success as consumers in the US and Germany had with the initiation and establishment of ge-free regions, US consumers did not succeed with their ge-food labelling campaigns. Only in Vermont a ge-seed Labelling law could be passed. In Germany ge-food, ge-feed and ge-seed have to be labelled by law. German Consumers and low input farmers tried to get also products derived from ge-feed included in ge-labelling laws. It seems a consumer influenced compromise that a new German legislation is about to be adopted which would allow for an easier Non-GMO-Labelling of food. Yet consumer opportunities to make informed choices about the food they eat seem to be still limited, especially in North America with the practical absence of federal ge-food, feed and seed labelling laws. Thus a few years ago, actors of the organic and natural food Industry teamed up to launch the so called Non-GMO Project, which shall soon open its Verification Program to the North American natural and organic food industry, offering a standard for ge-free or Non-GMO verification.*

## Introduction

Consumers directly and indirectly impact food and farming systems all over the world, e.g. by choosing where and what they buy, by requesting information about the food they eat (see e.g. Howard 2005), by voting for certain local food law initiatives (see e.g. Pick 2007) or certain regional and national politicians and their political (food) programs. Since a couple of years consumers in many regions of the world seem to be especially concerned about genetically modified plants and foods (about the difficulty to control GM plants see e.g. Clark 2004 or Brauner et al. 2002). Consumers can use a variety of influence possibilities to impact food and farming system and this paper tries to highlight the ones especially used by regional actors like consumers to successfully react on GMO issues in certain regions of North America and Germany.

## Materials and methods

Expert Interviews in North America (California, Vermont, Ontario) and Germany (primarily in Mecklenburg-Western Pomerania and Baden-Wuerttemberg) together with literature surveys examined different levels of involvement, challenges faced and

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achievements of consumers and other regional actors initiating or participating in the process of creating ge-free regions, ge-labelling laws or ge-free supermarkets.

## Results and Discussion

To arrange the various research results more clearly, they were displayed in Table 1 and will partially be explained and exemplified in the following paragraphs:

**Tab. 1: Consumer impact on food and farming with regard to GMO issues - Selection -**

Consumer impact food and farming	Examples from North America	Examples from Germany
because a majority of consumers wishes to eat ge-free foods and wishes to protect natural Biodiversity of garden or farm seeds	54% of North Americans said 2006 they were unlikely to eat GMOs, 38% said they were likely to eat them*	74,9 % of German consumers do not want ge-foods 18,3 % were indifferent about GMO issues 2006 **
by lobbying their local, state and federal politicians for sufficient Labelling Laws	Oregon and California Labelling Initiatives Vermont Seed Labelling Law	Recommendations to improve existing Federal Labelling Laws for ge-foods to include products derived from ge-feed
by shopping in natural food Stores, Coops and organic supermarkets	North American organic food market is with about 14% the fastest growing in the world. Its sales were estimated to be 11.9 Bill. Euro in 2005***	Organic food sales in Europe was approx. 12,5 Billion Euro 2004 Germany was app. 3,5 with a growth of 13%***
by donating benefits to ge-free Initiatives	Members of the COOP Supermarket in Mendocino County	Donations of regional actors in Ueberlingen
by initiating and encouraging ge-free supermarket initiatives	Big Carrot Project later developed into the NON-GMO Project in North America	Edeka Projects in Mecklenburg-Western Pomerania
by voting for or encouraging county administrators and farmers to vote for ge-free counties	County Laws in Mendocino County, Marin County, Trinity County and Santa Cruz County	County Resolutions in Main-Tauber County Oberallgaeu County
by voting for or encouraging administrator to vote for ge-free cities	City of Eureka, California Town Resolutions in Vermont	Town Resolutions in the Town of Tuebingen Town of Reutlingen
by talking to the source of their food for further information	consumer education events provided by Coop and organic supermarkets in Mendocino or Marin County	consumer education leaflets and movies provided by the ge-free region of Ueberlingen
by engaging in Community supported Agriculture	Community supported Agriculture in San Luis Obispo County (see also Strohlic 2004)	Farmer-consumer-networks, direct marketing
<b>Sources:</b> Expert Interviews in North America and Germany, *Pew Initiative on Food and Biotechnology 2006 ** gfk Market Research 2007, ***Willer and Yussefi 2006.		

Consumers have been often successful in their efforts to impact GMO issues, as Table 1 shows. They initiated and/ or supported for instance the introduction of many County Laws in California. In four of these it is now prohibited to grow ge-plants commercially (for details see Pick 2006 and 2007). Consumers also impacted County Resolutions in Germany where the County administrators decided to lease County land only to such persons who will farm it without the use of ge-plants. Similar Resolutions have been passed for Towns in Germany and Vermont.

Regarding the labelling of GMOs, Consumers and other regional actors have not been as successful, especially in the United States. Whereas Consumers in Germany campaign for stricter versions of existing Labelling Laws for GMO' s which would include products derived from ge-feed, Consumers in North America have to cope with the practical absence of any kind of mandatory ge-food, feed or seed labelling, with one exemption. In the State of Vermont, consumers, farmers and their representatives succeeded a few years ago with their labelling initiative and as a result a seed labelling law for ge-seeds got passed, the first and only of its kind in the United States. Other, especially ge-food labelling initiatives like the one in Oregon failed to be successful due to highly financed and Biotech Industry dominated counter Initiatives.

Rather smaller natural and organic grocery stores in California and Ontario started in 2001 and 2003 - in response to their customers who were concerned about ge-foods - their own initiative to discover the GMO status of their food assortment. The aim was to offer the stores' consumers an informed choice. One organic coop supermarket, The Big Carrot, was found to be an international role model in its consistent way of working together with its food processors and wholesalers in order to keep the food assortment in the store ge-free. Whereas in Germany by contrast the investigated co-op supermarkets like Edeka work directly with the farmers and obligate them to grow only ge-free seeds or feed their farm animals only ge-free food if they want to sell their produce under the supermarkets' brand.

The Big Carrot Natural Food Market in Toronto, Ontario implemented a non-GMO policy which simply discontinued those product lines that were not confirmed by the manufacturer to be non-GMO. But the absence of an authoritative standard for non-GMO created problems for this effort. In 2005, The Big Carrot teamed up with stores in California to form the Non-GMO Project, with the common goal of creating a standardized meaning of Non-GMO for the North American organic and natural food industry. (see also The Non-GMO Project 2007)

Since the spring of 2007, the Non-GMO Projects Board of Directors includes representatives from a lot of stakeholder groups of the natural product industry, like consumers, retailers, farmers, and manufacturers. Soon the Project expects to open its Verification Program to the industry, offering a Standard for non-GMO that is both meaningful and achievable. (see the Non-GMO Project 2007)

The implementation of any kind of label, especially one with such high oversight costs, has a tendency to higher the prices for the labelled products in this case for organic and natural food products. This kind of cost distribution is against the polluter pays principle. As much as consumers prefer to make an informed choice, they might not want to and should not have to pay for these extra costs which will likely arise.

## **Conclusions**

Consumers tried in different ways to impact relevant actors and actions in order to be able to continue consuming ge-free foods and to be able to continue choosing from

the natural and organic Biodiversity of garden seeds to plant in their garden. Therefore they need sufficient information on all levels of the food chain, including labelled seeds, enabling them to do so. Whereas in Germany consumers can make somewhat informed choices if they want to avoid ge-food, feed and seed, informed consumer choices in North America are more difficult in this regard. Although the vast majority of Consumers would prefer GMO's to be labelled, the Federal Governments of the United States and Canada do not consider mandatory labelling of these crop seeds, food and feed. In this Environment, the organic and natural food Industry of North America networked together and formed the Non-GMO Project Initiative for Non-GMO verification in order to be able to provide consumers at least with some kind of GMO related Verification. Its purpose is to protect organic and natural products from GMO contamination by setting certain standards. One question that remains open is who should pay for these GMO-related extra costs. The polluter pays principle would require that this is not the natural or organic food or seed consumer.

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# Consumers motivations for buying local and organic products in developing vs developed countries

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Key words: local products, organic food, food miles, consumers, developing countries

## Abstract

*Despite numerous studies reporting on organic consumer profiles, little is known on consumers motivations for buying local and organic products. More precisely, do consumers prefer local products because they want to support local producers or do environment and the question of food miles matter in their choice ? Besides, very little is known about organic consumers in developing countries, since most surveys are generally conducted in developed countries. Our purpose is to fill this double gap. By conducting qualitative surveys based on individual interviews in four developing countries (Brazil, Egypt, Uganda and China) and two European countries, France and Denmark, we plan to study consumers choice for organic products from supermarkets, farmers markets or local organic food network respectively. Products are selected to cover examples of imported organic products that compete with comparable products of local origin.*

*First results from Brazil and France show that French consumers are more concerned by the environment than Brazilian consumers, but that most consumers in both samples are not concerned by food miles and their subsequent environmental impacts. Results also shed light on different patterns related to commitment of supporting small or local farmers, and suggest implications for policy makers.*

## Introduction

The double situation on the one hand of increased demand for organic food and belief in Organic Food and Farming as a development pathway, and, on the other hand, the increased conventionalisation and globalisation of Organic Food and Farming, is the starting point for the Global Organic research project GLOBALORG ([www.globalorg.dk](http://www.globalorg.dk)). Four case studies in developing countries (Brazil, China, Uganda, Egypt) will be compared to two case studies in Europe: France and Denmark.

The objective of GlobalOrg project is to study the urban economic factors influencing consumer preferences respectively for short versus long procurement systems supplying organic food in developed and developing countries.

The project consists of three tasks:

To document the urban socio-economic development of the chosen areas

to document the various organic food procurement networks and

to study consumers motivations and barriers to buy, and meaning of, organic food.

This article presents some results from the third task, with a focus on consumers motivations for buying local and organic products in Brazil and France respectively.

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## Materials and methods

Individual interviews were conducted in each country, with 25 consumers in Brazil, and 28 consumers in France, who buy organic products from farmers markets, supermarkets or local organic food network. Products were selected to cover examples of imported organic products that compete with comparable products of local origin.

More precisely, interviewees had to compare a local and organic food product, a local and conventionally produced food product, and an imported organic food product. They had to

- (1) answer questions related to their attitudes and consumption intention (related to environment, health, price,...),
- (2) describe the person who typically buys and consumes each type of product
- (3) describe the person who never buys or consumes each type of product,
- (4) react after reading a discussion between three invented consumers (one who buys local or imported organic food, regardless of the mode of distribution or length of the distribution chain, the second one who only buys local and organic products and prefers not to buy them in supermarkets and, the third one who buys conventionally produced local products),
- (5) discuss on the basis of open questions about food miles, mode of distribution, and producers.

## Results

In the French sample, local organic food is highly appreciated. However, the invented consumer who prefers not to buy them in supermarkets is the least appreciated profile. On the contrary, the invented consumer who prefers organic food, and does not pay attention to the fact that it is local or imported, is the most appreciated profile by most consumers. Most respondents do not see major differences between locally grown and imported organic food as regard to environment.

However, two kinds of attitudes are noteworthy within the sample. First, according to some respondents, buying imported organic food is necessary since tropical products such as bananas cannot be produced in France. Others explain their consumption of imported organic food by the fact that the products are both organic and fair trade products. So the respondents described consumers who buy imported organic food as both environmentally conscious, but also involved in the support of small producers in poor countries. When we stressed the fact that many of organic imports to France are from the southern hemisphere countries, implying long distance transport and bad environmental effects, they answered that in that case supporting producers from poor countries is more important than preserving the environment. For example, a consumer stated: "To me, imported organic food is fair trade food. And buying fair trade products is sharing another vision of the world."

In sum, whatever their attitudes regarding imported organic food, respondents do not really take distance and its environmental impacts into account. Even for organic consumers who declare to be environmentally oriented, food miles do not really

matter, since organic consumers regard themselves as making a trade-off between food miles and other product attributes.

In Brazil, the image of local product is very strong: Brazilians are proud of their local tropical products, and do not see the use of imported products, apart from some processed food. They think 1) foreign products are too expensive 2) they do not like them because they think that transportation can lead to a loss of product quality, and 3) they do not trust foreign products. One respondent added that it seems snobbish to buy unnecessary imported products.

Some Brazilian interviewees also describe the consumption of local organic products as a political and ethical act. They are in the same time part of producers associations and actively support organic producers. Most Brazilian interviewees do not seem aware of nor concerned by Food miles; only one respondent spontaneously mentioned food miles and the consequences of transportation on environment.

## Discussion

In both samples interviewees express their preference for local and organic products, for different reasons: Brazilian respondents do not trust foreign organic products and therefore reject them. French interviewees are less reluctant to buy organic imported products. Environmental concerns seem more important in the French sample than in Brazil, where the consumers emphasized the closeness and support of local organic producers. However, in both samples the interviewees do not take into account pollution due to transportation, and only one consumer in each sample spontaneously spoke of food miles. This result is consistent with results from a previous study on consumers of conventional food products in France, who do not care about food miles (Sirieix et al., 2007).

Finally, support of organic and local Southern producers were for both the Brazilian and French interviewees a common motivation.

The differences between countries may be explained by the following points:

First of all, in Brazil there is still no state regulation or a Brazilian brand for organic food products. It is left to a wide range of local and/or internationally accredited certifiers, to guarantee that the products are following the rules of organic production methods. This could have an influence on the question of trust as well as on knowledge towards organic products from abroad.

Secondly, Brazil is a huge country so the question or notion of 'local' is different from its perception in France; this notion has to be specified in next surveys.

Thirdly, in Brazil organic food products sold through supermarkets are fairly new and very expensive compared to organic products sold through box-schemes, farmers markets or direct at farm shops. The consumers interviewed do not have a comparable choice between different outlets as in Europe.

On a theoretical level, the impacts of the findings of this study mainly relate to

- the links between personal values and behaviour (Wier et al., 2006), individual values, altruistic values (benevolence and universalism) and the related question of consumer reflexivity (Giddens, 1991). For example, in Brazil, imported organic food is more rejected than in France, but in both samples, consumer concerns and internal conflicts are linked to both

individual and altruistic values: some French consumers are willing to buy organic imported products such as bananas because they like them (individual value of pleasure), and others because they think that buying fair trade organic products allow them to support small producers from developing countries (altruistic value). Some Brazilian consumers reject organic imported food because they think the quality is lower (individual value of pleasure), and others because they want to support Brazilian organic producers (altruistic value).

- the links between local and/or organic consumption and social embeddedness. This relation is connected to the values of social mobilization for sustainable agriculture (Moreno-Penaranda, 2006) and the role local organic food networks can play in this regard (Seyfang, 2006).

Implications for public policy and marketing of local and organic products are important. Using an environmental argument such as 'food miles' to support certain supply channels may not generate the expected results as shown by our empirical investigation. In our survey, Brazilian consumers do not pay attention to food miles, but buy in local organic network to support small farmers and local economy, incorporating localisation, community-building and collective action as anticipated by Seyfang (2006).

Obviously our study is exploratory in nature, due to our limited sample size at this stage. The results should therefore be considered as a first step in a broad survey.

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# Influence of Young Children (3-6 years) on Organic Food Consumption in their Families

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Key words: attitudes, organic food consumption patterns, children, morphologic interview

## Abstract

*Our interest was to analyse families with young children (3-6 years) to understand their consumption patterns of organic foods. To understand the influence of children on organic food consumption, as well as the role and impact of kindergarten, we studied the attitudes, habits and behaviour of 24 mothers and one couple through qualitative interviews. We found that children positively influence the consumption of organic food in the families, and that organic foods served in kindergartens is highly accepted by the parents. Five consumer types were identified based on the criteria of motivation, knowledge and economic aspects. Three conflict fields influencing the decision making process for organic food. Consumption of organic products is not a linear development process but can change in different life periods.*

## Introduction

To date organic products are highly esteemed as healthy products. Factors like "quality of food" as well as "freshness of products" are main arguments in favour of organic products. Modern life-styles are therefore associated with the use of organic products. On the contrary, previous habits and additional efforts required for purchase and meal preparation are arguments against organic products. Income restrictions and the high prices of organic products are key arguments against organic food consumption (see BMLFUW, 2003: 68f). Nevertheless, persons with high income also follow other preferences. Health, especially of the children is an important argument for the use of organic products. It is apparent that parents prefer to buy organic food for their babies (see Oppermann 2001: 43). In public kindergartens in the city of Vienna, approximately 50% organic food is an obligatory part of lunch. However, our interest was to get a deeper understanding on how children in the home affect the consumption patterns of parents. We especially studied the influence of young children (3-6 years) on nutrition patterns in families and the status and significance of organic products in kindergartens. Additionally, we studied the factors influencing the private consumption of organic food (see Kannacher, 1982:2).

## Methods

In autumn 2006, a total of twenty-five qualitative interviews were done in Vienna (Austria) and its environs. Those interviewed were 24 mothers and one couple with

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children. Except one household, all consumed organic products in different intensities. First contacts with interview partners were at playgrounds and more were recruited with the snowball method. Most of the interviews were done in homes. For data collection, we used the morphologic interview (Fitzek 2000). Data analysis was done by coding the interviews based on the terms selected from literature, e.g. habits, attitudes, knowledge, motivation etc., following environmental psychology models e.g. from Ajzen & Fisbein (1977) (see also the following two paragraphs).

Our general theoretical background is the description and reconstruction approach of morphologic psychology, which is used in the marketing and media-impact research (Fitzek 2000). The aim is to concentrate and structure all collected phenomena in the interviews, which are linked with the influence of young children on the decision making process, for or against the consumption of organic food in their families. Finally, these conscious and unconscious everyday life correlations are reconstructed in different models. (1) Our first interest was, if there is a relationship between home consumption patterns and the acceptance of organic food in kindergarten. (2) Based on a modified definition of attitude, which is a result of motivation, economy and cognitive object assessment (Kroeber-Riel & Weinberg 2003), we classified consumer types. Attitudes are the result of consolidated and memorized opinions (Kotler & Bliemel 2001: 348). They influence the behaviour only if the consumer is cognitively involved. (3) In addition, we investigated, if there is a main factor influencing the decision making process, regardless of the attitude and intensity with which people actually consume organic food. (4) Following the morphologic approach, we used figurations, in our case, tension fields between two different positions for decision-making concerning the purchase of organic products. (5) Finally we studied if the consumption of organic products is a linear and irreversible process or an attitude which vary under different situations in daily life.

## **Results and discussion**

The age of interviewed persons was between 28 and 43. Net-income was between € 1,000,- to € 4,000,- per month. The education level of the mothers in this group was generally high. Families with two children were predominant.

### **Result 1: Acceptance of organic products in kindergartens**

The kindergarten meals were evaluated from "very awful" to "balanced and appropriate for children". The opinions were always linked with the attitudes and habits within the family household. Critical comments on organic products in the kindergartens were accompanied by a lower consumption of organic products at home. Nevertheless, there was a high acceptance on 50% organic food in kindergarten and the response on a future 100% organic food in kindergarten was always positive.

### **Result 2: Attitude between motivation, economy and knowledge of organic food**

In contrast to a general acceptance of organic foods in kindergartens, home consumption was a diverse mixture of part-time bio-product consumption. We identified five types, based on the criteria of motivation, knowledge as well as economic arguments.

Type 1: nearly always Bio-consumers: Nutrition is given a high priority; that organic are best for the children, own health and the environment. The knowledge on organic products is high.

Type 2: often Bio-consumers: Following the motivation of type 1; they have high income, but also prefer conventional products from supermarkets.

Type 3: sometimes Bio-consumers: This type favour bio-products, but are less informed and less motivated. If the price is not too high and if there is an occasion, they chose organic products.

Type 4: sometimes Bio-consumer for selected products: Type 4 also favour bio-products, but the information is limited, and they purchase sometimes only selected bio-products.

Type 5: sometimes one-product Bio-consumer: They are open for bio, but their information is very limited, they are constrained by the budget and therefore they buy a bio-product once in a while.

### **Result 3: Children as the driving factor**

In most cases, the impulse to purchase organic products, leading to increased home consumption was influenced by children. Following a child-birth experience, mothers changed their feeding patterns, using more organic products in their daily menu and mostly for the whole family. The most quoted argument for organic products is the need to secure the health of children. Besides that, concrete health problems of their own children or of other family members led to an increased consumption of organic products. „Ohne Kinder wäre Bio noch nicht so wichtig“, which means “without children, organic would not be so important.“ (23)

### **Result 4: Tension fields in the decision making process**

The decision making process for purchasing organic food is often accompanied by conflicts between different motivations, knowledge and economic potentials.

We identified three tension fields:

- High resolutions to consume organic produce versus high challenge to transfer this resolution into practice (they do not really know how to do so)
- High expectations on organic food versus doubts or uncertainty concerning the quality of the products
- Organic products are preferred but it is difficult to realise this because of economic restrictions (there are other competing expenses)

To point it out, the consumers are in a situation to decide between offering best food for children, doubts in the quality and financial challenges. This can be described with the following three conflict types (see Scheuch, 2007: 55): (1) Appetence conflicts: there are more alternatives but only one to be chosen; (2) Aversions conflicts: where two or more alternatives are not favourable but for one is to decide and the questions is how to avoid negative consequences; (3) Ambivalence conflicts: any alternatives have desirable as well as undesirable attributes.

### **Result 5: Phases of live and influencing factors on the use of organic products**

Attitudes are based on consolidated and memorized opinions. This is also in line with the theory on habits (Triandis 1977). Following this theoretical positions, we would conclude, that if consumers once decided for organic products, they will not change this habit in future. However, our results showed that changes in social settings does affect the use of organic products. An example is a one-time 100% bio-consumer, who reduced the consumption of organic products with a new partner; and after a break,

the consumer increased to the old level and influenced the partner to adopt organic products. Also divorce, house building, holidays or other expensive activities influence the organic food consume patterns. „Es gibt Phasen, wo man mehr oder weniger darauf (auf Bio) schaut“, which means “ / there are situations in life, where other aspects than organic food are more important.” (5)

The influence of life situations on consume patterns explains that the preference for organic products is a complex construction of decisions, but not a linear development process. This fact explains also, that consumer typologies only describe a stage of personal development, which cannot be generalized or predicted with precision.

## Conclusions

Kindergartens could be a place of first encounter to organic products for some parents. Therefore, it is obvious that private/ public organised educational institutes are able to influence consumer attitudes, especially if more knowledge is available. Also, young children provoke a (n) (re)orientation to organic food consumption and lead to modified consumption habits of the whole family. The decision making for or against organic farming is a complex process between firm convictions and a multitude of other preferences and challenges. In a multi-optional society (Gross 1994), consumer attitudes and behaviour is not a linear construct, the consumption habits are not always sustainable, because changes in life can modify them. From the scientific point of view, there is need to study families with elder children, to investigate if the trend of using organic products continues as the children grow, or whether other preferences led to a change of attitudes and behaviour.

## Acknowledgments

We thank our interview partners for their patience and willingness to spend their time and to reflect on these often very personal concerns.

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## **Public procurement: constraints and barriers**

# Overcoming constraints and barriers for organic public procurement – Applying the theory of loosely coupled systems to the case of organic conversion in Danish municipalities

Mikkelsen, B.E.<sup>1</sup>

Key words: public food systems, organic public procurement, organic foods, organic conversion, public foodservice

## Abstract

*Organic food and farming has been an integrated part of agricultural policies in most European countries for many years. In some cases this priority has resulted in strategies aimed at increasing public procurement of organic foods. Public service provision in schools, institutions and kindergartens include consumption of huge amounts of foods. This paper analyses three Danish local government cases of introduction of organic foods in public foodservice in order to study what kind of influence this has had on the governance of public foods. The findings suggest that organic food policies seem to result in a rethinking of public food provision and the creation of virtual public food systems. The findings also suggest that these developments have been fuelled by a sub optimal functioning of the foodservice supply chain and that this in turn has forced administrators to see food procurement in a new horizontal perspective in which different types of public foodservice is looked upon as a whole. The findings suggest that the emerging organic food policies have modernised the way in which public food is governed and that organic foods have created a sense of public political consumption. The paper discusses the opportunities that this development creates for the organic food sector and in particular whether the development can open up further the public as a sales channel for organic food.*

## Introduction

Traditionally public food service has been regarded as a necessary but simple add-on to other public services such as hospital treatment, day care in kindergartens, education at schools etc. Morgan and Sonnino (2007) have characterised it as a "mundane activity in prosaic settings" and in general public food is associated with low status and characteristics such as low pay, high labour turnover, high rates of dismissals, accidents, and absenteeism (Lucas 1996). Food service has traditionally been looked upon as a part of "something else" and as Mintzberg (1983) argues, for organisations such as hospitals, nursing homes or schools the task of cooking food is not being regarded as the core competence.

However the increasing attention given to institutional settings approaches to promotion of healthy eating as well as the call for more sustainable public food consumption has created a considerable pressure on this sector to innovate and modernise. In a number of countries sustainability policies have been launched aiming at increasing the volume organic foods in the public (Rimington 2003). The aim of this paper is to analyse Danish cases of organic conversion in public foodservice in order to determine what kind of influence organic conversion has had on the

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governance of public foods. In addition the paper investigates the fabric of “systems” that public food seems to be embedded in and discusses how public procurement of organic foods can take of advantage of the systems way of thinking. The paper uses the notion of *loosely coupled systems* (Weick (1976) to portray the idea that public food is part of “systems”. The term is often used in design of software systems to underpin the necessity of being able to integrate incompatible system technologies as well as the ability to disassemble the functional components again. For loosely coupled systems to work there must be a shared common language that ensures messages retain a consistent meaning across participating units of the system. This approach specifically seeks to increase flexibility in adding or replacing units and changing operations within individual units. In the life of organizations there are many examples of loosely coupled systems, projects being a good example..

### **Materials and methods**

The study is based on cases of organic food procurement polices in Copenhagen County, the City of Copenhagen and the Western Zealand County in Denmark. All projects were carried out from 1996 and onwards and were evaluated using external consultants and research partners. These processes informed the current study. In all three cases three types of actors in the public food environment functioned as the main informants: local government coordinators of organic conversion projects, local government procurement officials and local institutional food service managers. The Western Zealand County included 12 hospitals and institutions including worksite dining facilities at the institutions. In the city of Copenhagen municipal case the study was informed by in depth studies at 3 nursing homes and by the evaluation/monitoring process of the overall conversion project in 1200 municipal food service units. The case included all the different types of food service that the city of Copenhagen operates i.e. schools, kindergartens, nursing homes, worksites catering, community centre catering as well as other institutional catering units. In the Copenhagen County case the study included 12 institutions including hospitals, nursing homes and institutions for clients with special handicaps or needs. The data was produced by means of semi-structured interviews as well as by means of questionnaires. In addition, seminars involving catering kitchen managers and purchasers were used to inform the study as well as group interviews and explorative dialogue. A participatory approach was used in which external “lectures” by suppliers of organic foods and specialist in organic catering consultants was used. Information contained in reports seminars and meetings were used in the subsequent analysis as well as documents and minutes from administrative units, political committees etc. also contributed important information to the process. In the case of Copenhagen county some of the interviews with stakeholder were carried out by telephone using an open-ended interview guide which had been sent to the interviewees beforehand. Data collection were structured around the following themes: the outcome and effects of organic conversion, product-related as well as organisational barriers to implementation, workload and operational procedures, food quality and supply aspects of organic food supply, procurement contracts, quality requirements for organic food and procurement policies, characteristics of suppliers and supply situation of product groups and product chain networking. The results from interviews were coded and refined in a series of steps, resulting in an identification of themes, issues and statements that were common to most stakeholders.



## Results

The results of the interviews in all cases clearly demonstrated the complex nature of organic conversion in public food service. Unlike the process taking place among private consumers in the retail sector, the decision making process in public food environments follow a set totally different rules and norms. The data from all cases identify a number of obstacles and constraints to organic procurement, but in addition it also shows a pattern of solutions to these challenges. Findings from interviews with kitchen level managers showed that networks with other kitchens were seen as important in order to exchange practical conversion experiences. Kitchen level managers also underpinned the need for organic supply chains to operate more smoothly and that supply chains should drive innovation in order to secure supply of organic food in right quantity and convenience level. Managers were calling for improved assistance to help implementation of organic foods and for better in-service training opportunities. Main findings from interviews with county /municipal conversion project officials were that most conversion related tasks were seen as being the same across kitchen boundaries. In general kitchens were regarded as being able to benefit substantially from central coordination. Especially the challenges related to conversion project fund raising, liaison with the political level as well as to project management activities were underpinned as important tasks for municipal/county level coordination. Project officials also stressed the need for central coordination in order to secure minimum critical masses of organic food across kitchen boundaries. Findings from interviews with county /municipal level procurement officials were that in general the performance of organic food service supply were seen as sub optimal. Practical coordination of food procurement tasks at municipal level necessary as well as elaboration of product specifications and procurement contracts were seen as important tasks that should be centrally coordinated across kitchen boundaries.

## Discussion

The findings suggest that organic conversion in Denmark have contributed in creating a notion of food systems and that these new arrays present a field for further penetration of organic foods. The application of systems approach to public food is also found elsewhere across Europe (Morgan & Soninno, 2007). In cities like Rome, London and Paris public procurement schemes are emerging aiming at building in sustainability issue in food procurement contracts and thus underpinning the importance of public procurement in a political consumerism context. In some cities healthy eating and sustainability issues are being linked due to the apparent interaction between them (Mikkelsen et al 2006). New public food systems with a minimum critical mass have been created and a new type of governance of this area seem to be emerging. This new emerging view of public food service is paralleled by a development where municipalities are exploring the frontiers of public service and health care provision by engaging in new types of organisational constructions. Hence public private partnerships and other hybrid constructs with both private and public money are emerging. Common to these trends are that they require a move from the traditional catering production unit approach to a systems approach. This is due to the fact that for both health and sustainability objectives to be implemented successfully, a cooperation that stretches across both intra-organisational as well as inter-organisational boundaries is crucial. And such systems need governance, because they don't govern themselves. Kitchens can be managed but systems need governance. The "glue" which now suddenly is needed is not necessarily there and therefore municipalities must begin thinking horizontally across the food local area and

consider obligations such as kindergarten, school, institutions, hospitals etc. Local government should appoint new types of horizontal public food agents which would have to be supplied with the necessary competence. The development has been fuelled by a sub optimal functioning of the foodservice supply chain. This in turn has forced administrators to see food procurement in a new horizontal perspective in which different types of public foodservice is looked upon as a whole. It has also forced public administrators to engage in more committed type of supply chain cooperation. As a parallel organic food consultants and businesses should react to this new development and begin to handle relation with the public in a more strategic manner. The notion of loosely coupled system seems to be a convenient frame work to explain both the way in which food service units are to their parent organization. The notion can also help explain the way in which different food service units seem to be linking together horizontally as a result of the conversion trend. For instance a loosely coupling allows local government to redesign the way food is provided by substituting in house food service production with outsourced food provision. Similarly an in-house food service unit can be changed to provide food for several institutions. At the same time the notion can be used to explain the new type of cohesion between food service units that formerly has been operating in isolation. This has the potential to influence innovation and user driven change process such as processes related to demands for food quality, sustainability and healthy eating.

## Conclusion

The Danish local government cases show that the emerging public organic food policies have resulted in a new pattern in provision of public food in sectors such as schools, kindergarten and health care and nursing institutions. Food has become and object of political consumption, and organic food procurement strategies have forced administrators to see food procurement in a new horizontal perspective due to practical barriers in the supply chain. This has in many cases led to the creation of public food systems that formerly did not exist. This development offers huge possibilities for the organic sector since political consumption including organic food to an increasing extent are seen as strategic issues to which local government must relate.

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# Juveniles' organic food preferences and how parents deal with them

Riefer, A. & Hamm, U.<sup>1</sup>

Key words: Family, Children, Organic Food, Grounded Theory

## Abstract

*According to recent research it can be assumed that expenditures for organic food in families with children are declining as children get older. For organic food marketing this raises the question which kind of changes in families' organic food consumption appear over time and why they appear. For this purpose qualitative interviews with juveniles and parents were conducted and phenomenon-based relationship models designed. The phenomenon „parent's dealing with changed food preferences of juvenile children“, which is presented here, provides an insight into juveniles' demands regarding organic food products and parents' strategies and actions to deal with these. Thereby sweets, salty food snacks and chocolate spreads turn out to be organic food products mainly rejected by juveniles. As main reason for rejection the criteria of taste can be identified. Dealing with their children's preferences, parents follow the two strategies „making concessions“ and „not making concessions“. Product type, product attributes, consumption situation and price emerge as subjectively meaningful conditions for the interviewed parents. According to the results, marketing strategies for the organic food products concerned should mainly be targeted to juveniles' demands on taste on the one hand and parents' demands on ingredients on the other.*

## Introduction

Being an important institution of socialisation of children and juveniles, the family plays a decisive role for the acquisition of nutrition styles generally and sustainable nutrition styles specifically. For the marketing of organic products from a long-term perspective it is therefore indispensable to study the consumption behaviour of families rather than to merely focus on individual consumption behaviour. Therefore a differentiated analysis of the consumption of organic food in families over time is necessary. In this study, we investigate to what extent and at which time changes in the consumption of organic food in families appear. Moreover, the question for reasons of change in the organic food consumption of families arises. Explanatory approaches for this are already known from studies about motives for purchasing organic food. Thus, pregnancy and childbirth are turning points promoting motives for purchasing organic food like health. In contrast, children's adolescence, household formation, and economic or social crisis can be turning points for setting up or reducing organic food consumption (Kropp et al. 2005, p 41). Comparing the consumption of organic food in families according to different family life cycle stages expenditures for organic food in families with young children (oldest child under 15 years old), can be found to be higher than in families with older children (eldest child between 15 and 19 years old) (Michels et al. 2004, p 20; Wier et al. 2005, p 18). Accordingly, it can be assumed that

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expenditures for organic food in families decline with an increasing age of the children. Reasons for changes of families' organic food consumption can be deduced and assumed from previous studies. However, detailed descriptions of single phenomena did not exist.

### **Materials and methods**

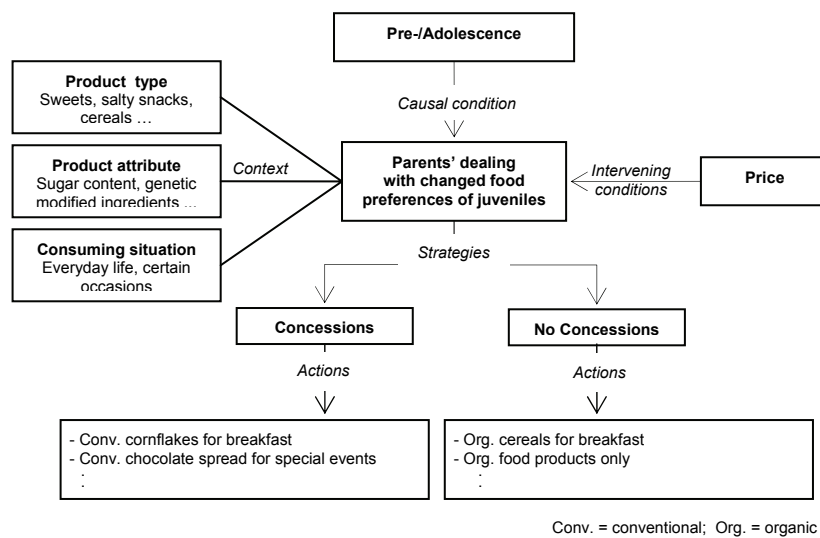
The research interest is to discover causal relationships between the development of organic food consumption in families from the subjective perspective of consumers. To do this, a qualitative research approach is most appropriate. Data is collected by means of the problem-centred interview (Witzel 2000), which is a combination of narrative and semi-structured interviews. Problem-centred interviews therefore allow the interviewee to narrate the development of organic food consumption on the one hand while, on the other hand, the interviewer can focus the interview thematically. The study is designed in multiple aspects according to research style and analysis method of the Grounded Theory (Glaser and Strauss 1967). For this, a research design of three waves of data collection and analysis, of 10 interviews each, has been created. In that way, the sampling criteria for the second and third wave can be adapted to the findings gained in the previous wave. For the first wave of data collection interviews were conducted with 10 parents, mainly responsible for food purchasing in their household. In these households organic food had been purchased frequently for a longer period of time, and at least one child of 12 to 18 years was present. The analysis of the interviews was strongly orientated to the coding procedures of the Grounded Theory according to Strauss and Corbin (1990). Based on the interviews, relationship models were worked out. These were enriched by the results of 10 additional problem-centred interviews with juveniles of 13 to 18 years about their attitudes and preferences as well as their purchasing influence on family decisions with regard to organic food. The emerging relationship models gave explanation about changes in organic food consumption in families with children. In the following example the phenomenon „parents' dealing with changed food preferences of juvenile children“ is presented.

### **Results**

The phenomenon „parents' dealing with changed food preferences of juvenile children“ emerges from all categories referring to organic food consumption. This differs from former consumption habits of the family and is caused by the demands of the interviewees' juvenile children. Differing food demands were expressed in statements about organic food products in the household which were rejected by children as well as statements about children's preferences for conventional food products. It is found that differing food preferences of children mainly appear in the product categories sweets, salty snacks, cereals, chocolate spreads and milk products. This corresponds to the results from the interviews with the juveniles. In contrast to the children, parents also mention lemonades on conventional quality as typical products preferred by their children. For the juveniles frozen pizzas are of relevance, too.

As causal condition for changing food preferences of children, parents refer to children's pre-adolescence or adolescence. This is explained by the development of juveniles' differing food demands. From the parents' perspective reasons for rejecting organic products by their children are motivated by the criteria taste, texture, price, packaging and image. Their children's reasons for accepting or even preferring

organic products are animal welfare and taste from the parents' perspective. Motives for rejecting organic products named by the juveniles themselves are less varied than their parents'. Taste turns out to be the central criteria for rejection. Beside taste, packaging as well as price - in cases where particular food products have to be financed by pocket money - is mentioned occasionally. Juveniles' identify health, food security and animal welfare as relevant criteria for organic food consumption. From the analysis of how parents deal with children's changing preferences, two opposed strategies emerge which can be entitled as „making no concessions “and “making concessions”, both depending on certain contexts (product type, product attribute and consuming situation and conditions. The first strategy is expressed e.g. in the action of insisting on purchasing organic food products. One mother tells that she stubbornly only buys organic breakfast cereals although her children prefer conventional ones and these cost more. As she says her children consume a high amount of breakfast cereals per day and conventional ones are of high sugar content and possibly of gene-modified ingredients. She obviously fears health problems for her children. The second strategy is expressed, for instance, in the action of purchasing conventional lemonade and chocolate spread only for special occasions like a television evening or Easter and Christmas. The relationship model in figure 1 gives an overview over how parents deal with children's changing food preferences and different intervening and context conditions like price, kind of product, product attributes and consuming situation.



**Figure 1: Parents' dealing with changed food preferences of juveniles**

## Discussion and Conclusions

As known from other studies, children influence purchasing decisions about sweets and snacks in their families considerably (Levy and Lee 2004, p 325; Mangleburg 1990, p 813). If young target groups are to be introduced to organic food products early in order to win them as future consumers, exactly this class of goods are possible starting points for marketing strategies. As seen, organic sweets, salty snacks, chocolate spreads and breakfast cereals do not always fit juveniles' taste demands. Therefore, much effort should be made to modify these products in a way which suits the taste of juveniles. At the same time, organic food products have to fulfil the demands of parents who are in the role of the final decision maker (Blackwell et al 2001, p 356) for the main part of household expenditures. For them, criteria like quality of ingredients or sugar content turn out to be of significant importance. Children can also be in the role of the decision maker for sweets and snacks when they finance these from their own pocket money. In this case, price is an important barrier for juveniles to purchase organic sweets. If organic retail brands are to be attractive for the whole family some organic sweets could be calculated with low premiums to attract children and win them over to consume organic products.

## Acknowledgments

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## The successful use of organic food products in eating out: A German case study

Rueckert-John, J.<sup>1</sup>

Key words: Sustainable food consumption, organic food products, eating out, organisational change

### Abstract

*Food consumption in western industrial countries seems problematic in the context of sustainable development. Organic agriculture and organic food products have a high significance in the German debate about sustainable food consumption. An important question for socio-scientific research is how a higher acceptance and consumption of organic food products can be promoted. This presentation will not focus on food consumption of private households – as it is customary – but on organisations of eating out. The empirical proof is given by a recent research by the author about the use of organic food products in catering facilities as promoted by the Federal Ministry of Food, Agriculture and Consumer Protection in Germany. From a theoretical perspective the presentation will firstly consider how a change towards sustainable nutrition with organic food products in catering facilities can be both conceptualized and examined. Secondly, the applied methods will be described. And finally, based on the theoretical assumptions the important empirical results will be presented. The study shows that concepts of sustainable nutrition are long-term learning and conditioning processes of the organisations.*

### Introduction

Food consumption has become problematic in western industrial countries and does not seem to be sustainable yet. In the current western context less the basic food supply of the population rather the outcome of the industrialized production of food is under discussion. This situation leads to questions about the handling of food prosperity and about malnutrition as a result of super nutrition. A non-sustainable nutrition in western countries means that the nutrition is problematic for health, if herewith the increase of different illnesses like cardiovascular diseases and obesity is connected. First of all today's nutrition in Germany and other western countries is problematic for the environment. The field of nutrition occupies directly and indirectly one-fifth of the total primary energy and material supply of all consumption fields (Wuppertal Institute 1997). Therefore organic agriculture and consumption of organic food products have a high significance in the discourse about sustainability in Germany supposing such agriculture and organic food production have a positive environmental effect. That means the consumption of private households as well as the consumption sector of eating out, the canteen kitchens.<sup>2</sup> In the context of this debate the presentation will discuss the possibilities of a more sustainable nutrition

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<sup>2</sup> Definition of eating out: All food and beverages preparation and intake outside home (DGE 2000). The eating out consumption is divided into two main sectors: the hotel and restaurant industry and the communal feeding.

based on organic food products in catering facilities. The central question is: How is sustainable nutrition in organisations of eating out possible? It brings a new focus on a long neglected field of food consumption. Nutrition in eating out receives great relevance from the perspective of sustainability because it bears enormous potentials for change.

## Materials and methods

Organisational structures can be described as decision premises, frameworks of expectations resulting from former decisions. Thus the organisational structure realises a basic stability under ever-changing conditions. They ensure essential redundancies of the organisation in a way that operations (as single events of usual decisions) are always linked up in the same way. Decision premises contain the possibilities of deciding whereby the risk of decision can be absorbed. According to Luhmann (2000) different types of decision premises of the organisation can be differentiated. The *determinable decision premises, which are built in reference to oneself*, are important for the organisation. That means aspects like tasks, personnel and the way of communication, which are bundled to a particular position. Furthermore a second type of premises is important for the organisation, which are *the decision premises in the organisation are non-determinable and self-referential*. That means organisational cultures, especially social values as components of organisational cultures are often barriers in a change process. A third type of *decision premises is non-determinable and built-up in reference to others*. These kinds of premises refer to connections into the environment of the organisation.

The change of those decision premises is the main empirical focus of the observation of processes introducing organic foodstuff. Change in organisations is widely discussed as an evolutionary change (Luhmann 2000) along its elements variation, selection and retention (or re-stabilisation). Based on the assumptions of organisational structures change can be observed as deviation from those. Firstly, one can focus on the disturbance of the decision premises, the redundancies, in the form of problems or conflicts. The application of existing premises is not longer possible. The organisation as social system gets under pressure and therefore it reflects on alternative premises. Secondly, now the selected variation which can find acceptance during the process when deviation increases circularly, comes into the empirical focus. The selected variation is often indicated as solution of a problem. Thirdly, since the selection leads to a rush of complexity the organisation must respond to it with re-stabilisation. That means, the new decision premise must be integrated in the organisational system and must be communicated to the actors in the environment of the organisation. The strategies of re-stabilisation can provoke subsequent irritations, which must be handled by the system. The circular cycle restarts.

This organisational model served as the heuristic for the recent research by the author about the use of organic food products in organisations of eating out (Rueckert-John 2007).<sup>1</sup> The first part of the study concentrated on describing the status quo of the use of organic food products in eating out based on a quantitative and representative

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<sup>1</sup> The precedent study was called "The use of organic food products by food supply services: status quo, difficulties and success factors, opportunities for development and needs for political action" (Rueckert-John et al. 2005). It was conducted between 2002 and 2004 and was promoted by the programme of organic production of the Federal Ministry of Food, Agriculture and Consumer Protection in Germany.



survey. The second part researched difficulties and success factors with a qualitative research design. Therefore seven best-practice-cases were analysed: a kindergarten, a university canteen, a staff canteen, a catering business, a hospital and two restaurants. In each organisation semi-structured interviews were used questioning relevant actors of the organisation and actors in its environment. In the following part of my presentation I will focus on the results of the qualitative case studies (Figure 1).

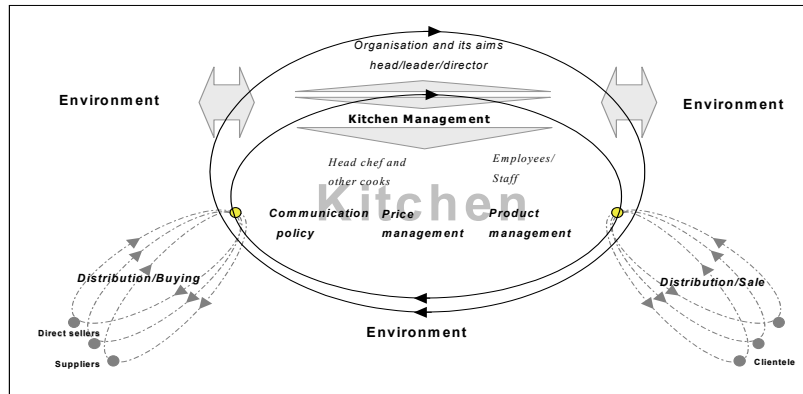


Figure 1: Research design of the case studies

## Results

*About decision premises, which are built in reference to oneself:* Programmes of sustainable nutrition in organisations of eating out pursue aims health, environmental safety and nutritional competence, which are communicated as semantics of naturalness. These are leading aims for all observed organisational programmes (e.g. about product, price, distribution and communication strategies). The occasions for the change of nutritional programmes often were reactions to irritations like BSE or other nutritional problems. The study shows that concepts of sustainable nutrition can be successful, if all relevant actor groups and not only the initiator will participate in the decision-making process in the organisation. Otherwise it is very difficult for the kitchen chef to promote it, if relevant actors like the head of an organisation, are not interested in an alternative nutrition concept.

*About decision premises, which are non-determinable and self-referential:* Organising the purchase of products is an important task of the kitchen chef. Criteria for a sustainable product choice are derived from the aims of a sustainable nutrition. It follows the leading aim naturalness. The observed kitchens order mainly organic food, regional, and seasonal as well as fair trade food products. Moreover strategies of a sustainable product use must be compatible with existing organisational structures (e.g. financing programmes) and conditions of the environment. For example, the use of organic food products must be affordable in facilities of communal feeding like kindergartens or hospitals. Furthermore, sustainable nutrition needs sensible strategies of financing, which should consider structural conditions of the organisation and the social environment as well as point out synergies between different motives. For example, a reduction of meat is one applied price strategy of the analysed

organisations. This strategy has also got a value of health. Regarding the kitchen staff, the performance of their specific tasks and their acceptance of programmatic values are very important. For this purpose a permanent communication of sense and updating of sense offerings are necessary. Successful forms of communication are meetings with the kitchen staff and also their involvement in the planning and in decisions about the realisation of sustainable nutrition.

*About premises of decisions, which are non-determinable and built-up in reference to others:* For a successful implementation of a sustainable nutrition concept in businesses and facilities of eating out structurally adequate suppliers and direct sellers are required. A trustful cooperation is one indicator for the success of sustainable nutrition concepts. To safeguard the clientele's acceptance of sustainable nutrition a structurally compatible communication strategy with specific offers of sense is needed. This means for the observed organisations of communal feedings for example forms of nutritional education like parent-teacher conferences in the kindergarten or seminars about healthy nutrition in the hospital. The actors use often sensorial forms of communication. In the restaurant it is a face to face communication of the cook and service staff with the guests. In staff canteens the actors practice different forms of a more faceless communication (information letters, posters, intranet platform). Two patterns of safeguarding the clientele's acceptance could be found: factual expansion (inclusion of additional task in the organisation) and social expansion (additional offers of clientele participation) of the nutritional programmes.

## **Discussion and conclusions**

The results of the empirical study show that concepts of sustainable nutrition are learning and conditioning processes, which are not short-term but rather long winded changes of social structures meaning in the case of organisations a change of particular decision premises. A more sustainable nutrition can at best be inspired by policy, society and scientific discourses. But it has to be always accepted in the systemic contexts, the organisation, via a specific sense making. Therefore, the change of existing nutritional concepts can be understood as a structural change of organisations with manifold consequences, which are located on different organisational levels. The benefit of this research can be seen in a theoretical and empirical extension of the term "sustainable food consumption" by an organisational perspective. It has brought a new focus on a long neglected field of food consumption.

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## **iPOPY – innovative Public Organic food Procurement for Youth. School meals – and more!**

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Mikkola, M.<sup>7</sup> & Mikkelsen, B.E.<sup>8</sup>

Key words: consumers, food policy, iPOPY, supply chain, nutrition and health

### **Abstract**

*One of eight pilot projects in the European CORE Organic programme, innovative Public Organic food Procurement for Youth, (iPOPY) will study efficient ways of implementing organic food in public serving outlets for young people (2007-10). By analysing practical cases of school meal systems and other food serving outlets for youth, we will identify hindrances and promoting factors in the participating countries (Denmark, Finland, Italy and Norway). Policies, supply chains, certification systems, the young consumers' perception and participation, and health effects of implementation of organic policies and menus are focussed in iPOPY. The main aim is to suggest efficient policies and comprehensive strategies to increase the consumption of organic food among young consumers in a public setting, and fostering sustainable nutrition. Interdisciplinary project tools under development will be presented along with the first project results, which will be available by June 2008.*

### **Introduction**

The project innovative Public Organic food Procurement for Youth (iPOPY) is one of eight pilot projects conducted under CORE Organic ([www.coreorganic.org](http://www.coreorganic.org)); a joint funding research programme among 11 European countries (2007-10). The iPOPY project is funded under the thematic area "Marketing research". The CORE Organic funding body network demands knowledge and practical evidence that will contribute to increase the consumption of organic food. Governments, companies, producers and caterers are increasingly committed to public procurement of organic food, but many challenges remain. The iPOPY project will analyse systems of public organic food procurement in four countries and suggest, on the basis of these empirical results, efficient policies and instruments for increased consumption of organic products in public food serving outlets for youth. In this paper, the project is presented in its initial stage, emphasising the goals and methods to achieve them. By June 2008, results will be available from the project work packages and presented.

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## **Project background, goals and structure**

Many European countries aim at an increased organic production and consumption, and the responsibility of the public sector to buy organic is recognised. Whereas organic food and - production have traditionally been linked to bottom-up processes, national and local public top-down policies are gradually developed on public procurement of organic food. However, national level decisions are often tackled inappropriately when implemented on a more local level (Kristensen et al. 2007). To be realised, political decisions are dependent on the enthusiasm of many secondary actors which have the power to contribute to, or hamper an implementation of organic food. Further, political aims are often conflicting and may counteract each other. Hence, knowledge is required about strategies and instruments that may increase the efficiency of national POP policies when these are implemented on a local level.

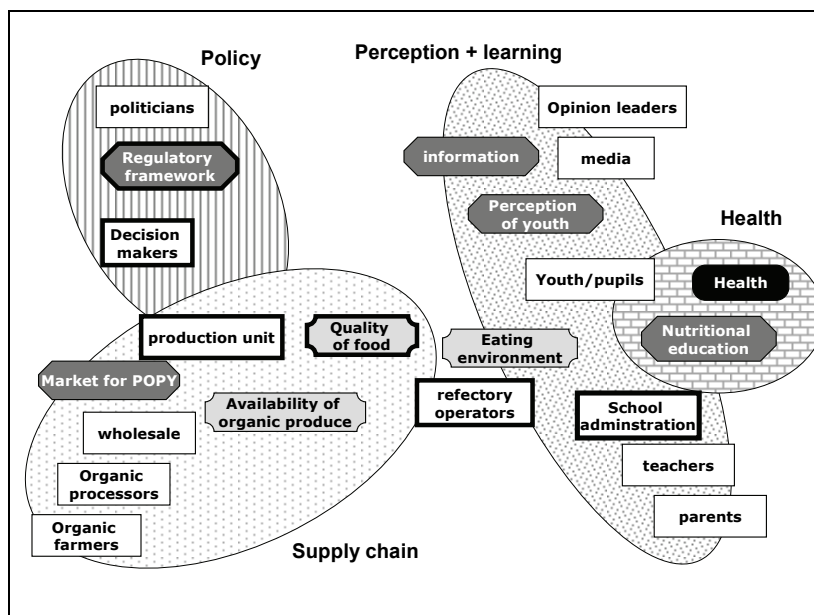
The aim of iPOPY is to study implementation of relevant strategies and instruments linked to food serving outlets for young people in some European countries. School meal systems are the most important way of public food provision for youth, but other areas such as kindergartens, hospitals and music festivals are also of interest. Within this field, the supply chain management, procedures for certification of serving outlets, stakeholders' perceptions and participation, and the potential of organic food in relation to health and obesity risks will be studied in four explorative work packages (WP2-5), whereas WP1 takes care of the project co-ordination.

The research project is a co-operation between Norway, Denmark, Finland and Italy. German researchers also participate, funded by the Research Council of Norway. The project coordination is placed at Bioforsk Organic Food and Farming Division (NO).

## **Methodology: An interdisciplinary analytical framework and national comparisons**

Public organic food procurement for youth (POPY) is a complex phenomenon that varies considerably across European countries. There is a need for cross-national comparisons of POPY systems to reveal determinants that are central for the development of such systems, as well as experiences and best practices that may be adopted by other countries and regions. National reports are developed for this purpose and published on the project web site. Furthermore, a complex reality calls for interdisciplinary research integrating diverse disciplinary knowledge about policies, supply chains, perceptions and learning as well as health and nutrition. To synthesize these diverse results, a common analytical framework is under development, using the methodology of constellation analysis (Schön 2007). Due to the large variety of POPY systems in the four project countries we initially focus on school meals. In the first stage of this work, the project team has suggested central actors and framework conditions and described their relations, which make up a POPY constellation. This preliminary version was visualised and "mapped" (Fig. 1). It serves as a heuristic tool for the research project. The visualisation points out central actors and framework conditions of the system, and allows for describing sub-constellations that form coherent sections of the overall constellation. Four sub-constellations, reflecting the four explorative iPOPY WPs, seem to shape the outcome of public organic procurement: policies of POPY, providing a regulatory framework; supply chain management; consumer perceptions, practices and learning; nutrition and health (Nölting et al. 2007).

An important aspect of the mapping of constellation and sub-constellations of the POPY phenomenon is that connections between actors as well as framework conditions are identified and described. Further, the visualisation may reveal “blind spots” and possible dynamic and feed-back loops between the sub-constellations. An important part of the procedure to develop the framework is to stimulate the discussion in the project across work packages, and to formulate hypotheses for further research.



**Figure 1: Mapping the constellation of public organic food procurement linked to school meals**

A coherent common terminology across work packages and disciplines is an essential part of this bridging concept. Altogether, the mapping process, the identification of central actors and framework conditions as well as common and clearly defined terms will provide an analytical framework to serve as a common point of reference for the research conducted in the work packages and ensure the comparability of national analyses and case studies.

### Coming results

The first outcome of iPOPY will be national reports describing the situation with respect to school meals (WP2), and to which degree organic food is included in school meals, in the four iPOPY countries. There is a huge variation between the countries with respect to school meal traditions, ranging from Italy, where all children receive a subsidised warm lunch daily and both local and organic food is heavily supported by public legislation (Morgan and Sonnino 2005), to Norway, where children may subscribe to daily milk and/or fruit servings. In Finland, warm lunch is served for free

but the share of organic food is low. In Denmark, various approaches to cold and warm lunch meals are being developed, with a considerable public support for organic; however, the implementation of organic food still has a long way to go.

The certification systems of organic production, processing and serving outlets in DK, FI, IT, NO, Germany and the EU in general will also be described in national reports (WP3). The aim of this work is to discuss and suggest general regulations and certification procedures for food serving outlets. By June 2008, initial results will also be available about supply chain management (WP 3), and relations between organic food and healthy eating (WP5). Positive attitudes towards organic procurement among catering managers have been shown to be associated with healthier menus in worksite canteens (Mikkelsen 2006), and iPOPY-WP5 will study whether this pertains also to young people, where a positive attitude towards organic food would be especially important to establish.

The overall iPOPY perspective is that food policies are crucial to achieve efficient public procurement systems of organic food, and analysis of actor networks (Hajer and Wagenaar 2003; Scott 2001) will be performed in WP2 based on information from other WPs. Drivers and constraints for public organic food procurement will be studied, as well as best practice cases, to develop and propose comprehensive strategies for POP that are practically and contextually adaptive. By responses from municipal stakeholders as well as actors in the school environments, these results will highlight the relationships between organic procurement policies, food and nutrition policies and the actual serving practices.

## Conclusions

At the ISOFAR conference, the project will be presented emphasising the instruments developed to analyse and synthesize results across WPs. Results from national descriptions of public organic food procurement systems for youth will be presented and compared, and a first discussion will be raised about how these results can be utilised to describe and explain each other.

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## **Economics and strategies on organic farms**



# Do organic livestock farms in Switzerland earn higher work incomes?

Lips, M.<sup>1</sup>

Key words: work income, organic farming, conventional farming

## Abstract

*In order to analyse the influence of organic farming on work income per standard working day, a multiple regression is carried out for Swiss farms engaged in livestock production, using farm accounts as a data basis. The work income of organic farms is CHF 24 (20%) higher per standard working day than that of farms participating in the "Proof of Ecological Performance" programme.*

## Introduction

Compliance with organic farming guidelines incurs additional running expenses over and above those of farms run according to Proof of Ecological Performance<sup>2</sup> (PEP) guidelines. Organic farms achieve better prices and receive higher direct payments. An analysis based on farm accounts is intended to provide information on their relative profitability by defining work income per standard working day by means of regression. The analysis concentrates on farms engaged in livestock production because the difference between organic farming and PEP concerning production technology is minor than for arable crops.

Offermann and Nieberg (2006) compare income for organic and conventional farming for several European countries. For Switzerland they report a higher income of 25 %, while the differences in Austria and Germany are 23 and 2 percent respectively. In an analysis for Germany von Münchhausen et al. (2007) demonstrate that there is any additional income and employment effect of organic farming vis-à-vis conventional systems.

## Materials and Methods

Reference farms for the accountancy year 2005 from the Farm Accountancy Data Network (FADN) of the Agroscope Reckenholz-Tänikon Research Station ART (ART 2006) are used for the analysis. Work income per standard working day serves as a yardstick for profitability. Standard working day refers to a working day of a person who is completely capable of work. As the measurement does not distinguish between employees and family labour, it allows a statement to be made on the remuneration for all work done. Equation 1 illustrates the method used to calculate work income per standard working day. Since, in addition to the remuneration of family labour, agricultural income also includes the rate of return on own capital, the own-capital interest claim must be deducted; the Government Bond interest rate is applied here.

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<sup>2</sup> For the Proof of Ecological Performance, various criteria must be met, such as e.g. the condition that 7% of the utilised agricultural area must be run as an ecological compensation area (Agridea 2006). The overwhelming majority of livestock farms in Switzerland achieve the PEP.

Labour costs are then added on. Finally, we divide by the number of standard working days.

*Equation 1:*

Work Income per Standard Working Day =

$$\frac{\text{Agricultural Income} - \text{Own Capital Interest Claim} + \text{Labour Costs}}{\text{Number of Standard Working Days}}$$

For the analysis, we focus on livestock farms, with five different types being used: *Commercial milk* (type 21 of Swiss FADN), *Suckler cow* (type 22), *Other cattle* (type 23), *Combined pigs/poultry* (type 53) and *Combined other* (type 54). Lips and Eggimann (2007) conducted separate analyses for all farm types. Multicollinearity resulted because of the small sample sizes. Pooling the five farm types and increasing the number of observations would be one way of reducing multicollinearity (Dougherty 2006). Table 1 shows a number of key figures, such as work income per standard working day.

**Tab. 1: Key figures of Swiss livestock farms**

	Unit	Organic	Proof of Ecological Performance	All
Number of farms		399	2033	2432
Utilised agricultural area	ha	20.7	20.3	20.3
Livestock units	LU	23.0	29.7	28.6
Standard working days	days	475	480	479
Work income per standard working day	CHF/day	132	120	122

Source: ART 2006

For the analysis, we use data from 2432 farms, 399 (16.4%) of which farm organically. This figure is higher than the percentage of organic farms in Switzerland, which is at 9.9% (Schweizerischer Bauernverband 2006).

### Regression Analysis

Work income per standard working day is determined by means of multiple regressions. Organic production is used as a dummy variable, assuming the value of 1 for organic farms and 0 for PEP farms.

The factors used are applied as further independent variables. Besides the assets (balance sheet), the capital/labour ratio, measured in assets per standard working day, is used. Also available as further independent variables are structural details (number of livestock units, animal density, area), production details (concentrate costs per cattle livestock unit, percentage of cattle out of total livestock, free-stall housing) as well as various key figures from the balance sheet. The structure of the outside

costs are deduced from the latter. The costs for plant production, animal husbandry, para-agriculture, work by third parties, machines, and the remaining structural costs (costs for buildings and fixed facilities) are expressed in relation to total outside costs, and enter the regression as blocks of costs.

Starting from an ordinary least square (OLS) estimate with all variables, a step-by-step exclusion is performed by means of an F-test. Here, the statistical significance of two estimates is compared, with one estimate containing additional explanatory variables. If the F-test on the 1% level shows no significant difference, preference is given to the estimate with fewer variables.

## Results

Table 2 contains the regression of the work income per standard working day. Around 20 % of the variance can be explained.

**Tab. 2: Regression for Work Income per Standard Working Day**

	Unit	Coefficient	Std. Error	T-Value	P-Value
Intercept		230	14.6	15.8	< 0.001
Organic farming	Dummy	23.8	3.77	6.3	< 0.001
Percentage of family labour	%	0.74	0.09	8.5	< 0.001
Share of loan capital	%	-0.25	0.05	-4.8	< 0.001
Livestock unit	LU	1.81	0.12	15.3	< 0.001
Animal density	LU/ ha	-13.9	2.30	-6.0	< 0.001
Cattle out of total livestock	%	-0.35	0.07	-5.3	< 0.001
Concentrate costs per cattle LU	CHF	-0.01	0.00	-2.6	0.011
Free-stall housing	Dummy	8.33	3.13	2.7	0.008
Cost percentage of animal production	%	-1.84	0.21	-8.8	< 0.001
Cost percentage of machines	%	-2.20	0.27	-8.2	< 0.001
Cost percentage of work by third parties	%	-1.52	0.47	-3.3	< 0.001
Cost percentage of para-agriculture	%	-1.31	0.30	-4.3	< 0.001
Percentage of structural costs	%	-1.96	0.21	-9.5	< 0.001
Mountainous area	Dummy	-10.4	3.39	-3.1	0.002

$R^2 = 0.215$ , F-Value = 47.2 df 14/2417, P-Value < 0.001; N = 2432

The findings clearly demonstrate that organic farming has a positive impact on work income, resulting in an additional CHF 24 per day. The coefficient is significant on the 1% level. Referring to the average income of CHF 122 per day (Table 1), it represents an increase of 20%. Computed for one year (280 working days), this corresponds to CHF 6720.

If the percentage of family labour rises by 1%, this raises work income by CHF 0.74. An additional percent of loan capital reduces income by CHF 0.25.

An additional livestock unit (LU) increases income by CHF 1.81. The animal density has a negative influence.

Farms with a high percentage of cattle out of total livestock tend to have lower income. An additional Swiss Franc for concentrates per LU lowers income by CHF 0.01. If the farm is equipped with a free-stall housing income is around CHF 8.3 higher.

The different values of the coefficients of the cost percentages are to be interpreted to the effect that the work income per standard working day depends on the cost structure; otherwise, the coefficients would be identical. If, for example, the cost percentage of work by third parties rises by 1% and the percentage of machines falls by 1%, this improves work income per standard working day by CHF 0.68 (CHF -1.52 instead of CHF -2.20).

Farms in the mountainous area achieve a work income CHF 10.4 lower than farms in the plains. The corresponding variable for the hilly area is not significant, and was excluded by F-test.

## Conclusions

The regression shows that for farms that raise livestock, organic farming leads to an approx. 20% higher work income per standard working day. Accordingly, changing from PEP production to organic farming is a way for individual farms to increase their income.

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# Gender Effects on Adoption of Organic Weed Management Techniques

Lohr, L.<sup>1</sup> & Park, T.A.<sup>2</sup>

Key words: technology adoption, information sources, count data, weeds

## Abstract

*Nearly 21% of U.S. organic farmers are women, compared with 9% of all U.S. farmers. Little research has isolated the factors influencing adoption of organic farming practices by male and female organic farmers. Male organic farmers adopt more weed control practices than female organic farmers and use a different portfolio of techniques. Results from a count data model and a national survey of U.S. organic farmers were used to decompose observed gender differences in technology adoption into a characteristics effect and a coefficient effect. The analysis shows that 40% of the adoption differential is due to differences in characteristics of male and female organic farmers. Education, experience, information sources, and institutional support are key factors causing the gender gap in number and type of adopted practices.*

## Introduction

Organic agriculture offers special opportunities for enhancing support for female farmers because women account for 21% of all U.S. organic farmers but only 9% of all U.S. farmers (Walz). To provide effective programming, causes of differential management decisions based on gender must be identified. More than 75% of both male and female U.S. organic farmers in a national survey by the Organic Farming Research Foundation (OFRF) (Walz) ranked weed management as the highest research priority. More than 70% of both males and females used five or more practices for weed control while only 6% required that many strategies for disease/nematode management. Our objective is to determine the factors that cause gender differences in adoption of weed management practices by organic farmers.

## Materials and methods

Our method is an extension of the Blinder-Oaxaca (BO) decomposition (Oaxaca) to a count data model. The technique decomposes observed differences in the adoption of weed management techniques across male and female farmers into two components. The first component, called the characteristic effect, represents the adoption differential attributable to the characteristics of male and female farmers. This component reveals how a disparity in adoption rates is driven by a characteristic (such as education) that differs between male and female farmers. The second component, called the coefficient effect, measures the relative strength of a characteristic (such as years of experience) on male and female decisions to use weed management practices. We extended Fairlie's model for binary outcomes.

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<sup>2</sup> As Above

We hypothesized that the selection of a given technology is related to other weed management strategies already used, and others that are available but not yet adopted, which enables us to analyze the complementarity effect of technology on adoption. Our hypothesis explicitly recognizes that the total technology package, rather than individual practices, maximizes a farmer's utility. To account for the interrelationships of weed control strategies with other management decisions, we used a count data model for the portfolio of weed management technologies.

Analysis on a scale broad enough to accurately reflect the production conditions must be drawn from a national survey that is representative of all organic farmers. Of the 1,192 responses to the 1997 national OFRF survey, 716 contained enough data for model analysis. The survey and results are available from the OFRF (Walz). A comparison of organic farms in the survey with data for all U.S. farms shows that the sample of organic farmers is representative of the size categories, farm income categories, and crop mixes for all U.S. farms (Lohr and Park).

In the survey, organic farmers who described themselves as using a given weed management practice on an occasional or regular basis during a year were defined as "adopters" while farmers who rarely or never used a strategy were classified as "non-adopters." The dependent variable was the number of adopted practices for weed control selected. On average, both men and women adopted six weed control practices, but men were most likely to adopt mechanical tillage while women were most likely to adopt hand weeding. Fewer than 40% of all U.S. farmers use crop rotations (39%), tillage methods (35%) and adjustments to planting dates (8%) compared with 70% to 90% of organic farmers using these methods (Walz, USDA).

The independent variables in the model included farm structure variables for sole proprietorships (male=74%, female=71%), corporation (m=7%, f=3%), managing organic and conventional systems on the same farm (m=25%, f=14%), percent of acreage allocated to vegetables and herbs (m=33%, f=47%), percent of acreage in field crops (m=44%, f=28%), average farm size (m=149 ac, f=40 ac), and farm income (m=42% <\$15,000, f=70% <\$15,000). Farmer demographics measured were completion of a college degree or higher educational level (m=55%, f=67%), part-time farming (m=64%, f=58%), experience as organic farmer (m=10.0 yrs, f=9.9 yrs), and number of different sources contacted for organic information weighted by the frequency of contact with that source (m=14.8, f=15.3). Regional variation in institutional support was captured by dummy variables for the federal administration of grants and support for sustainable agriculture including four regions – West, North Central, Northeast, and South. South was omitted in the regression.

We estimated the count data regression model of the weed management portfolio separately for male (n=562) and female (n=154) using Poisson estimation. We decomposed each variable's contribution to the difference between male and female farmers' weed management portfolios using the characteristic and coefficient effects.

## Results

In this model, characteristics shares are positive if they contribute to males adopting more practices and negative if they contribute to females adopting more practices. The sum of the characteristics shares is the total effect of male vs. female differences in the variables on weed management portfolio choice. The decomposition analysis shown in Table 1 indicates that 40% of the technology adoption differential was explained by differences in characteristics of male and female farmers.

**Tab. 1: Decomposition analysis of weed management practices adopted – male vs. females**

Variable	Characteristics Effect		Coefficient Effect	
	Estimate	Share	Estimate	Share
Sole Proprietorship	-0.010	2.6	-0.087	-2.5
Corporate	-0.015	-3.7	-0.016	-4.2
Mixed farming	-0.036	-9.1	-0.029	-7.5
Percent Vegetables	0.089*	22.9	0.552*	141.9
Percent Field Crops	0.229*	58.8	0.053	13.6
Organic Acreage	-0.021	-5.4	0.174	44.6
Organic Income	-0.024	6.3	-0.647	166.2
Part time Farmer	0.022	5.5	-0.115	29.7
Years Organic Experience	0.004*	0.9	-0.410*	-105.2
Education	-0.045*	-11.6	-0.029	-7.4
Information Sources	-0.019*	-4.9	0.197	50.7
West Region	0.017*	4.3	-0.878*	-225.7
North Central Region	-0.105*	-27.1	-0.569*	-146.1
Northeast Region	0.072	18.5	-0.733*	-188.3
<b>SUM</b>	<b>0.156</b>	<b>40.2</b>	<b>0.233</b>	<b>59.8</b>

\* Asymptotic t-value significant at  $\alpha = 0.10$  level.

The variable with the largest effect influencing choice of weed management practices was percent of acreage allocated to field crops (59% characteristics share) followed by the percentage of acreage in vegetables (23% characteristics share). While men allocated 44% of acreage to field crops and 33% to vegetables, women allocated 28% to field crops and 47% to vegetables. Although experience in organic farming averaged 10 years for both, male farmers' choice of weed management practices influenced by education (4% characteristics share). Education had the largest impact for female farmers in narrowing the gap in number of practices adopted compared with male farmers (-12% characteristics share), while the use of information sources had a smaller but statistically significant impact on female weed management adoption (-5% characteristics share). Both variables' mean values were nearly the same for male and female farmers, with both having at least some college education on average, and about 15 information sources contacted, weighted by frequency of contacts.

The decomposition illustrates the potentially misleading implications of looking at unconditional differences in mean values of variables across males and females to try to determine causes of gender differences. For example, average farm size was 149 acres for male farmers and only 40 acres for female farmers, but the size of the organic farm operation was not a statistically significant factor contributing to gender gaps in weed management adoption rates. Similarly, despite an average income difference of \$85,000 in favor of male farmers, income from organic farming is not a significant determinant of the number of practices chosen by men vs. women. A qualitative analysis alone would not correctly identify the reasons for differences. The coefficient shares show the degree to which individual variables affect the gap between number of practices adopted by men and women. Positive coefficient shares are associated with variables that increase the gap and negative coefficient shares show variables that narrow the gap. The sum of the coefficient shares was 60%. The percentage of vegetable acreage widened the difference between men and women (142% coefficient share). The coefficient associated with acreage in field crops showed this variable did not significantly influence the adoption decision across

gender. The coefficient effect for experience in organic farming resulted in a narrowing of the adoption gender gap (105% coefficient share). The coefficient effect for information sources was positive, indicating that the technology adoption decisions of male farmers were more responsive to information than were the decisions of females. The sign of this coefficient effect reversed the characteristics effect. Women sought more information sources than men, but the number of contacts was less likely to influence their weed management decisions.

## Discussion

Female farmers are concerned about weed problems but do not add more practices to address them, a response that is different from that observed for males. The survey reveals that male farmers have a proclivity to supplement mechanical tillage with crop rotations, cover cropping, and hand weeding methods when expanding their portfolios of practices. Female farmers follow a different pattern when considering additional weed control methods, with hand weeding, crop rotations, cover cropping, and mulching as the preferred techniques. The percentage of acreage in vegetable crops should favor these practices, but the factors that influenced women's decisions to add more weed control techniques were education and frequency-weighted number of information contacts. Women seem to be selecting their portfolio based on knowledge-seeking, while men select their weed management strategies based on crop mix and organic farming experience. This suggests that men are passing along knowledge through shared or observed learning, while women conduct information seeking to obtain the same information. The coefficient shares indicated that the gender gap in number of weed management practices is narrowed by farm experience and widened by percentage of vegetable acreage and number of information sources consulted.

## Conclusions

Weed management remains the most difficult problem faced by U.S. organic crop farmers. Women's weed management decisions rely on knowledge-seeking, while men rely on past experience. Educational efforts to improve the success of female farmers should account for this difference.

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# Financial success of organic farms in Germany

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Key words: farm economics; profitability; farm comparisons

## Abstract

*The conversion to organic farming is financially rewarding for many farmers in Germany. The majority of the organic farms make a profit above that of comparable conventional farms. A comparison of successful with less successful farms, measured by the average difference in 'Farm Net Value Added' to comparable conventional farm groups, highlights that the success of the conversion is less dependent on structural and site-specific factors than on the management ability of the farmers – above all in the area of marketing.*

## Introduction

Organic farming in Europe shows a very dynamic development. In the past fifteen years, the organically farmed land area in Europe increased more than ten-fold, and demand for organic products is continuously growing. Whether in the future a significantly larger number of farms converts to organic farming than previously is dependent on various factors, but above all on the financial viability of organic farming. Against this background, the question emerges of whether and for whom the conversion to organic farming is particularly profitable. This article aims to provide an overview of the profitability of organic farms in Germany and to analyse in an explorative way the question of which factors are most important for successful conversion to organic farming.

## Materials and methods

The analysis is based on data from the German Farm Accountancy Data Network and comprises of two different approaches. First, FADN book-keeping records from the last 11 years are used to analyse the development of profits of organic and comparable conventional farms. Second, detailed insights into the differences in the financial success of conversion are gained by using FADN data from the fiscal year 2005/2006.

"Family farm income plus wages per annual work unit (FFI+W/AWU)" was chosen as an indicator for financial success. This is the most commonly used performance indicator in Germany and allows the consideration of farms of different legal structures. The selection of the conventional farms was carried out in accordance with a differentiated, internationally harmonised method (see Nieberg et al 2007) using various natural and geographic factors, resource endowment (ha UAA, milk quotas) and general farm type as selection criteria.

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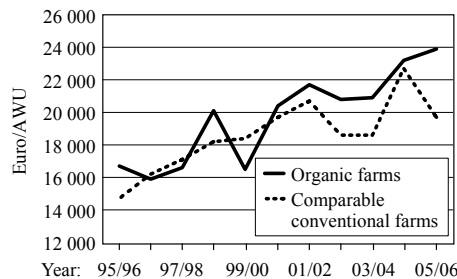
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To identify the most important success factors for a conversion, a comparison of successful and less successful farms was carried out. In order to evaluate whether the conversion to organic farming was successful, the difference in 'farm net value added' (FNVA) to conventional comparison farms is used as a measure of success. FNVA represents the return to all land, labour and capital and thus allows a comparison on a farm individual level irrespective of differences in ownership of these factors.

## Results

### a) Analysis of time-series data

As illustrated in Figure 1, the average profit plus wages per annual work unit on the organic farms is higher than the profit of comparable conventional farms in eight of the 11 years. In the fiscal year 2005/2006, the organic farms achieved on average profits more than 21 % above the profit of the surveyed conventional farms. It is however important to note that the average reflects only part of the reality. Furthermore, there is a great variation within the sample.



**Figure 1: Development of FFI+W per AWU**

Source: Own calculations based on German Accountancy Data Network

### b) Analysis of book-keeping records from the fiscal year 2005/2006

Past studies often focused on the differences in profitability within the group of converted farms (Gubi, 2006; Nieberg, 2001). This analysis in contrast looks at the differences in relative profitability, i.e. the farm individual profitability under organic compared to conventional management, using data of the fiscal year 2005/2006. The analysis shows that 11 % of the analysed German organic farms achieved only half as high a FNVA as their conventional counterparts. On the other hand, 14 % of the analysed organic farms were able to realise double the FNVA of their conventional comparison partners.

In order to gain a deeper understanding of the difference between particularly successful (double the FNVA) and less successful farms (half the FNVA), the organic farm sample has been split in two corresponding groups. The comparison of these two groups provides the first clues to the factors determining a successful conversion. As can be seen in Table 1, astonishingly the two groups differ in regard to only a few factors:

The clearest, and in most cases statistically significant, differences can be found in the producer prices. As was expected, the successful farms realise much higher prices for their products. One potential explanation for this results is that successful farms are more involved in direct-marketing

The successful farms also achieve somewhat better natural yields, however statistically significant differences were found only for dairy yields. In addition they tend to produce in a more market-oriented manner. They have a larger arable areas and cultivate more organic cash-crops such as potatoes and vegetables.

**Tab. 1: Comparison of successful and less successful organic farms  
(Year 2005/2006)**

		Organic farms with half as high   doubly high Farm Net Value Added as compared to conventional reference farms	
Soil Index	BKZ	34	32
Share of Part Time Farms	%	33	28
Total Labour Input	AWU/100 ha UAA	4,2	2,8 **
Paid Labour Input	AWU/100 ha UAA	0,3	0,4
Agricultural Training			
No formal agric. training	%	17	5
Certificate of apprenticeship	%	50	38
Certificate at Technical School/Master Farmer	%	20	31
College/University degree	%	13	23
}			
**			
General Farm Type			
Arable Farm	%	40	41
Grazing Livestock Farm	%	57	51
Mixed Farm	%	3	8
Farm Focus (Principal type of farming)			
Arable crops: Specialist cereals, oilseed and protein crops	%	27	18
Arable crops: Cereals and root crops combined as well as mixed cropping	%	6	18
Specialist dairying	%	30	36
Specialist cattle-rearing and fattening	%	13	0
Total Utilised Agricultural Area	ha UAA	59	98 *
Share of Rented Land	% of UAA	60	56
Share of Arable Land			
	% of UAA	55	63
Share of Cereals			
	% of arable land	53	54
Share of Legumes			
	% of arable land	5,4	6,6
Share of Potatoes			
	% of arable land	2,0	4,1
Share of Vegetables			
	% of arable land	0,6	1,0
Stocking Density			
	LU/ha	0,8	0,7
Number of Dairy Cows			
	Head	25	35
Number of Suckling Cows			
	Head	18	41
Number of Breeding Sows			
	Head	-	4
Number of Laying Hens			
	Head	44	548
Yields/Performance			
Cereals	t/ha	3,2	3,4
Field Beans	t/ha	1,8	3,3
Potatoes	t/ha	14,8	16,9
Milk	kg/cow	4293	5154 *
Producer Prices			
Cereals	€/t	207	306 **
Potatoes	€/t	360	424
Milk	€/kg	0,326	0,351 **
Fattening Bulls over 1.5 years of age	€/head	524	901 *
Fattening Pigs	€/head	194	248 *
Share of Farms with Direct Marketing			
	%	47	62
Direct Payments and Other Subsidies			
	€/ha	598	605
Thereof: Organic Payments			
	€/ha	190	166
Labour Costs			
	€/ha	69	118

BKZ: Soil climate index; AWU: annual work unit; UAA: utilised agricultural area; LU: livestock unit

\*\* significant at  $p < 0.05$ ; \* significant at  $p < 0.1$  (t-test and Wilcoxon-test).

Source: Own calculations based on German Accountancy Data Network (2005/2006)

- The general farm types are nearly similarly distributed in both success groups. Some differences exist with regard to farm focus: in the group of farms with a relative low financial performance compared to the conventional reference farms, specialised cereal, oilseed, and protein crop farms and specialised cattle rearing and fattening farms are more frequently represented, whereas the more diversified crop farms are comparably more frequently represented in the group of successful farms. Thus, an interesting question for future research is: Which level of specialisation/diversification promises the best chances for a successful conversion?
- The group of less successful farms comprise of more farmers that have no agricultural training. In contrast to this, successful farms are more often managed by farmers that hold a degree of a technical college or university. A good agricultural education seems to be an important factor for success.
- Interestingly, the quality of the farm-site (measured here on the basis of the soil-climate index) does not seem to have an influence on the success of the conversion. Conversion can thus be successful both in the case of advantageous and non-advantageous natural conditions.
- On average, the more successful farms were significantly larger than the less successful farms, which may however be due to regional differences in farm structure (East vs. West Germany) and requires further analysis on a regional level.

### Conclusions

In the past, the conversion to organic farming proved to be a financially rewarding choice for a number of converted farms. However, great differences exist in the level of success. Thus, great chances lie in the conversion to organic farming but also risks. The fact that above all the levels of realised producer prices are of great significance allows the conclusion that the success of the conversion is less dependent on structural and site-specific conditions, but rather on the management ability of the farmer, particularly in the area of marketing. In order to be successful, the organic farmer, just like his/her conventional counterpart, must have entrepreneurial skills and a high level of competence in production, but above all in marketing. Given the large number of possible hidden variables influencing the success of organic management, the results of this analyse are of explorative nature. More insights would be gained by applying a multivariate analysis.

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# Diversification and specialisation as development strategies in organic farms

Zander, K.<sup>1</sup>

Key words: diversification, specialisation, organic farming, socio-economics, Germany.

## Abstract

Unsatisfying economic performance, continuous work overload or the entrance of the younger generation are often the starting point for reorientation of the farm's organisation in order to increase the farm's efficiency. Theoretically, farmers are faced with two main options when looking for a viable farm strategy: diversification or specialisation. Based on a quantitative and qualitative survey of 40 farms, the results show that the decision to either diversify or specialise is usually a multi-dimensional issue. Only the analyses of the interactions between many different factors may help to understand the decision processes on farms. One central result of the study is that the personality of the farmer is the key driving factor in the decision on specialisation or diversification. The study also reveals that, whereas cost reduction is observed to be a valuable strategy in conventional farming, it seems to be of very limited relevance in organic farming in Germany

## Introduction

Unsatisfying economic performance, continuous work overload or the entrance of the younger generation are often the starting point for reorientation of the farm's organisation in order to increase the farm's efficiency. Usually, two main possible strategies can be distinguished. Specialisation in one or few farm activities aims at reducing production costs and is often associated with an increase of farm size. The second main option is diversification by increasing the number of activities. This strategy usually goes along with a closer contact between farmer and consumer and an increase of return, so that cost saving becomes less important.

Three types of diversification are to be distinguished in organic farming:<sup>2</sup> horizontal diversification is an extension of the existing range of activities, e.g. starting a new farming activity like potato production. Lateral diversification is related with the entrance into new product-market-areas, without a physical relationship with the former activities. This can be agro-tourism, catering or the production of renewable energies. Finally, vertical diversification (vertical integration) refers to pre- or post-agricultural production activities like on-farm processing or direct marketing.

The question of the optimal farm organisation with respect to the number of farm activities realised and the way they are combined with each other has long tradition in farm economic research, starting in the first half of the 20<sup>th</sup> century. The following impact factors were identified: natural production conditions, locality of the farm, infrastructure, general price and cost relations as well as the necessity of creating high

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<sup>2</sup> See Jacobs (1992).

soil fertility by adequate crop rotation and the use of manure, the use of own fodder, break down of work peaks, risk management and the personality of the farmer (see e.g. Aereboe 1919, Brinkmann 1922, Weinschenck and Henrichsmeyer 1966, Kuhnert, 1998). These factors determine the optimal farm organisation and the number of farm activities and thus a farm's degree of specialisation or diversification.

The aim of this contribution is to identify the key driving forces for the strategic decision regarding specialisation or diversification in organic farms. The results should help farmers to decide whether to opt for specialisation or for diversification.

### **Methodological approach**

The study was designed as an explorative study and thus the results are not representative for all organic farms in Germany. Interviews were realised on 40 successful organic farms with a clear decision for diversification or specialisation in the past. These farms were selected in close cooperation with organic farming extension workers and are supposed to serve as good examples for other farms in an orientation phase.

The survey combined quantitative and qualitative elements in face-to-face interviews. The qualitative part was mainly used when asking farmers to report on their farms' history in an almost narrative way, pointing at important events. A short initial interview with 12 advisors of organic farming revealed that the personality of the farmer was seen to be one key driving factor in determining the farm's development into specialisation or diversification. To grasp this issue the DISC personality concept was used in close cooperation with the extension workers. DISC is a commercial product initially developed for management purposes and it clusters people in four main dimensions: dominance, influence, steadiness and conscientiousness according to their behaviour (CIC 2007, Persolog 2007). This tool was supplemented with five items aiming at classifying personalities according to the "Big-Five" personality dimensions (Rammstedt et al. 2004). With respect to the farmers' behaviour and attitudes in their daily work some additional statements were included as well.

### **Results**

The group of surveyed farms contains all farm types and farm sizes located in different natural conditions. In analysing the results it has to be differentiated between the mere agricultural production on the farms and the whole farm system. With respect to the underlying question clear specialisation and diversification strategies can be identified in pure agricultural production: 13 farms chose the way towards specialisation, 14 farms diversified and 12 farms remained almost unchanged with respect to the number of agricultural activities.<sup>1</sup> But looking at the farm organisation in general, the picture is quite different. At this level, 80% of the farms have diversified their whole farm organisation, either horizontally, laterally or vertically. Most important activities besides agricultural production are direct marketing (82%)<sup>2</sup> and on-farm processing (46%). This causes the rather high endowment of labour of 7 agricultural work units

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<sup>1</sup> One farm had to be skipped for not being a successful farm with demonstration capability to other farms.

<sup>2</sup> Direct marketing is understood in a wider sense and includes marketing directly to the consumer and marketing via retailers (see Kuhnert 1998).

per 100 ha on average on the surveyed farms, while the average number of labour units in organic farms is reported to be about 2 units per 100 ha (BMELV, 2006).

Aiming at the identification of similarities, four main groups of farms were created according to the development strategy realised. There is the group of farms that diversified with respect to their agricultural production and also to other activities like e.g. on-farm processing, direct marketing, renewable energies etc. (Type 1). Another group of farms stayed with about the same diversity in agriculture, but diversified in vertical direction (vertical integration) (Type 2). The third group specialised and now concentrates on few agricultural products (Type 3), while the last group specialised at the whole farm level, as they reduced their farm activities and ended up with a rather simple farm organisation with one or few agricultural activities (Type 4).

Looking at the key driving forces for the decision to specialise or to diversify, there are no differences between the farm types with respect to endowment of land or the increase in acreage in turn of the farm's development. Almost all farms increased their farm size largely over time. The availability of highly qualified family or employed labour however is a precondition for a successful diversification. An aspect becoming ever more important is specialisation within the diversification by spreading responsibilities to various persons. The differences between the four groups became most obvious with respect to the personality of the farmer himself. For the summary of the results see Table 1.

**Tab. 1: First results on differences between farm types according to their strategy regarding specialisation or diversification**

Farm type	Features
Type 1	Farmers are always outgoing but are less direct and decisive and they like to work in a collaborative way. Diversity is of high importance for the farmer. They have good marketing opportunities. Two generations work on the farm. Highly motivated family or employed labour.
Type 2	Farmers are decisive and very extraverted. Diversity is of high importance for the farmer. They have good marketing opportunities. Two generations work on the farm and family or employed labour is highly motivated.
Type 3	Farmers are outgoing, correct and even-tempered. In the term of the farms' development they often passed Type 1 or 2, now concentrating on most successful farm activities. Most pragmatic organic farmer.
Type 4	Farmers are not outgoing, instead rather steady and introverted. They like to be independent. Quality production is highly ranked. Very low availability of (family) labour. Specialised also in the past.

## Conclusions

One important conclusion drawn from the results presented here is that diversification and specialisation in organic farms is a very complex issue. Farmers cannot simply be classified into the diversifying farmer on the one hand and the specialising farmer on the other hand. There are various forms of diversification in organic farms, and there is also diversification with specialisation in one and the same farm. Only the analyses of the interactions between various factors may help to understand the decision

processes on the farms. However, the personality of the farmer turned out to be the key driving factor in the decision on specialisation or diversification.

Most of the surveyed farms chose the way towards diversification on the level of the whole farm enterprise. An important motivation for the farmers to opt for the vertical integration was to be able to earn their livelihood by keeping the added-value of their products on farm. Only 10% of the farmers were "real specialisers". However, even these farmers care about the marketing of their products, such as engaging in farmers marketing associations or cooperatives, or being so large that good conditions can be negotiated on the markets. Thus one important result of this study is that pure cost reduction as observed to be a valuable strategy in conventional farming seems to be of very limited relevance in organic farming.<sup>1</sup>

However, this study used an explorative approach and it does not aim to be representative for the whole organic sector in Germany. The selection of study farms might be biased as the cooperating extension workers all are from organic farmers' organisations. It is likely that "cost minimising farms" are not members of organic farmers' organisations, but only follow the EU council regulation on organic farming (EU VO 2092/91).

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<sup>1</sup> This result is supported by Nieberg and Offermann (2007), who found comparatively high prices as a major reason for high profits in organic farms.



# The Impact of Labor and Hiring Decisions on the Performance of U.S. Organic Farms

Lohr, L.<sup>1</sup> & Park, T.A.

Key words: labor management, seasonal workers, elasticity of complementarity

## Abstract

*An increased emphasis on the viability and growth of local food systems which reduce "food miles" has promoted efforts encouraging farmers and processors to sell and distribute food products to local consumers. The elasticity of complementarity is used to predict adjustments in relative wage payments if organic farmers commit to local selling. We use comprehensive U.S. data on organic practices to show that a commitment to local sales leads to lower organic farm incomes. Policies that promote a shift to local sales would lead to decreased use of seasonal workers and higher wages for seasonal workers with smaller adjustments in the wages of year-round workers.*

## Introduction

The Organic Farming Research Foundation (OFRF), in its survey on organic production constraints facing U.S. producers, documented labor as significant production problem for these farmers. Respondents to the Fourth survey rated both high labor costs and the availability of labor to produce organic crops as among the most severe problems constraining production. Labor did not even appear on the list of production problems in the Third OFRF survey. Concerns about the availability and cost of on-farm labor were prevalent across all farm income groups but were identified as a more significant constraint among female than male organic farmers.

The limited research on labor issues for organic farms has focused on the employment dividend when organic farms employ more workers than similar sized conventional farms. A Soil Association study confirmed that organic farms in the U.K. support 32% more jobs per farm than non-organic farms (Maynard and Green). The Soil Association calculated that an expansion of organic farming to 30% of total U.K. farmland would lead to an increase of 28,000 jobs, or a 10% rise in on-farm employment. Duram (p. 79) highlighted research linking organic farming and rural development suggesting that there are "inherent values within the organic movement that could act to encourage local food networks and local community involvement." Lipson's analysis of organic marketing and fair trade marketing mentioned a growing awareness of the social and economic benefits of local and regional food sourcing but makes no assessment of the impact on producers.

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## **Materials and methods**

The first objective of this research is to explain how earnings for agricultural workers respond to changes in use of on-farm inputs (including farm size and hiring decisions) by evaluating elasticities of complementarity. The analysis distinguishes between the use of year-round and seasonal agricultural workers, an important feature of the workforce for organic farms. A production function for organic producers is estimated which incorporates indicators of the operational and environmental constraints facing farmers.

A second objective is to evaluate how earnings of agricultural workers on organic farmers respond to specific farm-level change in marketing practices. The agricultural marketing issue we examine is the increased emphasis on the viability and promotion of local food systems which reduce "food miles" and transportation costs while offering consumers the benefits of locally grown food. A Leopold Center report from Iowa State University highlighted the importance of food systems which allow farmers and processors to sell and distribute food products to local consumers. The report recommended that Iowa farmers, retailers, and food brokers "pursue opportunities to market produce and meats locally and regionally" while also diversifying production and processing practices to meet demand for local food. The production function approach provides an economic framework showing how producers are affected when focusing on sales to local markets and can be used to predict adjustments in relative wage payments if organic farmers commit to local selling.

Analysis on a scale broad enough to accurately reflect the production conditions is drawn from a national survey that is representative of all organic farmers in the United States. The data for this analysis is based on responses to the Fourth OFRF survey representing all crops grown organically and all regions in which organic crops are produced yielding 787 observations with complete information. Vegetable crops and herbs were grown by about 28% of the farmers in the sample, with a typical crop mix of at least four different vegetable crops. Fruit, nut and tree crops were produced by about 21% of the sample, with a lower degree of diversification which averaged about two crops in this category. Field crops were the predominant production category, with 51% of farmers allocating acreage across an average of two field crops.

The two inputs are labor and acreage, which are under the control of the producer and can be changed annually depending on the planned output for that season. The labor input is represented by year-round workers and seasonal farm employees. The average farm in the sample used two year-round and five seasonal paid employees. The majority of organic farm operations (52%) relied on both year-round and seasonal workers with of farm 34% hiring only seasonal workers and 14% using only year-round workers. Employment of both year-round and seasonal farm workers is more closely correlated with farm income than is farm size and the relationship is even stronger for organic farms with higher incomes.

## **Results**

We developed an indicator of the farmer's sales to local markets and examine how this variable influences both farm performance and farm-level employment outcomes. The local selling indicator measures the number of commodity categories in which the producer sold all products within 500 miles of the farm. The variable is based on sales information for organic products across four broad commodity groups as recorded in

the OFRF survey. The four commodity groups are (1) vegetables, including herbs, floriculture, mushrooms, and honey, (2) fruit, nut and tree products, (3) grains and field crop products, and (4) livestock products. The survey was designed so that producers were first queried about the marketing outlets they used to sell organic products, with sales across three broad categories identified to assist producers in organizing this information. The marketing outlets were direct-to-consumer outlets, direct-to-retail sales, and wholesale markets.

The local selling indicator measures the number of commodity categories in which the producer sold all products within 500 miles of the farm. Consider a producer who sold all of the vegetable products within 500 miles of the farm while some portion of other organic products were sold to more distant buyers. The local selling indicator has a value of one for this producer. Over 68% of producers sold their entire production of at least one commodity category within 500 miles of their farm. For convenience we refer to these farmers as locally committed organic farmers. Sales in local markets are emphasized by both male and female farmers as 66% of males and 72% of females have a positive local selling indicator.

Estimates from the production function are evaluated according to their impact on farm incomes for the organic farmers. An important result from estimation of the production function shows that producers who focus on local sales achieve farm incomes which are 15% lower than other producers. Empirically we find that a commitment to local sales leads to lower farm incomes, an impact which has not been mentioned in discussions about supply chains for organic products. The advantages of short supply chains characterized by close proximity between producers and consumers are frequently highlighted but the effect on organic farm incomes has not been quantified. Lockie et al. comment that "direct sales strategies do not abandon the promises of convenience, product diversity, and value-for-money on which mainstream retailers trade – they simply align them more overtly with values such as community building and the reduction of food miles (p. 186)."

## **Discussion**

Corporate or non-family partnerships who sell locally apparently are taking advantage of better marketing strategies in their operations. The incomes of these organic farms are 44% higher than other farms. One clear performance indicator that distinguishes the corporations or non-family partnerships is that they are better able to manage labor as the majority of these farms indicate no problems in hiring employees for production or marketing in their OFRF survey responses. In addition, these operations use a wider variety of marketing programs targeted to local sales outlets including farm events and demonstrations, local advertising and promotional efforts, product samples, in-store demonstrations and the use of organic certification labels and seals. Cooperative extension marketing specialists and growers association could examine these operations to learn what strategies they employ.

The model is useful in assessing farm-level employment effects associated with sales to local markets. Organic producers who specialize in local sales operate smaller farms compared with national sales producers. The model indicates that smaller farm sizes imply that the marginal value of seasonal labor decreases and hires of these workers decline. Organic farms with a local sales emphasis employ fewer total workers and hires of both year round and seasonal workers are smaller compared with other farm operators. The use of seasonal workers is about 50% lower while the demand for year-round workers is 40% smaller when farms engage in local sales.

Employment of both year-round and seasonal workers would decline with increased emphasis on local sales due to smaller farm sizes. Policies or incentives that promote a shift to local sales by organic farmers would lead to decreased use of seasonal workers and higher wages for these workers according to the estimated production function. An important finding is that increased reliance on seasonal employees reduces wages for these workers relative to the earnings of the year-round workforce.

### **Conclusions**

Decisions to hire and train year-round vs. seasonal workers are a key management decision for organic farmers and information about how this hiring decision is related to organic farm performance is rarely available. The estimated production function confirms that farm size (organic acreage) and both types of farm workers are complementary inputs. Incentives that encourage farmers to expand employment of year-round and seasonal workers will raise the marginal product, and therefore the rate of return to organic acreage. Proponents of organic marketing associations will be able to use the results to demonstrate farm-level employment effects associated with sales to local markets by organic farmers.

Organic farmers who specialize in local sales operate smaller farms compared with producers who sell across a diversified set of local, national, and export markets. A commitment to local sales leads to lower farm incomes, a side effect which has not been mentioned in discussions about supply chains for organic products. Employment of both year-round and seasonal workers would decline with increased emphasis on local sales due to smaller farm sizes. Policies or incentives that promote a shift to local sales by organic farmers would lead to decreased use of seasonal workers and higher wages for these workers according to these results.

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# Factors explaining farmers' behaviours and intentions about agricultural methods of production. Organic vs. conventional comparison.

Canavari, M.<sup>1</sup>, Lombardi, P.<sup>2</sup>, & Cantore, N.<sup>3</sup>

Key words: Organic farming, ethnocentrism, local origin, conversion

## Abstract

*We investigate the factors explaining behaviours and attitudes of farmers towards organic practices. Among a wide set of motivational, economic and environmental variables, we focus on those factors related to ethnocentrism of farmers and the importance of local origin labels. We find that ethnocentrism cannot explain neither the present status of farmers (organic vs. conventional) nor their future intentions about the adoption of agricultural methods of production. However, the absence of local origin labels is significantly affecting the choice of conventional farmers who do not convert to organic farming.*

## Introduction

Organic farming is receiving growing attention from policy makers and scientists over time. The reason would lie on the fact that it provides a beneficial environmental impact in terms of biodiversity and greenhouse emissions and on the healthiness of products obtained by natural methods of production. An abundant scientific literature focussing on different stages of the organic supply chain underlines the high social value of organic farming. Production, distribution and consumption issues are strongly analysed by scholars aimed at investigating the reasons and the driving forces behind the diffusion of organic food. In particular, this paper adds to the strand of literature focussing on the production side. Previous literature about production of organic food raised two main research questions that can be summarised as follows:

- Are organic farms efficient and profitable?
- What are the motivations behind the conversion from conventional to organic farming?

As the first research question previous studies confirm that though input costs for organic farms are much higher (Padel and Lampkin, 1994), organic farms are generally more profitable because of the higher premium prices and the policy subsidies (Lien *et al.* 2006, Kerselaers 2007). However, the market share for organic products is small and the organic market is still a "niche market".

Acs *et al.* (2007) by an inter-temporal optimisation problem stress that the conversion period in which farmers sell at stable prices is the main problem for organic farmers. An interesting scientific literature finds that other than economic reasons, technical, ideological and social reasons can explain farmers' choices about the adoption of

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organic production practices (Stock 2007). Our paper stems from this strand of literature. In particular, we will investigate the impact on organic farmers' behaviours and intentions deriving from crucial factors such as economic, technical, individual, environmental and social ones.

Previous scientific literature points out that organic farming represents an opportunity to valorise the local development of rural areas. The original contribution of our work will be the investigation of the ethnocentrism and products local origins labels as key variables affecting farmers' behaviours and future intentions about the conversion towards organic agricultural practices. We focus on these two variables because they represent two different but complementary concepts. Ethnocentrism is the subjective attitude towards the local origin issue, whereas the presence of local origin labels represents the external condition for farmers concerning the valorisation of local products (Shimp & Sharma, 1987). Moreover, another novelty of our paper is that differing from previous studies assuming a relationship between ethnocentrism and consumers' behaviour we test the same hypothesis for farmers' choices about the production practices. In the next paragraph, we will explain the methodology, in the section 3 the results, and finally we will draw our conclusions.

### **Methodology**

We drive a survey of 332 farmers in the Emilia-Romagna Region (organic, conventional and mixed producers) out of a sample of 874 initial selected individuals by a non-probabilistic sample (phone interviews, fax and e-mails). We outlined the survey instrument based on a literature review and qualitative analysis (focus group).

We run three logistic regressions. In the first regression, the dependant variable is a binary variable expressing the status of farmers (organic or non-organic agricultural production practices). In the second logistic regression, the dependant variable is a binary variable expressing the intention of farmers who adopt conventional and mixed (organic and conventional) methods of production or who adopted in the past organic methods of production to convert to organic farming. In the third logistic regression, the dependant variable is a binary variable expressing the intention of organic and mixed farmers to convert to conventional practices.

For each of the three logistic regressions we use the same set of independent variables. They can be summarised as variables concerning the social status, the characteristics of the organic farm, the motivational factors (economic, ideological, fashion and innovation attitude of farmers) the business constraints, the ethnocentrism and another group of heterogeneous variables which cannot easily be included in a specific group such as the social pressure variables.

Our set of variables is very wide (about 70), therefore we use a principal components analysis to reduce the dimensionality of the motivational and the business constraints factors. We then use a stepwise forward procedure based on the Likelihood Ratio in order to select only the variables which are significant or which provide significance to the regression estimation. In the next section, we present the results.

### **Results and discussion**

From our results, we can underline some interesting findings. To summarize we cite only the ones that seem to us more important. In the first regression (Table1) we underline that the probability to adopt organic practices is affected by ideological

motivations such as the environmental protection, animal welfare and health care. Conversely, the adoption of organic practices is more limited when farmers show the perception to believe that organic farming introduction follows a fashion trend. Internal financial and technical farm resources and difficulties in creating associations and consortia among farmers are other factors, which represent an obstacle to the adoption of organic practices.

**Tab. 1: Factors affecting the intention to convert to Organic Farming**

Variables	B	S.E.	Wald	Df	Sig.	Exp(B)
Suitability of the territory towards organic practices			9,966	4	0,041**	
1= I disagree	-2,561	0,887	8,346	1	0,004***	0,077
2= I partially disagree	-0,332	0,547	0,370	1	0,543	0,717
3= Neither agree nor disagree;	-1,044	0,681	2,352	1	0,125	0,352
4= I partially agree	-0,096	0,532	0,032	1	0,857	0,909
Favourable opinions of relatives and friends on OF			11,477	4	0,022**	
1= I disagree	-1,123	0,921	1,488	1	0,223	0,325
2= I partially disagree	-1,074	0,690	2,425	1	0,119	0,342
3= Neither agree nor disagree;	-0,922	0,651	2,006	1	0,157	0,398
4= I partially agree	0,698	0,509	1,882	1	0,170	2,009
Farm size (hectares)	-0,004	0,002	2,900	1	0,089*	0,996
Personal satisfaction			11,574	3	0,009***	
1= very satisfied	-1,370	1,048	1,709	1	0,191	0,254
2= satisfied	0,013	1,001	0,000	1	0,989	1,014
3= not satisfied	-1,365	1,142	1,429	1	0,232	0,255
Farm typology			5,248	2	0,073*	
2= Mixed (conventional and organic)	1,599	0,739	4,685	1	0,030**	4,950
3= Conventional	0,842	0,697	1,460	1	0,227	2,321
OA is only a fashion	-0,354	0,200	3,134	1	0,077*	0,702
Motivations linked to farm's characteristics	0,414	0,218	3,619	1	0,057*	1,513
Problems related to the certification system	-0,498	0,203	6,014	1	0,014**	0,607

Logistic regression. Dependant variable: Intention to convert to organic farming (1) vs. no intention (0). The sub-sample is composed by conventional, mixed and formerly organic farmers. \*\*\*p-value  $\leq$  0,01; \*\*p-value  $\leq$  0,05; \*p-value  $\leq$  0,10.

In the second regression (we omit the data for the sake of brevity), we focus specifically on conventional farmers, farmers who adopt a mixed strategy (organic and non-organic), or who used organic practices in the past. In this sub-sample, the management skills of farmers and in particular their attitude towards innovation influence adoption or rejection of organic methods and they are limited by the bureaucratic procedures concerning the certification system. Social pressures (opinion leaders and family opinions) could also play a role in inducing the conversion towards organic practices.

In the third regression, we find that low education methods are relevant in explaining future farmers' behaviours of organic farmers intended to leave organic practices and to adopt conventional practices. Finally, if we focus on the variables expressing local origins we find a set of interesting results. The variable representing ethnocentrism is not significant in all the three regressions. The variables representing the necessity to create a local origin label for organic products and a generic appropriateness of origin territory to organise organic methods of production are significant in the first and in the second regression.

## Conclusions

In our paper we investigate by discrete choice models the role of a wide set of factors on the behaviours and intentions of farmers towards agricultural methods of production. We find that a set of variables referring to the social and economic condition, which the past literature identified as relevant, are significant in our study. However, the specific contribution of our paper is that we investigate the role of local origin issues as driving force for the adoption of agricultural practices. In particular, we investigate the impact of ethnocentrism and origin labels. We find that ethnocentrism is not relevant in explaining organic farming adoption, but one of the reason for which farmers do not convert to organic farming is that they feel that laws and appropriate labels do not protect the local origin of organic products. We deem this is an important policy implication. The local origin issue is not important to stimulate organic farming if we consider subjective and personal beliefs, but is important in terms of rules and at institutional level. The interesting policy insight is that policy makers should produce the appropriate laws in order to valorise local origin of food. Strategies aimed at implementing opportune origin labels together with organic labels could represent the right policy tool.

## Acknowledgements

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## An integrated approach project for the revaluation of a traditional sourdough bread production chain

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Key words: wheat, sourdough bread, organic farming, old and new varieties, sensory evaluation.

### Abstract

*The influence of organic and conventional farming systems on the performance of a panel of old and modern Italian bread wheat varieties has been evaluated, with the aim to individuate an agronomic protocol suitable for the production of a sourdough bread traditionally prepared in a hill zone of Emilia-Romagna. The agronomic and technological characterisation of the wheat samples obtained in organic and conventional farming conditions has been done and the sensorial qualities of the sourdough bread obtained have been evaluated.*

### Introduction

Several types of traditional Italian bread, that have in common a long-time, sourdough fermentation step, are now re-discovered due to their peculiar nutritional and qualitative traits in comparison with bakery products obtained with breadmaking protocols based on the use of selected yeast and shorter fermentation step. Sourdough fermentation has in fact several documented effects on aroma improvement, delayed firmness and staling, increasing mineral bioavailability and vitamin content and lowering the glyceemic response. Moreover, it is well known that a wide spectrum of variability for breadmaking properties exists not only at cereal species level, but even at variety level. The influence of cultivars on technological properties, sensory profile and staling rate has been investigated for durum wheat, einkorn, bread wheat. The bread production is also influenced by growth location, by type of soil and climate and by year of harvest. Moreover, quality for a foodstuff is defined by Peri (2006) as "fitness for consumption", a complex system of both material and immaterial products requirements that collects safety, nutritional, sensory, guarantee and ethical requirements.

Starting from these remarks, in our project a panel of old and modern Italian bread wheat varieties have been evaluated, through a multi-disciplinary approach, for the production of a sourdough bread traditionally prepared in a hill zone of Emilia-Romagna. The aim of the project has therefore been directed to the revaluation of a low-input cereal production system for this zone, in which several organic farms are active.

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## Materials and methods

Starting from previous evaluation work on agronomic, technological and sensorial characteristics of a panel of old and modern bread wheat varieties, the three old varieties Autonomia B, Risciola and Terminillo, together with the modern variety Soissons, has been selected for further studies directed to the individuation of a fertilization protocol suitable for the hill zone of Pellegrino Parmense (Emilia-Romagna, Italy). The bread wheat varieties were sown in a two-years trial, in organic and conventional farms. Two different levels of nitrogen fertilization and a not-fertilized control have been compared (Table 1). Agronomic traits and resistance to biotic and abiotic stress were evaluated for all the samples. The deoxynivalenol content of all bread wheat samples was determined by a commercially available enzyme immunoassay (RIDASCREEN™ FAST DON, R-Biopharm GmbH, Germany). The technological properties of all the samples were evaluated determining protein content and alveographic indices. The sensory evaluation of the sourdough bread prepared from the different samples was done by two independent groups of assessors. The sensory variables taken into account are referred to visual characteristics (outside and inside colours, rusticity, size, crust), aroma, taste, flavour and texture (both of bread and crumbs) attributes.

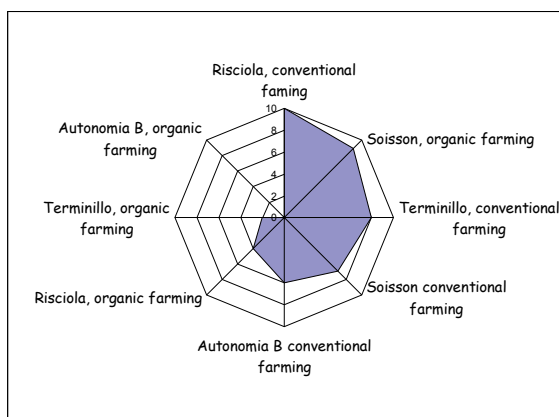
**Tab. 1: Agronomic and qualitative characteristics of the four varieties evaluated in a two years trial.**

	ORGANIC FARM					CONVENTIONAL FARM					
	2006			2007		2006			2007		
	Preceding crop										
	o/f/o o/f/o			o/f/o o/f/o		soy/hum			o/f/o o/f/o		
	Barlands (CPN 45 Kg/ha of N)			Barlands (CPN 41 Kg/ha of N)		Ammonium nitrate (CPN 147 Kg/ha of N)			Ammonium nitrate (CPN 90 Kg/ha of N)		
DRESSING	Production (12% of m.)	W per hectolitre	Fusarium head blight	Production (12% of m.)	W per hectolitre	Production (12% of m.)	W per hectolitre	Powdery mildew	Leaf rust	Production (12% of m.)	W per hectolitre
	t/ha	kg/hl	heads/m <sup>2</sup>	t/ha	kg/hl	t/ha	kg/hl	(0-8)	(0-8)	t/ha	kg/hl
Tot	3.98	79.75	0.65	3.43	74.63	3.46 C	80.37	0.00	0.00	3.35	73.83
DPI	3.83	79.47	0.43	2.83	74.06	4.75 A	79.15	0.29	0.21	3.50	73.36
SOLODI	4.48	80.65	0.67	2.55	75.44	4.24 B	79.85	0.08	0.13	3.37	73.62
Significance	n.s.	n.s.	n.s.	n.s.	n.s.	***	n.s.			n.s.	n.s.
CULTIVAR											
Soissons	4.29 B	77.24 C	0.64 A	3.13 A	73.95	4.45 A	80.14 A	0.00	0.11	4.84 A	73.55
Autonomia B	4.11 B	81.72 A	0.42 B	2.36 C	76.78	3.80 B	80.89 A	0.11	0.17		
Risciola	3.26 C	81.40 A	0.57 A	2.30 C	74.03	3.23 C	79.99 A	0.28	0.17	2.41 C	73.53
Terminillo	4.74 A	79.47 B	0.72 A	2.72 B	74.49	3.80 B	77.85 B	0.11	0.00	2.87 B	73.43
Significance	***	**	*	**	n.s.	***	***	***	***	***	n.s.
CULTIVAR x DRESSING											
Significance	n.s.	n.s.	n.s.	***	n.s.	***	n.s.			n.s.	n.s.
Means	4.10	79.95	0.59	2.60	74.71	3.82	79.74			3.37	73.50
CV%	10.06	2.18	39.31	7.49	4.07	7.98	1.92			11.86	2.13

## Results

In table 1 are reported some of the agronomic and qualitative data obtained when the four wheat varieties are grown in different environments with three different level of fertilization during a two years trial. The two years of trial were very different from a meteorological point of view. In fact, during 2006 the autumn was very rainy, during the winter there was snow coverage and during the spring low temperatures were registered. On the contrary, in 2007 the temperatures never fall below 0°C and the rains were limited.

The presence of Fusarium Head Blight and of mycotoxins like deoxynivalenol (DON), that are of great relevance from a safety point of view were investigated in all bread wheat samples. None of the genotypes was found to be heavily affected by Fusarium nor contaminated with DON. Only very few samples have shown symptoms of infection from powdery mildew and leaf rust (Table 1). The yield productions were different, depending from the year, from the treatments and from the genotypes (see Table 1). As expected, the modern variety Soissons gave the best yield results, followed by Terminillo. The weight per hectolitre was very high in 2006 for all the varieties, whereas in 2007 it was probably affected by the climate. In Figure 1 are reported the results obtained after sensory evaluation of sourdough breads prepared from a set of monovarietal flours derived from Autonomia B, Terminillo, Soisson and Risciola varieties grown in organic and conventional farming. For this experiment, it was taken into consideration the varieties grown in 2006 both in conventional (fertilization with ammonium nitrate, 167 Kg/he of N) and organic (fertilization with borlande, 46 Kg/he of N) farming. The bread samples were evaluated for the ten characteristics reported in Materials and Methods, giving to the samples one point for each trait exceeding the mean of all samples.



**Figure 1: Scores obtained by the sourdough bread samples prepared from flours of the four wheat varieties grown under organic and conventional farming.**

### Discussion and conclusions

In our project, a multidisciplinary approach has been applied with the aim to reevaluate a traditional sourdough bread preparation chain. Moreover, because organic farming system in comparison with conventional one has been found to have significant effect on sensory quality of yeast fermented bread (Kihlberg et al. 2004; Kihlberg et al. 2006; Annett et al., 2007), we have evaluated the farming effect and the different level of fertilization on agronomic and technological characteristics of old and modern bread wheat varieties. We have found significant effects of year, of genotype, of the preceding crop and of farming system on agronomic performance of the wheat varieties and on their technological traits. Preliminary results obtained after sensory evaluation of monovarietal sourdough breads prepared from wheat samples grown

under organic and farming conditions, indicate the old variety Risciola and the modern one Soisson as the most appreciated. As final results, this project, taking into account several genetic, farming and technological aspects, can help in delineating a sustainable production chain for a traditional Italian food.

### **Acknowledgments**

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# The impact of mycorrhizal symbiosis on tomato fruit quality

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Key words: Tomato, AM fungi, Mycorrhizas, fruit productivity, real-time RT-PCR

## Abstract

*The project investigates the potential impact of mycorrhizal fungi, which have been acknowledged as a new class of bio-fertilizers, on the quality of vegetables. To verify such a hypothesis, we selected tomato (*Solanum lycopersicum*) as a model plant to examine whether the beneficial effects of mycorrhizal fungi on plant development may be extended to some qualitative fruit features. As a second step, five genes related to carotenoid biosynthesis and volatile compounds were selected. Their expression was investigated through a real-time RT-PCR comparison of mycorrhized and non-mycorrhized plants.*

## Introduction

Arbuscular mycorrhizal fungi (AMF) represent a key-component of the rhizosphere, since they form a mutualistic association with the roots of 90% of land plants. They are known to carry out many ecosystem functions such as improvement of plant establishment and growth, enhancement of nutrient uptake and plant protection against biotic and abiotic stresses (Smith & Read, 1997). For these reasons, they are considered to play a fundamental role in natural as well as agricultural ecosystems together with other soil microorganisms, opening new employment perspectives in the frame of a low-input agriculture.

In order to check the hypothesis that in addition to an improved mineral nutrition AM fungi also benefit their host plants by influencing fruit traits, we selected tomato (*Solanum lycopersicum*) as a model. We first evaluated plant growth parameters and mineral content in order to verify whether tomato responds to AM fungi by stimulating its vegetative growth, phosphate and nitrogen accumulation and fruit productivity. Then the potential impact of AM fungi on fruit quality was assessed by considering carotenoid biosynthesis, a process which is strictly regulated during fruit development and ripening. As a second qualitative trait, the complex mixture of volatile and non volatile compounds that contribute to the overall aroma and taste of the fruit was considered. Real-time RT-PCR analysis was used to compare the expression of five genes related to carotenoids biosynthesis and volatile compounds in tomato fruit investigating mycorrhized versus non-mycorrhized plants.

## Materials and methods

Germinating seedlings of *S. lycopersicum* cv. Pearson were inoculated with the AM fungus *Glomus mosseae* BEG12 purchased from Biorize (Dijon, France). The growth experiment consisted of 14 pots filled with sterilized quartz sand mixed with the *G. mosseae* inoculum (30% w/w) for the myc condition plants (seven pots). The plants

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were placed in a growth chamber and fertilized once a week with a modified Long-Ashton nutrient solution. After 90 days the roots were sampled and the growth parameters were evaluated as well as the P and N content. The shoots were frozen and ground to a fine powder which was sent to Floramo (Rocca de' Baldi CN) for the chemical analysis. The N content was expressed in concentration %P/P while the P content was expressed as mg of P for each Kg of biomass. In a second experiment, 20 *S. lycopersicum* cv Micro-Tom plants were brought to fruit production.

For the expression analysis, samples of fruit pericarps from myc and non myc tomato plants were ground to a fine powder in liquid N. Total RNA extraction was performed with a modified C-tab method.

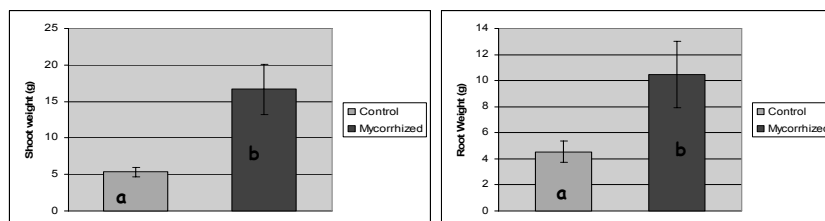
For conventional and real-time RT-PCR, the selected genes were targeted with primers newly designed, except for primers LeF1/LeR2 (Botella-Pavia *et al.*, 2004). The following genes were selected for expression analysis: deoxyxylulose 5-phosphate synthase gene (DXS), hydroxymethylbutenyl diphosphate reductase gene (HDR), phytoene synthase gene (PSY1), the carotenoid cleavage dioxygenase gene LeCDD1B and the lyxoxigenase gene loxC.

First single-strand cDNA was obtained with the SuperscriptII reverse transcriptase kit (Invitrogen). Real-time RT-PCR reactions were performed with specific oligonucleotide primers (0.3  $\mu$ M each), according to the conditions described by Siciliano *et al.* (2007).

## Results

### Impact of AM fungi on plant development

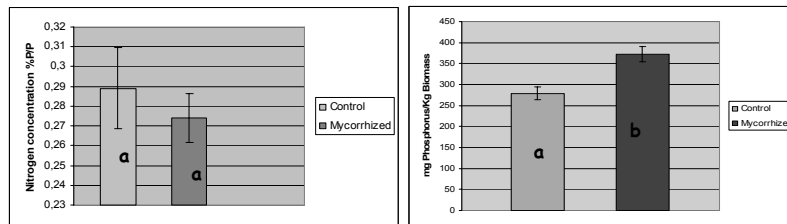
To verify the impact of the AM fungus on growth performance, mycorrhized and control plants were harvested and the fresh weight of shoot and root was evaluated. Mycorrhized plants displayed higher shoots and a wider root apparatus (Fig 1).



**Figure 1: Shoot and root weight evaluation. Different letters indicate significantly different values according to the Krukall–Wallis test of variance ( $P < 0.05$ ).**

To evaluate whether the increase in biomass was also coupled to a higher accumulation of mineral elements, the P and N content was evaluated. These elements are crucial for AM symbiosis, which is characterized by a nutrient exchange between the symbiotic partners.

No significant differences were found in N content, while a significant variation was detected when P was evaluated: the mycorrhized plants had the highest amount of P in their tissues.



**Figure 2: Nitrogen and Phosphorus content. Different letters indicate significantly different values according to the Kruskal–Wallis test of variance ( $P < 0.05$ ).**

#### Productivity of tomato plants

The first fruit was obtained for the myc condition 76 days after the sowing, while in the control condition, the first fruit was obtained 10 days later. The fruit was harvested from all the 10 inoculated plants, with an average productivity of 5.5 pieces of fruit per plant, while 9 out of 10 non mycorrhizal plants were productive, with an average of 2.2 fruit per plant. The inoculated plants produced fruit for a longer period (80 days of productivity, compared to 35 days for the control plants). Six months after seeding, 10 myc plants and 2 control plants were still viable.

#### Real-time RT-PCR assays

Real-time RT-PCR experiments were performed using cDNA from three independent biological replicates for each condition. The five genes were targeted in individual real-time assays. In all the cases a good amplification signal was detected, with threshold cycles (Cts) ranging from 16 to 21. The PCR efficiencies were comparable, and ranged from 98.1% to 105.6%. The Cts values obtained for the investigated genes were normalized by comparing them with the Cts obtained for the calibration genes (actin1 and 18S rDNA), according to the 'comparative threshold cycle' method. In all cases no significant differential expression was detected between the inoculated and control condition, with a maximal standard deviation of 0,3 on the mean values.

#### Discussion and perspectives

Here, we have shown that *G. mosseae* positively affects the growth development of tomato plants, the P content and fruit production. Inoculated tomato plants produced more fruit and their productive period was remarkably longer. This new finding can be explained thanks to the improved mineral nutrition, which is shown by the higher P content. However, a direct effect of mycorrhizal status on fruit development cannot be ruled out.

A number of plant carotenoids and derived compounds have an important nutritional value according to their activity as pro-vitamin A and their ability to act as antioxidants that help to prevent some types of human cancer and degenerative diseases (Fraser and Bramley, 2004). We monitored the expression in tomato fruit of two key genes of the MEP pathway, DXS and HDR, whose activity has been shown to be limiting for carotenoid biosynthesis during tomato fruit ripening (Lois *et al.*, 2000; Botella-Pavia *et al.*, 2004). At the same time, we analyzed the expression of the phytoene synthase gene (PSY1), which represents the first committed step of carotenoid biosynthesis in the strict sense (Fraser and Bramley, 2004). A significant accumulation of the PSY1

transcript was observed in ripening fruit, reaching the highest level at the orange stage (Lois *et al.*, 2000). Given that fruit aroma and taste is considered an important feature for good tomato quality (Baldwin *et al.*, 2000), we targeted two genes involved in tomato aroma composition: the first one (loxC) is involved in the generation of fatty acid-derived C6 compounds (Chen *et al.*, 2004), while the second is involved in the formation of volatile terpenoids from carotenoids (Simkin *et al.*, 2004).

We harvested the tomato fruit as the colour turned from yellow to orange, according to Gillaspay and colleagues (1993), who reported that carotenoid accumulation is concomitant with the first visible colour change in fruit. Under our experimental conditions, all the target genes were well expressed in the considered developmental stage, confirming published data. However, the five genes considered did not reveal a differential expression between the mycorrhized and control conditions. Two reasons can be given to explain the result: the selected genes do not represent a target of the mycorrhizal impact, or such an effect is not evident at the analyzed developmental stage. Alternatively, mycorrhizal symbiosis does not influence the metabolic pathways here considered.

### Acknowledgments

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## **New approaches in consumer research**

# Information Acquisition Behaviour of Fair-Trade Coffee Consumers – a Survey by Means of an Information Display Matrix

Aschemann, J.<sup>1</sup> & Hamm, U.<sup>1</sup>

Key words: Market research, marketing, information acquisition behaviour

## Abstract

*Fair-trade has grown into a noteworthy market segment. As a result, an increasing number of market players have emerged, each trying to communicate their own focal point in criteria and standards. However, the relative relevance of different criteria for the consumer remains unclear. This study explores the assessment of criteria in the choice of the most important fair-trade product, coffee, by tracing the information acquisition behaviour using an Information Display Matrix method. Special focus is given to organic production. Results serve as recommendations for those involved in the development of the organic fair-trade market.*

## Introduction

Embedded in a broader trend of demands for additional characteristics of products, there is a trend toward so-called 'ethical consumerism' (Carrigan et al. 2004, p. 401ff.). 'Fair' (see EFTA 2006 for a definition) and 'organic' principles of production are increasingly used jointly on this account, as reflected by the fact, for example, that 64% of the products labelled 'Transfair', the leading seal for fair-trade products in Germany, already also bear the organic seal (TransFair e.V./Rugmark 2006, p. 7). A deeper understanding of the fair-trade market and its consumers is therefore of importance for organic market players. Since the beginning of the fair-trade movement, many fair-trade initiatives have been established, and in their wake a high number of criteria and standards have been formulated concerning the production of goods. Each market player has a different focal point and chooses a different way of communicating and phrasing the product-related information. Thus, the search for information and the purchasing decision are complicated for the consumer (Lübke and Abel, 2005, p. 562f.). The relative relevance of different criteria in the eyes of the consumer, and the phrasing they prefer, have not yet been sufficiently examined. This study aims at resolving these questions with regard to fair-trade coffee by means of the Information Display Matrix method (IDM).

## Materials and methods

The IDM is a tool for research in consumer information and decision-making behaviour that is used to identify the cognitive processes underlying search, judgement, and choice. The method enables the detailed analysis of the kind, sequence, and amount of information sought, as well as the duration and structure of the information acquisition phase. Relevant product-related criteria and their relative importance for the purchase decision can be identified. This is done based on the scientifically

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substantiated assumption that earlier and more frequently acquired information is more important for the choice than information acquired at a later stage and less frequently (Mühlbacher and Kirchler 2003, p. 147ff.). The IDM method came into use in the 1980s but since then its value and opportunities have been greatly enhanced by personal computers (Jacoby et al. 1987). Previous studies of fair-trade consumers mostly used standardised questionnaires with choice proportions and ratings or Conjoint Analysis (Ottowitz 1997; De Pelsmacker et al. 2005). The advantage of an IDM is that the test subjects do not immediately realise the objective of the survey and that they interact just with the computer. In this sense the answers are less biased by social desirability or an interviewer effect.

In an IDM, the information is presented in the form of a matrix with the product attributes given on the vertical axes and the alternative product stimuli on the horizontal axis. The varying attributes corresponding to the respective product stimuli are hidden in blank fields. If the person clicks on a field, the information appears in a pop-up. Only one field at a time can be opened. As the test person explores the matrix, s/he obtains the information needed for her/his purchase decision in order to decide on one of the alternative product stimuli. The computer programme records every step of the information acquisition phase and the choice itself. This is linked with the data gathered by a subsequent questionnaire and stored under a randomly assigned number for each individual.

For our study, 150 consumers were interviewed in two German cities. The sample consisted of 90 supermarket customers and 60 customers of so-called 'one-world' shops, interviewed at the point of sale. The alternative product stimuli were standardised in package size and type and continent of origin. All 500 g packages of Latin-American coffee were fair-traded. The stimuli varied in six attributes, which are: 'product price', 'production system' (conventional/organic), 'environmental standards' in the coffee production, 'price premium' as a benefit to the coffee producers (the 'fair component of price'), 'origin' of the product (with regard to geographical region or kind of producer organisation), and 'child protection' in the coffee production stage. The order of the alternative product stimuli and attributes was randomised to avoid sequence effects. In addition to the computerised IDM, the test subjects took part in a short face-to-face interview. The interview helps in understanding the results of the information acquisition behaviour and choice against each individual's background.

## Results

Three measures were used to explain the information acquisition behaviour of consumers and their product choice. In the following, main results of the survey are presented. The number of \* indicates the level significance ( $p \leq 0.1$ ; \* =  $p \leq 0.05$ ; \*\* =  $p \leq 0.01$ ; \*\*\* =  $p \leq 0.001$ ).

The 'importance' of an attribute is operationalised through three indicating variables: 1) first accession incident being a field showing details about this attribute; 2) total number of accession incidents per attribute; and 3) number of repeated accession incidents per attribute. All three variables indicate that persons in the total sample expressed a significantly different importance for the attributes (Cochran Q 22.4\*\*\*,  $\chi^2$  121.9\*\*\* and  $\chi^2$  50.1\*\*\*, respectively). The ranking in relative importance of the attributes differs slightly, but the comparison in table 1 shows that the attributes 'production system' and 'price premium' are most important, 'child protection' and 'product price' less so, and 'environmental standards' and 'origin' least important for both the supermarket consumers and those in the one-world shop.

**Tab. 1: Importance of attributes for consumers in supermarkets versus one-world-shops expressed through three indicators**

Attribute	Supermarket			One-world shop		
	First accession (%)	Mean accession		First accession (%)	Mean accession	
		total	repeated		total	repeated
Production system	25.5%	5.2	1.8	33.3%	6.0	2.6
Price premium	16.7%	5.2	2.2	25.0%	6.4	3.7
Child protection	20.0%	4.2	1.4	10.0%	4.9	2.3
Product price	18.9%	4.6	1.7	6.7%	5.0	2.2
Environmental standards	10.0%	3	0.7	5.0%	4.3	1.8
Origin	8.9%	2.8	0.8	20.0%	3.8	1.5
All attributes	100%	24.9	8.7	100%	30.3	14.0

Analysing the differences in importance between the two groups in table 1, as revealed by the indicator first accession, 'origin' is more important for one-world-shop consumers ( $\chi^2$  3.8\*). The attributes 'child protection' and 'product price' are more important for supermarket consumers ( $\chi^2$  2.7<sup>p</sup> and 4.5\* respectively). Additionally, the total sample was split into the groups of buyers and non-buyers of an organic stimulus. Unsurprisingly, 'production system' was significantly more often accessed as a first attribute by those who chose organic ( $\chi^2$  6.4\*). Persons choosing conventional products accessed 'product price' significantly more often as a first attribute ( $\chi^2$  8.0\*).

The 'preference' for an attribute is operationalised by share of choice decisions for a product with this criterion specification contrasted with the expected probability share. As 80% of the participants chose an organic product out of the six product stimuli, it is not surprising that the preference for organic products is highly significant ( $\chi^2$  54\*\*\*). Organic products were preferred, even though the organic products had a higher price. Meanwhile, a preference for a more precise or tangible phrasing, as had been hypothesised, is not significant for any of the remaining attributes. The precise or tangible phrasing used for the attribute 'environmental standards' was, for example, 'shade-grown coffee cultivated in mixed cropping in order to preserve biological diversity', while the inexact phrasing was 'cultivation following fixed environmental standards'.

'Extensiveness' is measured by 1) duration of the information acquisition phase in minutes; 2) absolute number of accession incidents in total; and 3) percentage of the so-called submatrix (i.e. number of attributes accessed at least once, multiplied by the number of product stimuli accessed at least once) with regard to the matrix. Customers of one-world shops tended to conduct a more extensive information search, as they spent more time than customers of supermarkets (Mann-Whitney-U 2191\*). The two groups, however, showed no significant differences with regard to the other two indicators. Results with regard to the average of all three measures are as follows: 3) 2.58 (2.95) minutes, 2) 24.9 (30.3) and 3) 84% (87%) for supermarkets (one-world shops). Slight differences in the time spent acquiring information may be

due to the fact that the duration is longer when the one-world-shop customer is female and that the one-world-shop customers were mainly women. Apart from that, the two groups did not differ with regard to the remaining sociodemographic characteristics (age, presence of children in the household, household size, and income).

In order to contrast the two methodological approaches, the ranking of relative importance as derived from the IDM (mean total number of accession) was compared to the order of importance as derived from the questionnaire (mean rank given). It is noteworthy that while all other attributes remain in the same order, the position of 'product price' is third in importance in the computerised IDM but only fifth in the face-to-face interview. Thus, the rating of the attribute 'price' in the interview was most likely distorted by answers expressing social desirability.

## Discussion and Conclusion

The IDM has proven to be an adequate method for measuring the information acquisition behaviour of consumers for goods that are not self-explanatory, such as fair-trade products. Compared with simple face-to-face interviews, the results of the IDM seem to be more realistic, especially with regard to the price. The study has also shown that the combination of the attributes 'organic' and 'fair' is greatly preferred by fair-trade consumers, therefore backing the recent trend. Only a smaller segment of consumers seems to remain who favour fair-trade without the additional organic benefit. The findings indicate that consumers in one-world shops differ from supermarket consumers in their information acquisition behaviour, therefore suggesting the usefulness of a separate communication strategy. Unlike what was expected, a more precise and tangible phrasing of attributes was not preferred, although the criticism that the phrasings on fair-trade products are too complicated is often discussed. Further research should investigate the reasons for these findings.

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# Evaluating trust in organic quality marks: a network approach using laddering data

Gambelli, D.<sup>1</sup> & Naspetti, S.<sup>2</sup>

Key words: trust-building, laddering, network analysis, consumer behaviour

## Abstract

*A low level of information affects trust in organic quality in Italy. Since organic brands and labels credibility, depends on trust relationships that consumers perceive, it is crucial to understand which kind of relations are more relevant and which of them could have a positive or negative effect in the long-term. The purpose of this study is to examine trust relationship related to buying organic products, to better understand the consumer decision-making process and trust-builders inside the organic channel, using an innovative network approach based on laddering analysis.*

## Introduction

Marks as forms of quality signals to consumers – previously analysed using Means-end chain theory and laddering data (Naspetti and Zanolì, 2005), are investigated using a Means End Chain (MEC) approach. The study examines over 2124 sentences, structured into 56 codes, or variables, and attempts to determine how trust is built and how it affects other relationship outcomes (Zanolì et al., 2004). The relationships among consumers concepts are analysed using a social network approach (SNA) (Wassermann and Faust, 1994, and Bagozzi et al., 1996, for a SNA application to MEC), aiming to individuate sets of closely related concepts and to assess their relative importance in the consumers' trust cognitive process. Switching from a qualitative study to a quantitative one improved the comprehension of means-end relations and shed a light on the antecedents and/or consequences of trust in organic quality signs.

## Materials and methods

The objective of MEC theory is to understand what makes products personally relevant to consumers by modelling the perceived relationships between a product (defined as a bundle of attributes) and the consumer herself (regarded as holder of values). Naspetti and Zanolì, (2005) extend the notion of means-end chain structures of consumers' product knowledge to symbolic signs such as quality marks. They used the soft-laddering technique, which is used to construct MEC, in order to identify relations between consumers and products mediated by the benefits offered from any hypothetical organic quality mark. This methodology has been developed as a tool to discover what personally motivates consumers to have trust in organic products. Approximately 104 in-depth interviews have been carried out in Italy as part of a larger EU-funded project (OMIARD). In order to identify their cognitive structures, consumers

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were asked to imagine a quality sign, that would give them confidence in the organic origin of the product and to link these motivations to product attributes (A) and their consequences (C) in order to reveal their underlying beliefs, feelings and desired ends (Values – V). MecAnalyst+ package was used to code consumers interviews, to derive the implication matrices and the relevant Hierarchical Value Maps (HVMs). The implication matrix – a square matrix with a size reflecting the number of elements mentioned by the respondents (56) – which reports the frequency of the direct connections between single categories (A, C, V, referred to as nodes in what follows), was used as an adjacency matrix, which is the basis for the social network approach. In particular the laddering outcome matrix may be interpreted as a set of relational data. Relations are not the properties of nodes but of system of nodes; these relations connect pairs of nodes into larger relational system. The qualitative information raised by the laddering technique may be analysed via quantitative and statistical counts of relations. The adjacency matrix out-coming from the laddering is a valued and not symmetric one, the values being the absolute frequencies of relations occurring between each pair of nodes. The main interests for the purpose of data interpretation are: a) the individuation of the nodes that show the highest “importance” within the network, and b) the individuation of significant set of nodes that may eventually be considered as a structured subset of nodes within the general network of connection between A, C, and V. Concerning the first aspect, standard network **centrality measures** have been used: degree centrality, betweenness centrality and closeness centrality. The degree of a node is the number of nodes to which a node is directly connected. Degree centrality is a measure of “local centrality” as is a measure of how well a node is connected within its local environment. Beside degree centrality, betweenness centrality provides information about the extent to which a particular node lies between other nodes: in fact nodes with low degree centrality may however play a crucial role in connecting different subsets of nodes, hence playing an important “bridging” and role within the network. Betweenness centrality requires however the network to be symmetric, hence considers only the presence of a connection between two nodes regardless the direction of relations. The issue of laddering data symmetrisation is a delicate one and has been considered in (see Geiskens et al., 1998). For our purposes (i.e. individuate the “role position” of nodes arising from laddering analysis) indicators hinging upon the assumption of relational symmetry may provide useful information as well, integrating the results based on original directed data. Finally closeness centrality is an indicator of how close a node is with respect to all other nodes; it is therefore a measure of “global centrality”, and a node can be considered as central if it lies within short distance from many other points, the distance being defined as the length of the shortest path connecting nodes. In this paper is used to check for the actual hierarchic structure of the network. Concerning the second aspect, we have investigated the network using cliques analysis. Weak cliques analysis (i.e. a clique analysis ignoring the direction of links among nodes, have been used to individuate subset of nodes where every possible pair of nodes is directly connected, and such that these subset are not contained by any other clique. The concept of clique considers therefore group of nodes very strictly interconnected within the wider network. The network of laddering relationships has proved to be quite an interconnected one, and we decided to consider only cliques formed by at least 6 elements (quite a restrictive condition). All nodes indicated in table 1 are included in one or more cliques, hence confirming their active role in the choice process for organic products. We have tried to aggregate the cliques according to the nature of the nodes, and have accordingly defined labels that summarise their characteristics.



## Results

SNA computation have been obtained with UCINET 6. Results for centrality measures are indicated in Tab. 1; in particular the node "have trust" assumes absolutely the most relevant position within the network of relations investigated. Results from closeness centrality analysis, not included in Tab 1 for space purposes, have shown that out degree closeness centrality is higher for attributes and lower for consequences and values, and vice versa for in degree closeness, hence confirming the actual vertical integration of the network in terms of attributes, consequences and values. Such a result can be partially confirmed by the proportionally higher scores of out-degree centrality for attributes, and in degree centrality for values.

**Tab. 1: Centrality measures: nodes with higher scores**

		Degree centrality		Between centrality
		out	in	
strict controls	A	√	√	
Info about place of origin	A	√		
info about label/control/standards	A	√		√
Info about product			√	√
Have trust	C	√	√	√
feel relaxed	C	√		
avoid worries/feel safe	C		√	
own health	V		√	

In Tab. 2 a summary of results from clique analysis is indicated, showing five main clusters of attributes, consequences and values variously organised as a clique of at least 6 components, and labelled according to their characteristics: the clique group labelled "Reassurance" is the one including the higher number of nodes. In other words concepts linked with the Reassurance issue are those more strictly interrelated within the more general network, hence forming a much cohesive subsystem and showing that a wide amount of the trust building process organic quality signs is much connected with such an aspect. This is particularly relevant as the number of nodes that could be classified as belonging to the "Reassurance" concept is not over-represented in our database. Again, the clique clusters confirm the hierarchic structure of the network, with an increase of abstractness of concept attributed from clique group 1 to 5.

## Discussion

The results from SNA, substantially confirm the goodness of the qualitative MEC study hereby analysed, particularly the coding procedure, and the "vertical" structure of the model. The centrality of the "have trust" node was not unexpected (Tab.1). Firstly, because the cognitive study (MEC analyses) on quality signs shows the same unique nodal point (have trust), secondly, and more relevantly, because when deciding whether or not to buy organic products consumers usually mention the trust issue. The presence of a lot of aspect connected with the types of information to be placed on the label (tab.2) was also confirmed by the previous MEC study (Naspetti and Zanoli, 2005).

**Tab. 2: Cliques clusters and node aggregation by clique membership**

Clique group label	n. of cliques	Total n. of nodes included for each group label
Organic label	2	12
Look for health	3	18
Reassurance	8	48
Serenity	6	36
Feel good	1	6

The clique analysis has been particularly helpful in the individuation of subgroups of strictly connected nodes; furthermore these are organised in homogeneous groups according to the nature of the nodes they include. The resulting classification helps from one side to understand more clearly the essential factors affecting the trust building process, and may be a basis for a re-definition of more focussed analysis.

### Conclusions

Network analysis can provide valuable support in interpreting and integrating information arising from laddering techniques, particularly in measuring in a consistent mathematic approach actual importance and role of different aspects (nodes) included in the laddering analysis. SNA may be considered as an useful diagnostic tool for standard MEC analysis and the integration between the two approaches shows a potential for further in depth analysis in the cognitive aspects of consumers behaviour. Since SNA emphasise the network nature of the cognitive structure and the role of single nodes and different types of relations between nodes, it is a valuable tool for implementing benefit-based market segmentation.

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# Identifying the gap between stated and actual buying behaviour on organic products based on consumer panel data

Niessen, J.<sup>1</sup> & Hamm, U.<sup>2</sup>

Key words: Marketing research, consumer panel, consumer buying behaviour

## Abstract

*Evaluating the German demand for organic food in the majority of cases has been done by interviews, which are restricted by massive overestimation of consumers themselves. By using consumer panels, it is possible to survey actual consumer behaviour in combination with consumer attitudes and socio-demographic data and also by additionally requested consumers' stated buying behaviour. Such methodology enables exposure and quantification of the gap between stated and actual buying frequency. Also the dimension of conventional products bought by mistake, while intending to get organics, can be identified. These results may give considerations for prospective survey design and adjustment of marketing policy.*

## Introduction

Over the last few years the organic market in Germany has shown remarkable growth. Nearly all big supermarket chains and many conventional food processors offer organic products and competition between them increases. Thus, a professional marketing policy is necessary to survive in the market. However, market success also relies on information on relevant consumers' buying behaviour to adjust marketing efforts towards consumer demand. Researchers in consumers' behaviour usually face the problem that consumers tend to greatly overestimate their spending for organic food when approached in an interview survey (Fricke 1996, Michels et al. 2004).

Based on data of a special consumer panel for organic products in Germany, the objective of this contribution is to analyse and quantify the gap between stated and actual buying behaviour in the case of organic food including the problem of consumers' buying conventional food for organic by mistake. The results may give important information for designing prospective surveys and developing or adapting marketing strategies within the organic sector.

## Material and Methods

The research is based on data of a household panel from the year 2003 in Germany. This panel run by the market research company Gesellschaft für Konsumforschung (GfK), was specially designed to collect data of private households' purchases of organic food and financed by Zentrale Markt- und Preisberichtsstelle (ZMP) in Germany. Every three months, 5,000 representative German households took part in screenings. Selection criteria for participation in the panel were the declaration that the

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household used to buy organic food at least once a month and had bought a minimum of one organic product in the current or past month. Thus it was secured that only (stated) organic buyers took part in the panel and not persons who bought organic products without knowing or intending to. In context of the screening, panel households had to declare how often they normally buy organic products and what type of retail outlets in particular they use. The participating households alternated monthly within the panel. Hence, bias caused by extremely high purchases of a household was avoided. It could be achieved that more than 200 relevant households filled in a specially prepared diary on a monthly basis, listing all purchased organic products including brand, organic label, type of retail outlets, volume, price, certification number etc. Many plausibility checks were done to assure that the listed purchases were really done for organic products. So it was possible to evaluate the "organic buying behaviour", combined with the stated buying behaviour before participation on the panel and the households' socio-demographic data.

This paper focuses on two parts of a larger research project. The first part is to verify general differences between stated and actual buying frequency on organic products. In the second part we analyse the problem that consumers may have bought conventional products instead of the intended organic products but did not realise their mistake. As households had stated their buying frequency on retail outlets' level, we want to show the mix up of buying conventional instead of organic quality exemplarily in the case of direct marketing (farmers' markets and farm shops).

## Results

To compare stated and actual buying frequencies, the latter were classified according to the stated classification within the screening questionnaire, as shown in Tab. 1. Observing the classified frequencies in a cross tabulation, the percentages of households' stated and actual buying frequencies are comparable.

**Tab. 1: Comparison of stated and actual buying frequency (% of households)**

		Self estimated buying frequency of households				
		"How often do you buy organic products?"				
Actual buying frequency		Once a month	Several times a month	Once a week	Several times a week	Actual overall
None		60	50	41	23	46
Once a month		15	12	9	4	14
Several times a month		15	19	19	12	17
Once a week		5	6	10	9	7
Several times a week		5	13	22	52	18
Total		100	100	100	100	100
Stated overall		19	42	28	11	100

Example for reading: 60% of participants who estimated that they bought organics once a month did not buy at all (actual buying frequency = none). But only 15% of all households that stated they bought organics once a month really did. Of all organic-buyers 19% stated that they bought organics once a month, but only 11% really bought organics once a month (arrow).

Source: Own calculation

The percentage of non-buyers is shown in the first line of Tab. 1. A total of 46% of households did not buy organic products within a month although they stated doing so. The less the stated frequency in this group, the higher the percentage is of non-buyers, going up to 60% of the stated "once a month buyers". The inside columns of Tab. 1 show the actual buying frequencies as percentages of the stated ones. The highest consistency between stated and actual frequencies is identified within the "several times a week buyers"; 52% of households of this group estimated their buying frequency accurately. Comparing overall values of stated and actual frequencies (bottom line and right column), the stated percentages are considerably higher than the actual ones. An exception is the "several times a week group"; only 11% of households estimated that frequency, but 18% really did so. On the other hand however it is very astonishing that 23% of this group did not really buy organics once a month at all.

We want to widen the above presented results with respect to the problem of buying conventional food instead of organic by mistake. To get preferably differentiated outcomes, producers' marketing as a type of retail outlet was divided into farmers' markets and farm shops. Tab. 2 shows percentages of stated and real organic buying frequencies, also considering the part of non-organic purchases, differentiated into four frequency-groups. The stated behaviour with respect to farmers' markets is three times higher than it is really. Overall, nearly 46% stated but only 15% really bought at farmers' markets, whereas 6% bought conventional qualities assuming they were organic. At farm shops the gap between stated and actual behaviour is not that high. The overall part of conventional products however is very similar to organic products (both nearly 9%).

**Tab. 2: Comparison of stated and actual buying frequency at farmers' weekly markets and shops including mistaken buying acts of non-organic products (%)**

"How often do you buy organic products at <b>farmers' markets</b> ?"				
Buying frequency in % of panel households	Stated	Actual		
		Total	Organic	Non-Organic
Once a month	9.3	6.6	4.4	2.8
Several times a month	14.4	5.8	3.6	2.2
Once a week	18.9	1.6	0.9	0.7
Several times a week	2.0	0.9	0.5	0.4
Households overall	45.5	15.0	9.4	6.1
"How often do you buy organic products in <b>farm shops</b> ?"				
Once a month	6.6	6.8	3.6	3.4
Several times a month	8.0	6.0	2.8	3.2
Once a week	7.9	2.6	1.4	1.1
Several times a week	1.6	1.8	0.7	1.1
Households overall	24.1	17.1	8.5	8.9

Source: Own calculation

The problem of purchasing conventional products by mistake, whilst intending to get organic products at producers' direct marketing channels, has also been analysed on product-level and considering socio-demographic parameters. The highest rates have been located with eggs (66%) and beef (54%), but also potatoes (45%), bread (35%)

and milk (29%) have been mixed up by high percentages. With all retail outlets and households this averages by 12%, whereas in producers' direct marketing by 34%. Especially households of older consumers without children mixed up conventional with organic products.

## Discussion and Conclusions

The analysis of consumer panel data points out a big gap between stated and actual buying behaviour in the case of organic food. The results challenge the validity of the mass of interview-based surveys on the organic market. Whether social desirability or personal ignorance (Bryman 2004) about organic products are responsible for the gap between survey results and reality, is not to be answered by our study. However this would be worth attempting in further research studies and requires methodological enhancements in combining panel research and qualitative approaches to ascertain consumers' insights whilst measuring their buying behaviour. The results should be regarded when interpreting and designing consumer surveys on buying organic products. They lead us to emphasise the importance of panel research combined on household level with interview surveys to highlight the background of consumer behaviour in the case of organic food.

A gap between stated and actual buying frequencies and the high percentage of mixing up buying conventional instead of organic quality is one part of discovering discrepancy between statement and behaviour. Also the expressed willingness to pay diverges from the actual spending, as results of a Danish consumer panel show (Millock et al. 2002). To survey actual buying behaviour in the case of organic food, methods of panel research seem to be irreplaceable. The results provide the possibility to "calibrate" and enhance interview-based surveys and methods, which are necessary, as panel surveys are very costly. However methodical approaches to improve and further develop interview design (Groves and Heeringa 2006) should be considered to solve the problem of discrepancies between stated and actual buying behaviour regarding organic food.

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## Organic Certification and Livelihood



# Impact of the adoption of participatory guarantee systems (PGS) for organic certification for small farmers in developing countries: the case of Rede Ecovida in Brasil

Zanasi, C.<sup>1</sup> & Venturi, P.<sup>2</sup>

Key words: organic certification, transaction costs, participatory guarantee systems, developing countries, local markets

## Abstract

*Different types of organic certification have been developed to overcome the problem of its relatively high cost for small organic farmers in developing countries. Among these the participatory guarantee systems (PGS) for organic certification, which does not involve a third party certification body. Providing a theoretical framework able to define the characteristics of PGS influencing its role in promoting local market development and communities social cohesion, as well as the access to export markets, is the aim of this paper. The level of formalism in the relationship among the stakeholders involved in the PGS, its interaction with the flexibility and the scope of their relationship, social control as a substitute for a third party certification body, are considered as influencing factors. A case study is provided: a survey among organic farmers involved in the participatory certification, members of the Rede Ecovida (Brasil), has been carried out, as well as interviews to the different stakeholders. The positive effect of the participatory approach on local organic market development and its still very low chances to access the export market emerged. An interesting finding regards the role of the farmers network (Rede Ecovida) in promoting trust on PGS certified organic products beyond the boundaries of the local communities.*

## Introduction

Organic production in developing countries contributes to their environmental as well as social and economic sustainability (Halweil 2007), Juma 2007). It also supports the local culture in rural areas. The costs associated to a third party organic certification following the standards defined by different national and international organisms<sup>3</sup> are relatively high; they reduce the potential for growth in developing countries, both of production and consumption of organic products, and their access to international markets. In the PGS all the stakeholders involved in the organic production and consumption take part in the certification process, sharing responsibility (Dos Santos L.C.R., 2005) they cannot be considered third party certification bodies<sup>4</sup>. PGS certifications thus apply to domestic organic markets. The application of PGS by the

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<sup>3</sup> Reg. 2092/91 UE, USDA NOP (USA), JAS (Japan), CGFDC (China).

<sup>4</sup> The organisations involved in PGS still do not conform to the ISO 65 norms and other norms defining them as Third party certification bodies (IFOAM, 2006); consequently the products cannot be traded internationally, unless integrated by a third party certification according to the exporting market norms.

Rede Ecovida<sup>1</sup> in Brazil has been recently studied (Ruzzi et al. 2006). Social control, trust, collaboration, third party role, showed an influence in the adoption of this certification in different market areas (local national, international). These factors are also taken into account by the institutional economics approach (Farrell 2005). It describes the interaction between the level of formality of the companies contractual agreements and the level of mutual trust and collaboration in influencing the size of the market area and the scope of the relationship. Formal institutions rely upon detailed written rules and are able to enforce them through a third party body and an efficient legal system. Informal institutions are based mainly on unwritten rules, often quite flexible, broad in their scope and not precisely defined. The rules are enforced through bilateral relationships and/or social control. As a consequence, if the adoption of a PGS for organic certification conforms to the characteristics of an informal institutional agreement, the market areas size should be local, in order to allow for an effective social control. Social control, in turn, can be effective if social cohesion and shared objectives are in place. The goal of this paper is to evaluate the relevance of this analytical framework in explaining the influence of the PGS for organic certification on the accessibility to different market areas (local, regional, national and international) in particular the interaction of PGS procedures with local community social cohesion and its consequences on the development of local markets.

## Materials and methods

Information have been collected through the analysis of the literature, interviews to the Rede Ecovida management and a survey based on a sample of 20 farmers adopting PGS for organic certification, from the municipality of Ipê, Rio Grande Do Sul. The statistical approach is descriptive and a mixed qualitative/quantitative set of variables has been used<sup>2</sup>. In particular:

for the analysis of the PGS compliance to an informal relationship: a) scope and flexibility of the relationship between farmers and the stakeholders involved in the certification; b) rules enforcement procedures based on social control;  
for the variables influencing the cohesion necessary to an effective social control for PGS: a) frequency of participation to local community meetings for PGS implementation and problems related to participation; b) role of the local institution in promoting a PGS for organic certification (reputation of local institutions);  
for the role of PGS in supporting organic smallholders development of local markets: a) motivations for entering a PGS related to market accessibility; b) market channels shares for the Rede Ecovida products and geographical distribution of their market areas.

## Results

Although clearly structured, well organized and managed, the Rede Ecovida participatory certification approach shows the characteristics of an informal institution.

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<sup>1</sup> Rede ecovida is a network among 2432 farmers organised in 270 groups, 30 ONGs, 24 Regional kernels, 32 organisations of consumers, processors and traders, 133 local markets; is located in the Rio Grande do Sul, Paraná and Santa Catarina States. Its principles are: respect for the environment, local cultures, human beings and life, solidarity and cooperation. This vision is defined as "agroecologia". Organic production is part of their vision.

<sup>2</sup> The sources for the different variables (survey, literature and interviews) are reported in the results.

The stakeholders interviews and literature analysed show that a wider range of issues and flexible agreements are included in the participative process when compared to third party certification; they involve the whole of the technical and economical aspects of the general and organic farm management which are discussed during the audits. The enforcement of the certification rules is granted by bilateral and social control: different single stakeholders (consumers, other producers) and formal local and regional control groups from Rede Ecovida are involved in auditing organic farmers. The PGS influence on the community cohesion and trust is positive; a study on the Rede Ecovida (L.C.R. Dos Santos, 2005) reports that 61% of the meetings involving farmers and local community of stakeholders, take place more than five times per year; only 10% of the respondents indicated the lack of interest as a factor influencing their meetings attendance. The role of social cohesion and trust in influencing the increase in the PGS adoption among farmers emerged: local institutions or personal relationships (farmers and farmers organisations) played a major role (Tab.4).

**Tab. 3: Why you choose a participatory organic certification (multiple choice answers)**

Farmers answers	Share
Cheaper than third party organic certification	76,5%
More chances to access local markets	52.9%
We can use non certified inputs	5.9%

Source: our interviews to farmers

**Tab. 4: Who encouraged the adoption of an organic participatory certification?**

Organisations	Share
Other farmers an local farmers associations	76%
Rede Ecovida representatives	18%
Other non specified	6%
Total	100%

Source: our interviews to farmers

The positive role of PGS in encouraging local organic markets development is confirmed by a share of 52.9% of the farmers indicating the easier chance to access local markets as a factor encouraging the adopting of the PGS (Tab.3). The market channels structure shows a share of organic products sold at local markets of 27% of the overall Rede Ecovida products (organic and conventional) (tab.5); this value increases quite substantially if related just to the organic products; the overall share of land dedicated to organic products within the Rede Ecovida is in fact around 68% (L.C.R. Dos Santos, 2005)<sup>1</sup>.

The network between organic farmers and other stakeholders reduced the gap between rural marginal areas and the “modern” sectors of society allowing the access to supermarkets and catering. The interviews to representatives of Rede Ecovida showed that organic products certified by Rede Ecovida are sold in other regions and states (Santa Caterina and Paraná) as they are accepted by other consumers already familiar with Rede Ecovida products. The export is still relying on third party certification, integrating the PGS.

## Discussion

Broad and flexible relationships, within the PGS process, strengthened the ties among stakeholders, helped farmers understanding not only the importance of organic farming but also how to start a community based local organic market.

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<sup>1</sup> The quantity of organic production is not available.

**Tab. 5: Marketing channels, values and shares of organic products sold by farmers belonging to Rede Ecovida de Agroecologia - year 2003.**

Marketing channels	Value R\$	%
1. Local organic markets (Feiras Ecológicas) (***)	8.946.682	26,89
2. Export (*) (**)	6.975.796	20,97
3. Catering	5.854.783	17,60
4. Supermarket chains (*) (**)	2.238.804	6,73
5. Food industry(*) (**)	1.434.371	4,31
6. Wholesalers	1.123.408,	3,38
7. Specialised retailers	1.111.225	3,34
8. Others	5.584.714	10,05
<b>TOTAL</b>	<b>33.269.783</b>	<b>100,00</b>

Source: Rede Ecovida. (\*) organic and non organic; (\*\*) Third party organic certification included; (\*\*\*) only PGS organic certification. For other channels the products certification is not specified.

Trustworthy institution (Rede Ecovida) and social cohesion helped expanding PGS among farmers; this apply also to consumers, accepting products coming from areas not directly under the local social control. These results, coming from a small area and from a relatively small sample of respondent, adopting a descriptive approach, cannot be generalised. The approach provided a useful tool to analyse the PGS role in the promotion of organic production and the market development in rural communities. The focus on social cohesion, trust, rules enforcement within an informal network, seems particularly relevant to this end. Further studies should investigate the PGS based organic certification in different contexts to identify possible strategies for introducing the principle of agroecologia and participatory certification in other developing countries.

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## Participatory Guarantee Systems: New Approaches to Organic Certification - The Case of Mexico

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Key words: organic certification, participation, local food systems, Mexico

### Abstract

*In an effort to address some of the problems associated with mainstream organic certification (such as high costs, extensive bureaucracy, inflexible processes, and a lack of community development focus), groups around the world have begun to develop alternative systems commonly referred to as participatory guarantee systems (PGS). These systems are based on the standards of mainstream certification agencies, but differ in that they adapt them to suit local conditions, employ simple verification procedures, minimize bureaucracy and costs, and incorporate an element of environmental and social education for both producers and consumers. This paper presents the experience of PGS in Mexico, with a focus on the case study of the Tianguis Orgánico Chapingo (Chapingo Local Organic Market). It is based on participant observation and informal interviews conducted by the authors during the course of their work as scholar-activists developing and promoting PGS as a certification option for Chapingo, as well as for an additional 16 markets that form the Mexican Network of Local Organic Markets.*

### Introduction: An Overview of the Mexican Organic Sector

Since 1996 the amount of Mexican land devoted to organic crops has grown on average by 33% annually, employment in the sector by 23%, and income generated by 26%. By 2007 over 126 000 Mexican producers were cultivating more than 450 000 hectares organically and generating more than 430 million U.S. dollars in income (Schwentesius et al., 2007). 98% of the country's organic producers are small scale, meaning they farm 30 hectares or less. The average size of these farms is just 3.3 hectares; however, it is this group that accounts for 84% of the organic land cultivated and generates 69% of the organic sector's earnings (Gómez Cruz et al., 2006).

For these small scale producers, many of whom are indigenous, the costs and bureaucracy associated with mainstream organic certification can be overwhelming. In order to address this problem, many have formed cooperatives and established internal systems of control so that the costs of certification can be shared. In addition, some farmers receive assistance from NGOs (or, in the case of Chiapas, from the state government) that can help them pay for certification (Gómez Cruz et al., 2006). However, in spite of these efforts, the high price and extensive documentation required for certification from Certimex, IMO Control, Naturland, or other agencies

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<sup>4</sup> As above

active in the country, leaves this option out of reach for many Mexican producers. As a result, approximately one quarter of the organic land in Mexico mentioned in the above statistics is not certified.

While the issue of organic certification has always been essential in terms of accessing the lucrative export market for organic products, with the passing of a new law governing the Mexican organic sector in 2006, certification will now be a legal requirement for using the organic label both for export and for sale within the country. This new regulation could have been potentially devastating for small scale organic producers who do not certify but still want to differentiate their product in the marketplace; however, thanks to heavy lobbying by the Mexican Network of Organic Markets (one of the primary promoters of small scale, local organic production and consumption in Mexico), article 24 of the new law recognizes PGS as a viable option, provided it is used for local sale only. Although the details of the new law have yet to be refined, the inclusion of PGS was seen as a major victory for the local organic movement in Mexico.

#### **PGS in Action: The Case of Chapingo's Local Organic Market**

In Chapingo, one of the markets that makes up the Mexican Network of Local Organic Markets uses PGS to maintain its organic integrity. With no certification cost charged to producers, the basis for this system is a committee consisting of approximately 14 volunteer members - producers, professors and students from the local university, and consumers. The first step for a producer wishing to achieve certification and enter the market is to fill out an initial questionnaire outlining past and present production practices. This can be obtained by visiting the market or by contacting the market coordinators. Upon completion, the questionnaire is reviewed in a meeting of the certification committee. If no obvious barriers to certification are evident, a farm map, daily activity log, and sales log are requested, and a visit to the farm or processing site is scheduled.

The leaders of the Chapingo certification committee were adamant in explaining that this visit is not viewed as an inspection per se, but rather as an interactive experience designed to be educational for all those involved. The visits are conducted by members of the committee and normally last approximately 2 hours. In most cases 5-7 people attend the visits; however, all members of the committee are always welcome to participate. It is important to note that those conducting the visits have varying degrees of knowledge regarding organic standards and production practices; however, everyone is encouraged to actively participate in the visits with the understanding that they will gradually develop their abilities. There is currently a tendency to rely on the expertise of one committee member who is a trained organic inspector, but all members (including the inspector) expressed a distinct desire to gradually decrease dependence on this person, so that the committee will be strengthened as a whole. As part of the effort to build the capacity of all members, the committee organizes continual training workshops; however, the organizers of these workshops stressed that active participation during PGS farm visits is one of the most effective ways to develop certification skills.

During the farm visits, each committee member consults a checklist that includes basic data about the farm operation (e.g. size of territory, number of crops, etc.) as well as basic organic control points, including: source of seeds; source of water for irrigation; soil management practices; pest and disease management practices; post-harvest management of crops, including storage and cleaning; and the potential for contamination from neighbouring farms. All committee members emphasized that

these visits are not merely designed to decide whether or not a producer immediately qualifies for organic status, but also to provide advice and support for those producers wishing to improve their operations and move closer towards the organic ideal. As such, unlike in mainstream certification, in all visits conducted for the Chapingo market PGS committee members offer comments, suggestions, and constructive criticism with regards to how producers could optimize their management practices.

Generally within a week of the visit the Chapingo PGS committee meets to review the case and make a decision about certification. These meetings usually last approximately 2 hours and the case is discussed until a consensus is reached with regards to whether or not a producer can be certified to sell in the market. The members use the standards of agencies like Certimex and OCIA as a guideline for what is acceptable organic practice. If a producer meets the standards and has completed a 36 month transition period away from conventional production they are granted organic status within the market and certified without condition. For most producers however, certification is contingent on agreement to meet a number of conditions. Two of the most common of these conditions are the development of natural barriers on the borders with neighbouring conventional farms and the composting of manure before application. One of the leaders of the PGS group in Chapingo, who is also a producer at the Chapingo market, stresses that the committee tries as far as possible to work with willing farmers to help them meet these kinds of conditions, or to connect them with extension and education resources that could be of assistance. During this time, provided that they meet the basic requirements of organic production, producers will be allowed to sell in the market under the 'natural' as opposed to 'organic' label. If follow up visits demonstrate compliance with the conditions, a producer may eventually be moved to the organic section of the market. In the case that a producer is denied certification, clear reasons are outlined and the committee offers to maintain a relationship with the producer and help them make the transition to organic production. In the majority of cases that have come before the Chapingo PGS committee, regardless of the outcome, producers are provided with a list of recommendations for improvement that are not necessarily conditions for certification, but are designed to help the producer optimize their production practices.

Because transparency and community involvement are integral aspects of PGS, the results of all questionnaires and committee decisions are available to the public, and the Chapingo market coordinator made clear that anyone who wishes to join the certification committee is more than welcome to do so. In addition, consumers are encouraged to interact with producers at the Chapingo market (for example through participation in free educational workshops) and this interaction has led to the development of strong relationships of trust, and in some cases friendship, between the buyers and sellers of organic products. These relationships are an important means of supporting the process of PGS, as they can provide the consumer with an extra sense of security.

One of the biggest challenges for implementing PGS in Chapingo is that the certification committee relies almost entirely on volunteer labour. Thus, members' time is limited by work, family responsibilities, and other commitments, making it difficult to schedule visits and meetings and work on capacity building within the committee. Organizers noted that these challenges have made it difficult to keep up with the demand for certifying new producers who wish to enter the market, and also to consistently monitor the farms of existing market members. In addition, due to lack of time on the part of its members, the Chapingo group has yet to publish a document

clearly outlining the organic standards it uses as well as the way in which the system functions – something that ECOVIDA (2004) notes is essential to the successful functioning of PGS endeavours. Because participatory certification systems are so context specific, the standards and procedures of other groups can be used as a basis, but they cannot simply be replicated. As a result, groups like the one in Chapingo find themselves learning through trial and error and gradually developing functioning systems.

Another problem for PGS is that, although the bureaucracy is minimal compared to mainstream certification, producers in Chapingo still sometimes reported that it was difficult to provide the required maps and production activity logs. Market organizers noted that this is primarily because there is no cultural tradition of maintaining such records. One final prominent challenge is that the PGS ideals of equal participation, horizontality, cooperation and consensus building can be difficult to effectively put into practice, and conflicts of interest within the certification committee were sometimes apparent. For example, non-producer committee members noted that, in some cases, producers could be very easy on their peers in the hopes of receiving an easy evaluation themselves. In other cases, non-producers felt that some producers were overly critical of their peers, possibly because of feelings of competitiveness or a desire to achieve high standing within the group.

### **Conclusions**

In their manual on participatory certification, ECOVIDA (2004) quotes Paulo Freire: “The thinking subject cannot think alone; he or she cannot think without the co-participation of other subjects in the act of thinking about the object. There is no ‘I think’, there is ‘we think’...” This notion of thinking and acting as a community can be challenging to put into practice, especially in today’s individualistic society; however, it is at the heart of the participatory organic certification movement. Indeed, PGS is not merely designed to ensure consumer confidence in organic products, although that is certainly one important goal. Rather, it is meant to be a tool for holistic sustainable community development with a triple focus on environmental protection, community building, and local economic development. It is meant to help support producers in the shift to organic production, to make organic products accessible to a wide variety of consumers, and to help the organic movement return to the philosophical roots of its early pioneers. Although it is still a nascent movement, experiences such as that of the Chapingo Local Organic Market demonstrate that participatory certification, although not without its limitations, can be implemented effectively, and can be a rewarding, if at times challenging, experience for all those involved.

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# The Circular Economy of a Local Organic Food Chain: Xiedao in Beijing

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Key words: Local and organic food chain, Circular Economy, Leisure Agriculture

## Abstract

*The local organic food market in China is growing and so-called leisure agriculture has been widely accepted and advocated in urban areas as a positive means of relaxation. This paper presents an analysis of a local organic food chain based on leisure agriculture and seeks to explain development of organic food in Urban China using the theoretical frame of the Circular Economy. The study uses a local organic food chain involving Xiedao as a case. In conclusion, the paper provides an estimate of the energy use efficiency of the chain.*

## Introduction

China has reached an export value of 0.35 billion USD annually exporting organic agricultural products and has become the 3<sup>rd</sup> largest country of organic production in the world (Zhang, 2007). However, globalisation and trade liberalisation cause food to be transported over ever longer distances between producers and consumers exacerbating environmental pollution and increasing resource use (Friends of the Earth, 2002).

Circular economy (CE) may interlink manufacturing and service businesses seeking to enhance economy-environment performance through collaboration in management environmental and resource issues. The thrust of the CE concept is the exchange of materials where one facility's waste, energy, water, materials, and information into another facility's input (NDRC, 2006). When the triple-R (i.e. reduce, reuse and recycle) principle of circular economy is applied to the field of agricultural sustainable development, it consists basically with the philosophy of organic farming. China has focused her endeavours on circular economy, integrating cleaner production and industrial ecology in a broader system to support resource optimization (Wang, 2006). This paper analysis the material and energy recycling in one case of local organic food chain, which is the Xiedao Ecological Holiday Village (abbreviated as "Xiedao"). Meanwhile, an estimate of energy use efficiency of the chain is provided.

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## **Materials and methods**

First author conducted an empirical study of local organic food production in the Xiedao, Beijing, China. The data collected focused on the organic food chain, and material and energy recycle of the case. Data were collected by the following methods:

- 1) Administration of questionnaire, including section for background data on the case.
- 2) Two interviewee groups were visited with different objectives: one group includes the manager of organic production, farmers, and visitors in Xiedao, with regards of local organic food chain based on leisure agriculture; another group is composed of directors in charge of different sectors in organic food chain, focusing on circulation of energy, matter and resources.
- 3) Direct observation: the first author visited the case spot---Xiedao.

## **Results and Discussion**

### ***Local organic food chain based on leisure agriculture***

The total land area of Xiedao is about 200 hectare, of which 90% is in use for organic production, including planting and farming, the rest 10% is used for tourism. However, 70% of the income of Xiedao is coming from non-farming related activities, covering restaurant, sightseeing, entertainment based on organic products. Respondents believed agricultural pattern in Xiedao is the emergence and growth of leisure agriculture and food production activity, which brings together production and consumption activities, increase the added-value of agricultural products and reduce ecological footprints. It not only meets consumer demands for fresh, safe, and locally produced food but create job, encourage entrepreneurship, strengthen community identity and break the conventional agricultural food marketing system, which means that food is produced in the farm, but marketed and consumed in urban area. During the whole year of 2004, the total number of visitors reached about 1 million.

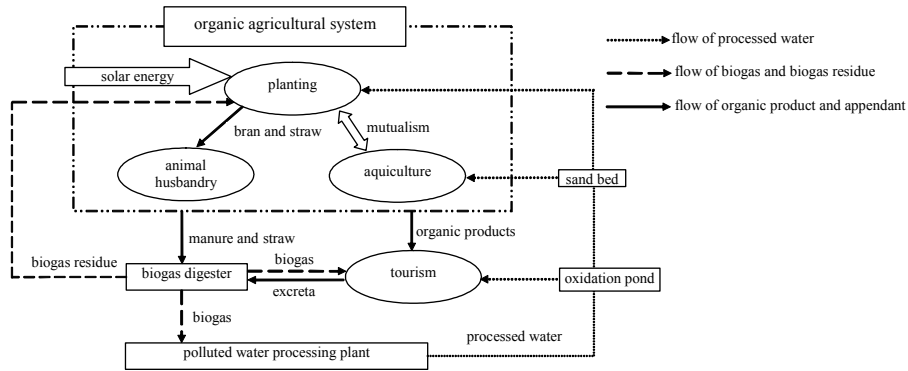
In addition to strengthening the local economy and reducing environmental pressure, Xiedao is also a community-building initiative. Local organic food chains are built up between farmers and consumers, and consumers gain a sense of connection to the land and agricultural products through picking and consuming organic products. The Xiedao organic market stall is decorated with leaflets and posters advertising a range of organic foods.

### ***Circulation in Xiedao organic food chain***

Material circulation in Xiedao is mainly composed of three flows (see Fig.1), covering flow of organic products and appendant, flow of processed water, and flow of biogas and biogas residue.

The organic agricultural system in Xiedao involves planting, animal husbandry, and aquaculture. Organic products such as soybean, rice, vegetable from planting, and meat, crab and fish from animal husbandry and aquaculture, are consumed and bought by tourists. In planting system, parts of the produced rice bran and straw are transferred to animal production and aquaculture as fodder, to resolve the waste in planting. In addition, the pattern of rice and crab together has been developed according to the principle of mutualism: rice provides shelters for crab, and weed,

float, insect in paddy field are the food for crab; at the same time, crab has the ability to loosen the soil, and increase the production of rice.



**Figure 1: Circulation in Xiedao organic food chain**

Manure from the animal husbandry system, and excreta from tourism system are fermented in 300 m<sup>3</sup> high temperature fermentation biogas digester to be biogas and biogas residue. Biogas is mostly used as renewable fuel in tourism and electrical power in the polluted water processing plant. Biogas residue, as fertilizer transferred to planting system, accounts for 88.4% of total input in planting system, and with zero input of chemical fertilizer and pesticide, which equals to 600, 000 Yuan reduction input per year. The recycling or renewable energy in Xiedao include biogas, terrestrial heat, and solar energy, substituting coal and petroleum to meet the demand of fuel in tourism. 73,000 m<sup>3</sup> of biogas is produced per year, equal to about 1 million Yuan. Solar energy (photovoltaics) has been developed to power road lights and irrigation in agriculture.

The energy equivalents of input and output in organic agriculture system in Xiedao include direct and indirect forms of energy. Energy input-output analysis has been used to evaluate the efficiency and environmental impacts of organic production system, and the ratio of energy input-output in Xiedao organic agricultural system is 2.2, compared with 0.1 in American agriculture and 0.25 in Japanese agriculture (Bian Y., et al., 1995).

The average amount of polluted water produced in Xiedao is about 1000 m<sup>3</sup> (800-1200 m<sup>3</sup> per day). A polluted water processing plant was built in 2002. The water from the plant flows and cleans biologically in oxidation pond as the second cleaning. The recycled water is used to irrigate the farmland, and breed fish and crab, and other animals, after sand bed.

## Conclusions

Organic agriculture in China is mainly oriented towards rapid growth of external markets. However, local markets for organic products bring both market and non-market benefits, the latter of which may be summarized in terms of local sustainability and rural development. The case study of Xiedao demonstrates that a local and sub-urban organic food chain involving tourism may help "break" traditional agricultural

development patterns, and enables a “circular economy” kind of organic agricultural and food (marketing) system. An energy ratio of 2.2 indicates that the Xiedao organic food chain do well also in terms of energy efficiency.

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## Organic Agriculture: A New Field of International Development Policy

Egelyng, H., Høgh-Jensen, H., Kledal, P.R. & Halberg, N.<sup>1</sup>

Key words: Organic Agriculture, Development Policy. WDR '08. OECD DAC '06.

### Abstract

*This paper reviews strategically selected global policy documents and development literature and analyse perspectives on the role of organic agriculture (OA) as a possible vehicle for sustainable development in developing countries. It shows that not only has compliance assessed organics made entry in terms of projects and programmes in many LICs. OA is also gaining position in formal policies and strategies of international donor agencies and organisations. If agriculture is generally "back" in development business, organic farming has certainly "arrived".*

### Introduction

Focusing on agriculture as a vehicle for pro-poor development, the OECD Development Assistance Committee (DAC), last year included an organic route on its map. In May 2007 the FAO hosted an international conference on the role of OA in food security, marking a new and improved understanding of OA in resource poor and low input contexts. Finally, the World Development Report 2008 came "back" (re)focusing on agriculture, after a quarter of a century being *anderswo engagiert*. Along with increasing agricultural portfolio donor investments, the above are indications that not only do agriculture climb up development policy agendas worldwide, so does OA. A point in scholarly analysis of the rationale of this new focus is that while development studies long understood agriculture as an engine for development with forward and backward linkages and multiplier effects, most donor communities had lost interest in agriculture. Some scholars argue agriculture is back because agriculture connects the poor to growth. We favour a complementary explanation: power over agricultural policies has shifted from sector ministries and into a broader political realm matching a new economic paradigm (environmental and ecological economics) and a contemporary understanding of agricultures multifunctional roles. The supermarket revolution and global value chain organisation along with a global consumer movement and internet helped shift the game. While none of these developments brought sudden consensus regarding limitations and possibilities for OA to help rural development in low income countries (LIC), OA is both globalizing and glocalising. Certified sales are now reported passing USD 40 billions and low income countries (LICs) enter the market with comparative advantage and major de-facto or "non-market organic" areas rather ready for certification.

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## Materials and methods

The materials of development studies are often existing data and literature, analysed from a novel analytical or theoretical perspective. In this paper the materials analysed are policy documents: the *WDR 2008* and the 2006 OECD DAC Agriculture *Policy Guidance for Donors* and a strategic sample of recent and further “grey” development literature dealing with organic farming and development. A literature search was done for articles on the developmental role of organic farming in international journals. The method then consisted of analyses of the texts of the policy documents and reviews of the additional literature, from a perspective of development studies, ecological economics, and political ecology.

## Results

The World Development Report 2008 notes that organic products, along with exports of horticulture, livestock, fish, and cut flowers, now makes up 47 percent of all developing country agricultural export value (!) The report does not specify the organic contribution to those forty-seven percent, but elsewhere it does quote global organic 2006-sales at USD 23,9 billion compared to certified fair trade 2005-sales at 1.4 billion. It further notes that markets for “premium quality goods such as coffee, organics, and Fair Trade products” grew and that producers of these have “considerable scope for expanding exports” (World Bank 2007; 60, 61). Referring to “organic foods” to illustrate how public standards can help “ensure fair competition [and] reduce information costs to consumers”, the very institutional mechanism that allows markets to recognise and reward organic producers, namely certification (schemes) has also caught the eye of the bank for its relevance in new areas: perhaps such certification could help reduce environmental impacts of biofuels! The WDR 2008 stress that while offering high prices, specialty markets – a category including “organic, gourmet”, and “Fair Trade” perhaps along with geographic indications and Rainforest Alliance–certified products – are small, but elaborates organics with cases of regional experience (World Bank 2007; 71, 123, 130, 132, 137, and 189).

The WDR does speak of “food miles”, “environmental footprints” and of how the triple production challenge create needs to reduce the environmental footprint of intensive crop and livestock systems. In particular, reducing the same footprint caused by “agrochemical and animal waste pollution, is a priority” (68, 181, 199, 237). The World Bank would not be the World Bank, if “getting the incentives right” was not “the first step towards sustainability” (199). Yet, eco-efficiency, ecotaxes or pesticide tax has not found its way to the WDR 2008. The WDR does not seem to see the rise of alternative – including organic – markets as a result of any global social movement of frustrated citizens providing “institutional responses” to deficiencies in regulation regimes at global, regional and national levels of governance. The WDR, it seems, prefers a narrow interpretation of demands for certified organics as one of a market mechanism satisfying a consumer demand. This is unfortunate, because it could mislead policy-makers to believe LIC farmers should be left relying on (market) price premiums only and thus to forget the other side of the coin: the obligations and role of the state in creating a broad institutional environment far more conducive to sustainable including low carbon farming methods. It is noteworthy nevertheless that “agriculture is back” on the World Bank agenda, to an extent where acronyms such as EPOPA and IFOAM as well as environmental footprint, environmental services and food miles has entered the vocabulary of the WDR. Similarly noteworthy is that OA, now according to an OECD DAC report, is one of the pathways poor people may

pursue out of poverty: a sustainable trajectory out of poverty and pro-poor growth will rely on “diversification of outputs” which will again involve a change to “capture more value added”. The report identifies “a wide range of technological options” among which it includes “organic farming” [] “to supply global supermarket chains”. It stresses that “well resourced producers can more easily meet demands for volume, quality and timeliness of deliveries, while “others” are “likely to need finance and extensive institutional support” (CBTF 2006).

The above reports published 2006 - 2007 “stand” on a recent (new millennium) history or foundation of an increasing number of bilateral and multilateral donor agencies and organisations - a subsection of FAO first among them - pioneering OA as a developmental pathway for LICs (Egelyng and Høgh Jensen 2006). The latest in a series of FAO initiatives to serve LICs seeking policy advice unfolded in May 2007 in a conference aiming to identify OA’s potential and limits in addressing the food security challenge. The conference culminated in urging the FAO Committee on World Food Security to consider promoting OA as a strategy, by including it into national and regional programs. Among the recommendations from the same conference was a suggestion on creation of a Consultative Group for Organic Agricultural research (International Conference on OA and Food Security Rome, 03 - 05 May 2007, see [http://www.fao.org/organicag/ofs/docs\\_en.htm](http://www.fao.org/organicag/ofs/docs_en.htm)). All this happen while African countries in particular continue facing strategic choices on their future agricultural development. Views remain split between one continuing to draw on the Asian Green Revolution along with proprietary technologies and a different one focusing on the absence in Africa of the kinds of economic, geographical, infrastructural, institutional and geopolitical conditions that characterized Asia at the time of the Green Revolution. This has implications for anyone promoting OA in an African context. For instance: huge transaction costs are involved with diversification of production in Africa, implying that any potential for agricultural growth there, will hardly be rooted in green revolution style technological transformation among millions of small-scale, poor and diversified African farmers (Sumberg, Gilbert and Blackie. 2004; 131-146). International development agencies no longer face any shortage of advice on how to help development of OA in the South. They can, for instance follow the example of the Swedish development agency and assist African farmers to go certified organic and thus enhance their capacities to compete in global markets and they can generally reform institutional environments, policies and programs to be more conducive to sustainable agricultural methods (Egelyng and Høgh-Jensen 2006). They can chose among no less than 50 (fifty) more concrete recommendations compiled by UNEP, UNCTAD and the Capacity Building Task for on Trade, Environment and Development, all aimed at giving recognition and encouragement to the organic sector – and to remove obstacles and biases against OA (CBTF 2006). One challenge common to farmers and the agricultural innovation system (R4D) is the globally increasing demand for organic products and the perceived need of scaling up – or out perhaps. A host of scientific and technical research demands arise from the expansion of certified OA, providing a major opportunity for any “Organic” CGIAR like initiative – such as the one proposed by the May 2007 FAO conference - to support the OA sector. Organic farming with its stringent rules on external input use has to be even more innovative than common agriculture, to solve production and processing problems. Projected increases in certified OA raise additional opportunities for any such institute to contribute to development goals, through helping to develop, maintain or optimize agricultural productivity and soil nutrient levels whilst controlling costs, improving labor efficiencies and harvesting synergies from crop rotations, crop-livestock systems and all the other ecologically based principles characterizing OA.

The recognition of multiple positive externalities of OA led the European Commission to realize that opportunities existed and exist for harvesting "dividends" of public policy through a greener CAP. LICs are often in a completely different situation with no dividends (no, few or small damaging subsidies) to harvest and no significant volumes of non-renewable resources use and pollution (from fossil fuel - carbon and pesticides) to tax. On top, significant constraints for LICs to profitable production, processing and marketing of organic products for export does exist. Yet, their low wages and tropical geographies, may add comparative and potentially competitive advantage in many organic foods. Of course, the current organic price premiums may decline in the long term, as supply catch up with demand and as larger producers and retailers enter the market. A lower price premium will then make OA less economic for many small producers in LICs with poor rural infrastructure and services. Still, organic practices in low external input systems can increase combined market and non-market gains significantly for organic methods to remain preferable.

## Conclusions

For a long time, the international development community had a limited or stereotypic understanding of the productivity, if not development potential of OA in resource-poor areas. Perhaps discussions were really based on imagined counterfactuals or data from temperate countries and a context of energy intensive agricultural systems. The international development research literature is yet to pay significant attention to certified organics in the context of development in LIC. Generally, however, the broader development related literature has noted certified OA as increasingly involving LICs, within a global food & fibre system with increasing sales and steadily rising areas of certified land - and potential to contribute to socially, economically and ecologically sustainable development. In the absence of dramatic change in donor investment patterns, the majority of de-facto smallholder farmers in agriculture-based societies may have to continue looking in vain for better post-structural adjustment conditions. The new globalised food system challenges them with exclusion from modern value chains. In the near-absence of domestic markets for organics (Africa) or weaker ditto (China, India), this challenge is no less for farmers wishing to certify as organic producers for the world market. OA is nevertheless posed to play an important role in the trend towards drawing further development policy consequences of the multi-functionality of agriculture.

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## The institutionalization of Participatory Guarantee Systems (PGS) in Brazil: organic and fair trade initiatives

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Keywords: standards and regulations, conformity assessment mechanisms, organic agriculture and fair trade, economy of conventions, social network analysis

### Abstract

*Since the nineties the Brazilian organic movements have been looking for alternatives to certification. They have argued that in and of itself or alone certification of family farms and small enterprise is not enough to promote either the learning processes associated with organic production or stimulate development of the local market. The discussion on a Brazilian System for Fair Trade began in 2004, and PGS were considered helpful for organizing farmers, providing guarantees and improving the market. In 2007, a draft of PGS regulation for use in organic was elaborated. The same actors who helped build the Organic System are also discussing Fair Trade System. With the help of public resources, NGOs and family farmers have established systems that provide credibility to consumers with regard to organic qualities and fair trade criteria. The use of PGS is a trend for family farmers trying to access quality markets and also helps participatory research. To some, one perceived challenge is to integrate the two policies (organic and fair trade) since the target publics are similar and the international cooperation agencies give support to both. However, current international initiatives for regulating PGS do not take into account the position of local movements. In the nineties a strategy blind to such a weakness split the organic movements in Latin America and it is unlikely that a similar strategy will promote harmonization or equivalence in the future.*

### Introduction

When the first Brazilian organic regulation was established in 1999, the perspective for using other conformity assessment mechanisms in addition to certification was institutionalized. Officially recognised organic agriculture (OA) in Brazil which represents around 19 thousand projects includes big enterprises but is mainly comprised of family farmers (around 80%). In 2003, when the Law 10.831 for OA was published after being discussed by public and private organizations, PGS became recognised in the regulations. The first Brazilian initiatives on Fair Trade (FT) were for export (coffee, cacao, orange juice). After 2001, the discussions on the development of FT began at local level. The target public of this initiative is the solidarity economy movement organized by groups or associations. Again PGS was considered as a possible mechanism for consolidating credibility in the local market. Research suggests that consumers tend to associate organic and fair trade principles when purchasing food and non-food (Wilkinson, 2006).

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## Material and methods

This paper is based on a social network analysis and it depicts the actors within PGS regulation in Brazil, examining the motives and the methods involved in developing these systems. It identifies the conventions underlying the negotiations on the criteria for conformity assessment carried out by public and private sectors. The profile, principles, criteria, challenges and limitations of the organic and fair trade experiences were investigated to capture the institutionalization of those two local markets and identify their convergence. In addition to theses on OA (Fonseca, 2005) and FT (Mascarenhas, 2006), and academic publications (Wilkinson, 2006; 2007), information on OA was primarily based on two PGS workshops held in 2007. In these meetings, representatives from the organic and fair trade movements, involved mainly with family farmers and local development, but also with international trade, got together to elaborate a proposal for a PGS norm to be presented for approval at the Organic Agriculture Sector Chamber of the Agriculture Ministry. Information on Fair Trade was also gathered during the meetings of the Working Group (WG) for the Brazilian System of Fair Trade at the Ministry of Work and Employment, in addition to the database of the Solidarity Economy published in 2005 (Brasil, 2006).

## Results

In 2002, a pilot project was implemented in Brazil by the ISEAL Alliance to promote the development of conformity assessment criteria, exploring the opportunities and challenges for family farmers involved in organic and fair trade markets. Two inspections (organic and fair trade) can imply double costs, more bureaucracy and greater time spending for family farmers. At this time, the idea of a clearing-house for harmonisation/mutual recognition was discussed. Those issues were also aired at the ITF FAO/UNCTAD/IFOAM for harmonisation and equivalence on organic standards (Wynen, 2004). PGS for organic guarantee systems has been discussed since the nineties and as from 2002 it has been explored in relation to the Fair and Solidarity Trade System. Since then public audiences have discussed the principles and criteria and a WG was created in 2006 to elaborate the framework of the system.

**Shared Networks and Values** – the Organic and Fair Trade movements have based their standards on international references but have made adaptations to local contexts based on agro ecological and solidarity economy criteria. Officially recognised organic projects (around 19 thousand) and fair trade initiatives (around 15 thousand) have been developed mostly by family farmers. The database of the solidarity economy undertakings (Brasil, 2006) capture the characteristics of the actors: area of action – 50% from rural, 17% active both in rural and urban sectors; products distribution by type of activity – agriculture, fishing and wild harvesting (42%), food and drinks (18%) and handcraft products (13%). A project elaborated collectively by WG CPR GAO (Organic Agriculture Group) was approved to draft PGS regulation for organic conformity assessment systems, and included visits to two functioning PGS experiences: ECOVIDA in the Southern Region, and the ACS in the Northern region of Brazil in 2007. These visits provided the opportunity for exploring a range of question: principles, definitions, performance, criteria for inclusion and exclusion, training, technical support, costs, dynamic, information to consumers, and distribution channels. The central question was: how does this system provide guarantees to consumers? In addition to these two experiences, nine other networks from the North, the Centre West, the Northeast and the Southeast regions presented their experiences, describing the functioning of their guarantee system. The conformity

assessment systems have very different backgrounds and function in very diverse conditions, but share many common features. Most use national regulations adapted to their local socio-ecological conditions, small-scale production, and local market (short distribution circuits). Most produce for the organic market but also for the FT and solidarity economy. The procedures are simple and there is minimal bureaucracy to maintain costs low to farmers and limit time spent filling-in forms. These experiences have technical advisors for helping with the registers, but also with the correction of non-conformities. Most rely on an educational process and social control involving many actors of the production chain focusing on consumer participation to uphold their organic quality system. Transparency is maintained through stimulating active and collaborative participation within the networks but also registers. About the effectiveness of both systems, Minister of Agriculture has registered products as organic from PGS since 2007, and products submitted to PGS mechanisms are in internal market but also for export besides they need to be certified to accomplish with regulations in external markets.

**PGS Principles and Characteristics** – In addition to the basic elements elaborated by the PGS WG1 (IFOAM, 2005), Brazil defined others. The PGS include different methods of creating credibility adapted to different social, cultural, political, territorial, institutional, organizational and economic realities. The main features of PGS are: social control, participation and solidarity accountability. The social control is established by the direct collaborative participation of the PGS members. These actors define and promote collective actions of conformity assessment from the suppliers to the standard reference. Participation and solidarity accountability are complementary features that make possible social control and shared power, and govern the evaluations and decisions related to product conformity.

### **Discussions**

At national and international level, the PGS experiences have increased around the world since the first workshop held in 2004 (Lernoud & Fonseca, 2004). They are being used for OA taking into account international and national organic standards and regulations. Eight countries in Latin America and Caribbean (LAC) have the possibility of using PGS for OA (draft regulations or regulations not fully implemented). In Table 1 we compare the basic characteristics of PGS and certification, seeing that they use different mechanisms but have common regulatory objectives: to give guarantee about specific qualities of the product, process and services. For organic and fair trade initiatives domestic and civil conventions are negotiated, and face the same problems: a) little knowledge of the possibilities of different commercial chains and existence of few specialized channels; b) low awareness by clients and consumers of the concepts and principles of organic and fair trade; c) low levels of organisation and capacity for marketing by family farmers and solidarity economy undertakings; d) excessive bureaucracy for accessing public policies.

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1 After the Workshop held in 2004, a PGS WG was created with the mission to develop, facilitate and encourage PGS around the world.

**Tab. 1: Basic characteristics of certification and PGS**

PGS	Certification
- Participation	Impartiality
Shared Power (concertation of interests)	
- Public and private partnership	Independency
Solidarity accountability (mutual)	
- Continuous correction of non conformities by peer reviews and technical advisors (constructing agro ecological knowledge and empowerment)	Competence

### Conclusions

The PGS normative text for OA quality system is a real demonstration of how regulations can be more inclusive when governments discuss criteria with civil society. Certification or other conformity assessment mechanism such as PGS provides consumers with the organic qualities and fair trade principles that they are looking for. The implementation of a control system without prior discussion with the movements is likely to provoke tensions. Such tensions were apparent during the LAC PGS Workshop held in October 2007, when organic movements were made aware of the draft PGS IFOAM Manual as since the creation of the international PGS WG there has been little contact with local movements. Based on this analysis we conclude that in Brazil a strong civil society has acted to draw legislation beyond a simple matter of trade and business standards and rather far into a (rural) development mechanism seeing controlled organic agriculture and fair trade as core/integrated par of a sustainable (consumption, production and) future for both urban and rural people.

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## **Challenges for standards and certification**

# The Differentiation Process in Organic Agriculture (OA) – between Capitalistic Market System and IFOAM Principles

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Key words: conventionalisation, differentiation, IFOAM-principles, organic agriculture, ethical values

## Abstract

*The organic food chain is in a differentiation process, in between of external (society and conventional agriculture) and internal driving forces (IFOAM principles). Seven external tension fields were identified, which affected the differentiation process. One of the most important internal driving forces was the development out of the four IFOAM principles. It is recommended to address all stakeholders in the organic movement and to identify possibilities for transferring aspects of the IFOAM principles into standards/ guidelines. Furthermore, it is necessary to intensify the network with key societal players.*

## The fact of differentiation processes in the organic movement

Worldwide, the whole agriculture and food industry, agricultural practice and research are undergoing changes in terms of economy, trade, labour, environmental conditions, and consumer attitudes. Agricultural practice, and especially traditional and ecological oriented concepts are under pressure because of different societal developments and institutions, where offshore agriculture and food industry as well as consumer decisions increasingly influence production. The organic food chain, which is a sub-system of the whole food chain system, is in an intensive process of differentiation into different subsystems worldwide (see Schimank 2000). Organic Agriculture holds the pole position in the sustainable debate on agriculture and human nutrition, but it is in danger of losing this pivotal position as a guiding moral model concerning sustainability as well as the actual right for premium prices or environmental subsidies. With the following reflections, I try to offer some insights on selected external and internal driving forces, which could explain the differentiation process of the organic agriculture in general and the conventionalisation process specifically:

- *External driving forces:* agricultural and societal development processes, in which the organic movement is embedded.
- *Internal driving forces:* the debate and role of the four IFOAM principles.

The conclusions integrate the findings and especially what the organic movement is able to influence by himself to ensure the outstanding position and quality of OA.

## Background of the differentiation process

### (1) External driving forces

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OA increased rapidly in the last 20 years. To date we can find many different agricultural practices and interpretations of organic agriculture, which have their general roots in geographic and climatic conditions, as well as traditions, habits, convictions, understanding of nature, religions, philosophies, local and global politics and economic interests. As a result of this differentiation process, we can identify three main communities of OA: A conventionalisation (or rather simplification), B practice following strictly standards and regulations, C organic PLUS (additional sustainable activities). This internal broad interpretation of OA is on the one hand in a certain sense a result of climatic and cultural backgrounds, but on the other hand also undermining the whole organic movement, where the organic food chain is becoming more and more similar to the conventional approach.

The specific focus of this article is to understand the background mainly of the extreme A. The conventionalisation trends of the whole organic system has different roots. To explain the process of conventionalisation, we have to analyse the environment of this development, which we can describe with seven tension fields:

*Standards / regulations:* Different stakeholders i.e., producers, processors, traders and industries alike, try to influence the standards / regulations in their own interest (towards conventionalisation): (1) Those who wish to participate in the organic food chain and don't want to change substantially their production and processing or trade concepts. (2) Those who want to sell fertilizers, pesticides and other agriculture inputs. (3) Those who wish to reduce the distance between organic and their own agricultural practice in order to be able to use a similar label as the organic producers, but without substantially adapting organic concepts.

*Ethic values:* Conflicts with ethical values are where the use of wheat is not accepted for energy production in OA, while the situation is not the same in conventional farming. Nevertheless, green energy has a positive image. Another example is the dependence of OA on certain private food and agriculture industries such as breeding companies producing genetically modified plants, what is not in line with the OA approach. In both cases OA is neither free of expectations from society nor dependencies from private organisations with different or contrary value systems.

*Economic rules:* To be realistic, the amount of organic farms e.g. in Europe and the share of turnover in supermarkets is less than 5%: But at least, they are part of an economic system and in this capitalistic system (characterised by private goods, regulation of economy by the market; maximising of the profit (Hösle 1992: 113)), there is an endeavour to make the best price with the lowest inputs. In organic production, it might be a general problem to behave in opposition to this capitalistic system (Hösle 1992: 113). Nevertheless, OA has made heavy use of these open markets opportunities to get good offers. Therefore, it is not surprising that the processing / trade sector with organic products follows more and more the conventional economic systems (see also De Wit & Verhoog 2007).

*Habits, traditions and social dimensions:* Stakeholder (producers, processors or traders) who convert from conventional to organic have their own predetermined ideas based on traditional practices and the social contexts. Therefore, it becomes difficult for every stakeholder to change habits, following the completely different organic agricultural, processing or trade paradigm, whereas at the same moment, the conventional agricultural and societal mainstream is developing in contrary direction.

*Research, training and education:* Research for OA is also limited to some research divisions; their budget is far less than that of conventional agriculture. The same



budgetary restraint applies to education sector, training, and advisory services. The question arise, if OA is able to hold and deepen their specific quality?

*Media:* Communication is key to the expansion of life styles into the society. Media policy is influencing the behaviour and values of a society. The dominance of conventional and the very cool information on their conflict potential for a sustainable development on one side, and the more and more critical media reports on organic products on the other side lead to a high pressure on OA.

*Policy and private sector:* Several decisions at EU policy sector are a result of the high economic interests of multinational companies and their influence on the agriculture policy decision making process in the region. The latest example is the blockade of the 50% reduction of pesticide use by 2015. Further more, the private industrial sector is arguing that OA is not able to feed the world.

The above tension fields affect societal, economic and ecological values of the organic food chain and the discourse on the future development. In brief and to demonstrate with two other examples, if the organic movement does not open their system for the green gene-technology but also biomass-based energy production or conventional consume patterns like the unlimited availability of non-seasonal food, they risk being branded as anti-progress and being marginalized in the public debate. To find a way out of this paralysing situation, the organic movement has to develop new strategies.

## **(2) Internal driving forces:**

The organic food chain is regulated by guidelines and has developed its own principles (Luttikholt 2007), which are termed as normative ethical guidelines:

- The principle of health: OA should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible unit.
- The principle of ecology: OA should be based on living ecological systems and cycles, work with them, emulate them, and help sustain them.
- The principle of fairness: OA should build on relationships that ensure fairness with regard to the common environment and life opportunities.
- The principle of care: OA should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.

These principles occupy an outstanding position in the debate on sustainable agriculture. Nevertheless, there are some weak points, which can explain that the conventionalisation process is also home-made by the organic movement themselves:

- Which is the focus of the four principles itself? They are addressing OA. But only some insiders imply that the principles focus the whole organic food chain, which includes also processing, trade and consumption whereas the majority assumes that these principles are mainly developed for the producers.
- How obliging are the principles? The principles tell us what we should do. They are not the same as standards / regulations, which have the function to tell us what is allowed / forbidden. They have a guiding but not a binding function.
- Are the principles translated into standards and regulations? A systematic translation of the principles into regulative instructions is open, except those aspects, which focus on the "dealing with the nature (agricultural practice)" and a

catalogue of standards and regulations for processing and trade, which comprises technical schedules.

To conclude these observations, the principles have to address clearly each customer of the food chain and should be obliging. Further more, it is to reflect, how certain aspects of principles could be part of standards and regulations. Even if there was a broad discussion on the development of the principles in many countries, this discussion was limited to outstanding persons and does not affect the organic farming movement as a whole. If moral norms are established in a top-down approach, we cannot assume that customers will follow automatically. This process is always full of conflicts and often not successful. For instance consumers are free in their decision to make any choice for any product no matter whether it is organic or not, local or international, local/seasonal or not, high meat consumption or not. At least consumers are able to foil the idea, which is presented with the IFOAM principles. Nevertheless, we are living in a free society, where a private consumer has a freedom of choice.

## Conclusions

The internal development of OA is tremendously influenced by the societal environment. To protect the outstanding organic quality it is necessary to build up networks to get more political, scientific and societal support. The four IFOAM principles are not really transferred into daily practice. In retrospect we can say, that the IFOAM principles were developed in a worldwide process, but they did not affect the majority. From a practical point of view, there was no alternative to this approach. But more and more the national activities e.g. Bioaustria in Austria started an own debate on values (e.g. fairness, healthy products / dignity of animals / ecology). It is recommended to establish those grass root processes in all IFOAM member countries with a permanent roundtable on organic principles and especially what and if, and how to transfer them into practice (standards / regulations) for the whole organic food chain. This participatory oriented approach is following the concept of discourse ethics (Eser & Potthast 1999: 43).<sup>1</sup> This discourse ethics has its practical limitations, comprises some risks, and has to find pragmatic solutions, but is an entry point to put new life into the debate.

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<sup>1</sup> Consideration of all persons concerned, all arguments, fair dialog (free of hierarchy, constraints); rationality of argumentation (Habermas 1983: 101; see also the principle of Universality (131))

# Dropping organic certification - effects on organic farming in Norway

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Key words: organic farming standards, opting out, motivations for organic farming

## Abstract

*From 2002 to 06, the annual dropout rate of certified organic farmers averaged 7.3%. A project was started in 2007 to explore farmer's reasons for opting out of certified organic production. Important factors seem to be public regulations including standards for organic farming, agronomy, economy, and farm exit. While many organic farmers with relatively small holdings have opted out, farmers with more land and larger herds tend to convert to organic agriculture. The trend towards larger-scale farms in organic than in conventional agriculture, encouraged by the design of the organic farming payments, challenges the organic principles of diversity and fairness. Means should be considered to ensure that small organic enterprises are also economically viable.*

## Introduction

Numerous studies have examined organic farmers' characteristics, motives, attitudes and barriers related to the conversion from conventional to organic farming. Recent studies have also discussed the perceived problems and reasons stated by organic farmers for opting out of certified production. In Norway, farmers' reasons for opting out of certified organic farming have so far just been explored on a regional level or limited to one production; most such analyses have not been published internationally. E.g., it has not been explored if the farmers in question return to conventional practices or exit farming altogether. It is also possible that some who opt out of certified production in fact maintain a farming practice close to the organic principles. In this paper we present the number of farmers entering and opting out of organic farming in recent years; their reasons for opting out; and some characteristics of such farmers.

## Materials and methods

This paper is based on results from various previous Norwegian studies, agricultural statistics, and preliminary results from a research project with a combined quantitative and qualitative approach. Interviews were conducted to better understand the complex phenomena of converting to organic agriculture and to opt out. A list of farmers was prepared, including farm data of those who opted out in the period from 2002 to

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autumn 07. Experienced advisers for organic farming helped to pre-select farmers. The interview results presented are based on two interviews with advisers and four with farmers with grain, vegetable, sheep and dairy milk production.

## Results and discussion

On average, 179 farmers per year resigned from certified production between 2002 and 2006. This represents 7.3% of the average number of Debio<sup>1</sup> certified organic holdings in this period. About 4% of these farmers were 67 years or older, (retirement age), which is close to the normal figure for farmers in general. Even so, the total number of organic farms<sup>2</sup> increased from 2303 holdings in 2002 to 2500 holdings in 2006. In the same period, the area of organically certified farmland and land in conversion increased from 32,546 ha to 44,563 ha. This rate of growth is far too low to achieve the national goal of 15% organic food production within 2015. The increase in organic farmland per farm has, however, been quite impressive. The average organic area per Debio registered farm increased by 42%, from 11.0 to 15.5 ha from 2002 to 06, while the average total agricultural area on these farms increased by 25% from 19.7 to 24.7 ha<sup>3</sup>.

In the period 2002-05, organic farms had on average about 17% more agricultural area than farmers opting out, and also 17% more land than the overall Norwegian average (Table 1). This illustrates the tendency that farmers with access to more farmland consider organic management as more attractive than those with less land. Note also that 72% of the farmland on organic farms was certified<sup>2</sup> during 2002-05, while only 41% was certified on the farms opting out. One reason for this difference may be that the farmers gradually opted out of certified organic production over a period of several years. Alternatively, some of the farmers opting out may only have converted some farmland as a test area.

While there was little difference between all Norwegian farms and organic farms with regard to herd sizes (Table 1), much fewer organic farms had milking cows than in Norwegian farming as a whole. There were also fewer dairy farms in the group of farmers who opted out, and the average herd size was also slightly smaller in that group. From 1995 to 2006, 360 farms supplied organic milk to the TINE dairy cooperative (Lutnæs 2006), which is by far the largest dairy company in Norway. Since 1995, 62 of the 360 farms stopped supplying organic milk to TINE. Of these 62 farms, 40 ceased dairy farming and sold their milk quota. Another 9 stopped producing milk without selling the quota, and 13 started joint operations with other organic dairy farms. Since 1996, TINE has paid a premium price for organic milk; mainly to farmers delivering to an organic milk processing dairy. The price premium prevents organic dairy farmers from opting out: 30 of the 62 farmers did not receive a premium price (Lutnæs 2006). However, 22 of the 62 farmers did receive a premium price, so a high payment is not always enough to stay in business. The claim that farmers had to be localised close to a dairy processing organic milk to receive a premium price has

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<sup>1</sup> Debio is the Norwegian inspection and certification body for organic agricultural production. Debio also certifies farmland for the receipt of government payments for organic farming.

<sup>2</sup> In this paper farmers with certified organic area or area in conversion are named organic farmers.

<sup>3</sup> In Norway parallel production of organic and conventional farming is allowed if there is a clear partition between both production systems, so not all farm area on organic farms has to be certified for organic production or in conversion. As soon as a farm has some certified organic production; the farm is registered in statistics as an "organic farm".

hampered conventional dairy farmers from converting. Over time, the regions where premium prices are paid have increased in size, and the demand for organic milk is now so high that new strategies are probably considered to increase the production of organic milk.

**Tab. 1: Key characteristics of farms in Norway**

Year	Farms opted out				Organic farms	All farms
	2002	2003	2004	2005	2005	2005
Farms	199	210	182	153	2496	51069
Agricultural area; ha/farm	17.4	15.9	15.6	24.9	23.9	20.1
Organic and in-conversion area; % of agricultural area	28.7%	47.2%	48.7%	39.4%	72.1%	4.2%
Dairy cows; cows/dairy farm	14.3	12.6	17.1	15.5	17.7	16.8
% of farms with dairy cows	11.4%	16.9%	15.7%	11.9%	22.1%	31.8%
Sheep, over 1 year; sheep/sheep farm	36.5	43.9	41.8	47.0	59.0	64.0
% of farms with sheep	40.0%	40.2%	39.9%	32.6%	32.3%	33.4%

Sources: Debio, annual statistics ([www.debio.no](http://www.debio.no)) and Statistics Norway ([www.ssb.no](http://www.ssb.no)).

From 2002 to 04, relatively many sheep farmers opted out (Table 1); these tended to have smaller herds than both the organic farmers and the Norwegian average. Sheep farmers with small herds probably experienced the new organic regulations, e.g., required solid floor lying areas for all animals, as a too expensive investment. Preliminary results from interviews with experienced farm advisers and farmers who opted out confirm the trends described above. Farmers mention that the organic standards changed frequently and unexpectedly, and became stricter with time. For some changes, the farmers complained about a lack of scientific evidence. New regulations for buildings often required considerable long-term investments, which are considered as especially risky since agricultural policy is regarded as being not very predictable (Koesling et al. 2004). At the same time, low unemployment rates and high salaries tempt farmers to seek off-farm employment. Organic crop farmers mentioned problems linked to weed control and plant nutrient supply. Especially for organic vegetables it was challenging to find local buyers and to get a premium price. For the organic animal husbandry farms, the access to straw for bedding material is a challenge because many regions in Norway are not suited for grain production. Thus, the housing of sheep on slats or expanded metal floors is common practice. In addition, it is difficult to be self-supported with concentrates. The requirement of solid-floor resting areas and 100% organic fodder led many farmers to quit organic sheep farming. For organic dairy farmers not receiving a premium price, the demand for 100% organic fodder and loose-housing barns in 2011 have probably caused them to opt out. The Norwegian results are in line with an Austrian study (Schmid 2005), where the most important reasons for farmers to revert from organic farming were high costs or a shortage of organic concentrates or feed grain, lack of price premiums for organic products, and too frequent changes in regulations.

Most of the government payments for Norwegian agriculture are differentiated in relation to farm size and region, with lower rates for larger farms (agricultural area and herd size) and farms in the most favourable regions. Contrary to this, in general the

subsidies for organic farming are very little differentiated according to farm size or region<sup>1</sup>. The system for organic price premiums is comparable. Such a system encourages the conversion of farms with much farmland and/or large herds. In addition, these farms may also utilize economies of scale, especially when marketing their products, buying inputs and special equipment, adapting their buildings to new regulations, or building new ones. Our results show that there is a clear trend in this direction in the structure of the Norwegian organic agriculture. As was found in our study and Austria, also in Denmark, farmers reverting to conventional production were primarily motivated by economic reasons. However, a recent study shows that reverting farmers in the Northern part of Norway were still interested in organic principles. 47% of these farmers in fact were considering to re-register for certified organic production, and 38% answered that they still were farming in line with the organic principles but without being inspected and certified. This indicates that a notable group of farmers who have opted out may still be interested in organic farming.

## Conclusions

As in other countries, there are different reasons for farmers to opt out of certified organic production in Norway. Important factors were regulations, agronomy, economy, and farm exit. But there was no indication that more organic farmers quit farming than farmers in general. To achieve the ambitious goal of 15% organic production and food consumption by 2015, it seems that fewer farmers would opt out if the regulations would be more stable and foreseeable. Especially where investments are needed, long-term agricultural policy, government payments and organic price premiums could give farmers more long-term reliable conditions for their decisions. Furthermore it should be considered if regulations and policies promote farms with more farmland and/or more animals and if this is intended.

## Acknowledgments

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<sup>1</sup> Support is differentiated between crops, and animals in the Northern part of the country receive some more support.

## Analysis of differences between EU Regulation (EEC) 2092/91 in relation to other national and international standards

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Key words: standards, organic agriculture, regulatory framework, standards database

### Abstract

*Differences between the EU Regulation (EEC) 2092/91 and selected private as well as governmental organic standards were analysed as part of an EU-funded research project on the revision of this regulation. Most of the differences were found in the following areas: conversion, fertilising, animal feeding, veterinary treatment and animal husbandry. Many differences have specific justifications, influenced by specific national or regional circumstances or policy framework. The variations between the EU Regulation, governmental and private-sector standards do not concern basic requirements; i.e. there is a general agreement on the main general principles of organic agriculture within the EU. A certain regional flexibility can be justified.*

### Introduction

Although the Regulation (EEC) 2092/91 for Organic Agriculture exists since 15 years, its implementation in the EU Member States still varies. Private standard-setting organisations and some governments within and outside the EU have long-established organic standards, which in some areas are more detailed and/or more demanding than the EU regulation. The revision process of this EU regulation is an opportunity to reflect the potentials for harmonisation, simplification and regionalisation of the rules; the analysis of different standards can indicate possibilities for change.

### Materials and methods

The differences of various standards were analysed based on the Organic Rules database ([www.organicrules.org](http://www.organicrules.org)). The source data were submissions from standards experts for most of the relevant private, governmental or international standards in 17 countries. The submissions consist of a brief summary of each standard's requirements, description of the differences and their justifications compared to the EU Regulation (EEC) 2092/91. Each submission was categorized into subject areas. Furthermore the differences were grouped according to the four ethical principles of the International Federation of Organic Agriculture Movements (IFOAM) of health, ecology, fairness and care. The authors then analysed compliance with and differences to Regulation (EEC) 2092/91. Furthermore (but not in this paper) potentials for harmonisation, simplification and regionalisation were outlined in the report as recommendations for the EU Commission (Schmid et al. 2007).

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## Results

The analysis of differences between the (EEC) 2092/91 and other international and national organic standards covered 34 standards from 16 European countries and the USA as well as 3 international standards (IFOAM, Codex Alimentarius and Demeter International). In total 714 differences were uploaded in the "Organic Rules" database until December 2006 of which more than 85% were related to Annex I provisions (Rules on production), followed by approximately 10% in relation to Annex II (Permitted substances).

Because Regulation (EEC) 2092/91 is the legal framework for the EU, European national governmental and private standards setters have to follow these rules and cannot be less restrictive. Some national governmental standards, e.g. the Danish, French, and Swiss ones, contain additional requirements based on specific national legislation and policies or due to specific concerns of producers, processors, consumers or the general public. Many national private standards are more detailed than the EU Regulation or the national governmental standards. Many differences (>30) were found in standards from countries that have a long tradition of organic farming such as Austria, Germany, Sweden or the UK. Many standards also include areas not covered by the EU Regulation, such as wine production, aquaculture, care of the environment and non-food production and processing.

The analysis of specific thematic areas followed the structure of the EU Regulation (EEC) 2092/91. It revealed mostly differences of a technical nature described below. In the field of crop production there were 206 in livestock 294 differences submitted. More details see Table 1.

**Labelling:** Regarding the labelling of food there are little differences compared to the Regulation (EEC) 2092/91. Several standards cover non-food items.

**Conversion:** Different approaches are identified regarding reducing the period for conversion of land, either by shortening the period itself and/or by facilitating retrospective recognition of the conversion period. Nine European standards (of which one governmental: DK) require conversion of the whole farm; however the transition period can vary from 2-8 years in the case of a step by step conversion.

**Plant production:** There are differences regarding the implementation of a seeds database and on the criteria for the authorisation of use of non-organic seeds and propagation materials. In the area of fertilization the most often found differences were fertilisation intensity, manure use, crop rotation and restrictions for certain fertilisers and soil conditioners. In Europe all national governmental and private standards must respect the maximum limit of 170 kg N/ha/year for manure application required by the Regulation (EEC) 2092/91. However some standards do not set maximum limits for the total application of nitrogen. Other governmental and private standards set lower maximum amounts than the Regulation (EEC) 2092/91 for the total application of nitrogen. In several standards the source of conventional as well as organically derived nutrients is restricted as well. Some private standards have stricter requirements regarding the treatment of manure-based fertilisers. Several private standards in some countries have more detailed requirements for the crop rotation. Regarding pest and disease control in general, most of the regulations and standards have very few additional requirements. Several European governments have excluded the use of specific substances such as rotenone (DK, FR, UK), neem (DK, FR, UK), copper (DK, NL), because of their national pesticide authorisation.



**Tab. 1: Analysis of differences between Regulation (EEC) 2092/91 and private, national governmental and international standards**

Main areas (Articles or annexes in Regulation EEC 2092/91)	No of differences	Countries (n=17)	Main type*	Main justification, relevant IFOAM principle(s)
Labelling (Main regulation Art 5)	20	7	P	Consumer
Seeds and seedlings (Art. 6a)	12	3	P	Trade, Ecology
Conversion of land (Annex I A1)	37	11	P, N	Precaution
Fertilising (Annex I A2) (I A 2 & II B)	72 31	11	P, N	Ecology principle National legislation
Pest and disease control (I A3)	13	7	P, N	Ecology, health, National legislation
Collection of wild plants (I A4)	14	7	P, I	Ecology principle
Conversion of animals (I B2)	40	11	P, N	Precaution
Origin of animals (I B3)	15	6	P	Precaution (BSE)
Animal feeding (Annex I B4)	70	12	P, N	Precaution, Animal welfare, Ecology,
Veterinary treatment (I B5)	26	7	P, N	Precaution, health
Livestock husbandry (I B6)	58	10	P, N, I	Animal welfare
Manure (I B7), (Annex VII)	24 (15)	8	P	Ecology
Housing and free range (Annex I B 8) (Annex VII)	76 22	12	P, N	Animal health and welfare
Processing (Annex VI)	28	10	I, P, N	Care principle
<i>Areas not covered by Regulation 2092/91</i>				
Greenhouse and perennials	54	7	P	Ecology principle
Ecosystem management	9	4	P	Ecology principle
Soil and water conservation	13	8	P	Ecology principle
Biodiversity and landscape	16	6	P	Ecology principle
Contamination	15	8	P, N	Care principle
Aquaculture	12	8	P	Animal welfare

\*P= private standard(s), I = International; N = National governmental standard(s)

**Animal production:** There are significant variation between standards, regarding the proportion of conventional feedstuff, on the proportion of feed to be grown on the same farm holding and on roughage and herbage to be fed to herbivores. In veterinary treatment of animals there are little differences, except the US NOP (after use of antibiotics animal products cannot be sold as certified organic). In animal husbandry management there are several differences in the area of animal breeding and rearing techniques: mutilation and dehorning, livestock housing and behaviour, electrical conditioning, tethering, transport as well as slaughter and traceability. Several governmental rules and private standards have very detailed requirements on supporting the behavioural needs of animals (bedding material, weaning, exclusion of electrical conditioning, etc.). Some private standards are explicitly outlining under which circumstances animals may be tethered but not permanent. Several national private standards have rules, which indirectly reduce the animal stocking density (e.g. nutrient balance for the whole farm, restricted use of feed from external sources).

Several national governmental and private standards have a vast variety of different requirements for animal housing and free range areas.

**Processing:** Detailed food processing standards for specific product groups have been elaborated only by a few private standards setters and in one national standard (ban on use of some allowed additives in DK).

**Areas not covered by the Regulation (EEC) 2092/91:** Regulation (EEC) 2092/91 includes only few specific requirements regarding ecosystem management, but some of these aspects are addressed in general EU legislation in various ways. Several national private organic standards have general requirements concerning low energy consumption; few limit the energy consumption in greenhouse production and/or the water use. Biodiversity and landscape requirements are found in several private organic standards; e.g. by requiring a minimum % of the farmland to be dedicated to diversification and habitat management. Prevention of contamination with pesticides, but also other contaminants like GMO, is an area of concern in the US NOP, one national standard and in several private organic standards. Many national standards have rules on aquaculture. However only few standards (4) had social requirements.

## **Discussion**

The variations between the EU Regulation (EEC) 2092/91, governmental and private-sector standards do not concern basic/fundamental requirements; i.e. there is an agreement on most of the general principles of organic agriculture within the EU. Differences are rather in technical aspects at the implementation level or mostly found in private standards of private organisations, which want to differentiate themselves from the EU rules. Generally the differences are very much dependent from different factors: state of development of organic farming, national legislation, consumer perception, regional pedo-climatic factors, etc. This would justify possibilities for more regional flexibility, as foreseen in the new Council regulation (EC) No. 834/2007.

## **Conclusions**

The analysis indicates some areas, where the EU Commission could envisage a harmonisation in the implementing rules under the new regulation (EC) No. 834/2007, mainly where many standards have already introduced comparable rules. However there is also a justification for a certain regional variation and a differentiation of private standards as long as these lead not to trade distortion and consumer distrust.

## **Acknowledgments**

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## Organic operators' satisfaction with their certification body – a survey in Germany

Zorn, A. & Renner, H.<sup>1</sup>

Key words: Organic inspection and certification, organic association, organic processors, satisfaction, Germany

### Abstract

*Organic certification represents different functions for the stakeholders involved in this process. For a producer of organic food, it is mainly a service provided by a certification body. Hardly any information currently exists on organic operators' satisfaction with this service. In a survey of German organic processors, we examine the satisfaction and other questions connected to the relationship certification body – client and offer insights for certification bodies and organic associations.*

### The market for organic inspection and certification in Germany

The organic food market in Europe is regulated by Regulation EEC (No.) 2092/91. This regulation does not only determine the organic production process, but also the process of inspection and certification. In the case of organic food, an independent so-called 3<sup>rd</sup> party inspection is an efficient solution to guarantee organic quality, since the production process results in credence attributes that cannot be easily verified by consumers (Darby/Karni 1973). In Germany, the national legislation authorises private bodies to inspect and certify organic operators. Currently, 22 certification bodies (CBs) are operating and offering their services in Germany.

The operator can select his CB from these 22 registered CBs - a relatively broad range compared to other European countries. An economically rational organic operator would therefore compare the service offered (the CBs' quality) and the required remuneration (certification fee) before choosing a CB. In this competitive environment, the operator is also able to change the CB, if the offered service or price is not satisfactory.

In the case of organic certification, choosing the appropriate service is of particular importance, since the CB is not just a service provider but also the publicly authorised institution that will guarantee the organic integrity (consumer protection), which includes disciplining organic operators, i.e. its own clients. There is potential of conflict in the neutral inspection of one's own clients within the framework of these two roles.

Dissatisfaction as a reason for changing CB can result from insufficient support on the one hand (e.g. slow handling of requests, inspection results not transparent), but also from (perceived) captious inspections.

That is - in short - the legal and economic environment in which German CBs are acting. This study mainly examines the importance of different criteria operators use to

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select their CB, then questions their current satisfaction with their CB and, finally, asks their reasons for changing their former CB.

### **Materials and methods**

In the literature, the reliability of certification systems and potential shortcomings, as well as suggestions for the optimization, are regularly addressed (e.g. Jahn, Schramm, Spiller 2005, GfRS 2003). In contrast to certification systems research, hardly any literature exists on organic operators' satisfaction with the organic certification process and their criteria for selecting a CB.

This study is based on an online survey of organic processors conducted in July and August 2007<sup>1</sup>. The questionnaire was addressed to 1565 companies in Germany. The e-mail addresses of organic operators were gathered from organic associations' homepages (21.5% of the contact data). Furthermore, two certification bodies disseminated the questionnaire to their clients (78.5%). The questionnaire can be structured in 3 parts: questions on a) the company profile, b) the CB selection process and c) the current satisfaction with the CB. In order to attain a higher level of response, the number of questions was limited to 23, some of which were further divided into subcategories. The statistical analysis (comparison of means) is based on 199 questionnaires from German organic operators, resulting in a response rate of 12.7%<sup>2</sup>.

### **Results of the statistical analysis and their discussion**

Organic food processing comprises many different branches, with very specific fields of activity. The most prevalent branches (multiple answers) in this survey are wholesale (n=46), packaging (40), baked goods/bakery (40), import (32) and restaurant (including cafeteria) (29). 58 companies are active in two or more (up to 4) branches of food processing.

The majority (56.3%) of the respondents are running a mixed business and produce organic alongside non-organic goods. In these companies, both the average share of organic assortment (28.3%), as well as the average share of organic sales volume (28.6%), is below 30%. In the case of only 20% of the mixed companies, organic processing is more important (> 50 %) than non-organic, in terms of sales and proportion of stock. Amongst the members of an organic association the proportion of operators who exclusively produce organic (58%) is much higher than amongst the non-members, where only every fourth company produces only organic goods.

The share of companies that are members of an organic association is 54.3% (non-members 45.7%). Membership is mainly of the two associations Demeter (63.2% of affiliates) and Bioland (42.5%). 15% of the companies are members of two or more associations. German organic associations play an important role in the national organic sector, which is also reflected in the process of finding a CB; for every third

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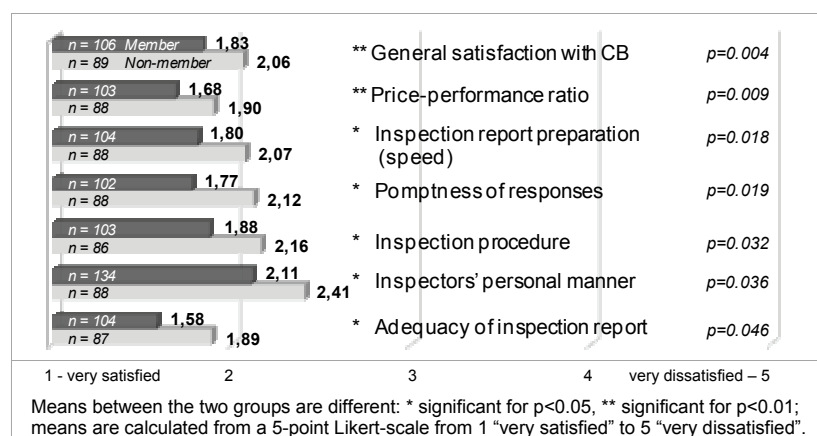
<sup>1</sup> The original survey also included Swiss operators. Since the number of addresses and subsequently the number of responses was limited, the corresponding data was not included in this study.

<sup>2</sup> Questionnaires finished after the first questions were excluded from further explorations. This applies for 11 questionnaires. Reliable information on the response rate of the two sources of contact data (organic associations, CBs) is not available, since the survey was conducted anonymously.

respondent, their initial awareness of the CB can be attributed to an organic association<sup>1</sup>. Of course, this link is more important in case of member operators, but every tenth non-member company also referred to this link, with respect to the search for a CB. In both groups, recommendations or hints from already certified companies are very important; for non-members, this is the most important lead when contacting a CB (25.6% of responses), followed by internet research (24.4%). For member companies, information from organic operators is second in importance (19.6% of responses), after the association's recommendation (56.1%). In this respect, professional consultants, professional associations, CBs' advertising and public administration play minor roles. Overall, information from personal acquaintances is very important, with regard to the choice of a CB. This conclusion is reinforced by the answers to the question for the criteria selecting a CB; the most important criterion is that of having a capable contact in the CB – information that only an insider can provide.

Generally, respondents are satisfied with their CB's work, with 40% considering themselves as very satisfied and 49 % as satisfied, for a total of nearly 90% of the operators<sup>2</sup>. Only 2.5% are slightly dissatisfied, while no respondent is completely dissatisfied with his CB. The itemized question on satisfaction with the CB's service (e.g. inspection procedure, comprehensibility of the inspection report - in total 12 questions) showed that, in 9 out of 12 cases, satisfaction was stated by over 79% of the respondents. In the other three items the number of satisfied operators lies at 46% (information on current legal changes, support in case of residues or suspicion concerning the organic integrity) and 67% (ratio price – performance).

**Tab. 1: Comparison of means – members of an organic association versus non-member organic operators and their satisfaction with the respective certification body.**



<sup>1</sup> Historically, some German CBs were part of an organic association (e.g. Bioland). The requirements of ISO 65 led to the separation of CBs and associations. However, an affinity still exists between organic associations and these independent CBs.

<sup>2</sup> The top two ratings on the 5-point Likert scale have been combined as "satisfied operators" in order to give a better indication of the overall satisfaction.

A comparison of means between the satisfaction of operators that are members in an organic association such as Bioland, Demeter or Naturland, and the satisfaction of non-members, shows significant differences. Non-member operators are generally more satisfied with the overall service of their CB than those that are members of an organic association. A detailed analysis of the itemized questions shows that the greater satisfaction in the non-member group results from a significantly higher degree of satisfaction concerning the price-performance ratio, the promptness of the inspection report, the inspection procedure, the personal manner of the inspector, and finally the appropriateness of the inspection report (see Table 1). These findings are not intuitively plausible and require further research. One explanation could be that German organic associations have higher standards than the EU regulation, i.e. higher potential not to fulfil the certification requirements. This might lead to additional work for operators to meet the standard. Furthermore, the certification procedure for an association certification is twofold, hence more complex and more costly. This may lead to lower satisfaction rates in the items of Table 1.

Severe dissatisfaction, along with economic and also formal reasons can lead operators to change their CB, something 11.9% of the respondents had done in the past. 18 of the 23 operators that changed CB gave concrete reasons: 22% changed for economic reasons, such as high prices or synergy effects; 22% were forced to change, e.g. because their CB had closed; the remaining 56% switched due to dissatisfaction with the CB itself, e.g. because of poor cooperation or discord with the CB, poor availability or inspectors'/CBs' "arrogance".

### **Conclusions**

The overall satisfaction with the organic certification bodies considered in this study can be regarded as very good. Significant differences between the groups of member and non-member operators with regard to their satisfaction with the certification process became apparent, but could not be further explained by the existing data; here further research seems pertinent. When choosing a CB, operators take personal acquaintance and links, e.g. of other companies or organic associations, into particular consideration.

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# CERTCOST – Economic Analysis of Certification Systems for Organic Food and Farming at EU level

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Key words: Organic inspection and certification, transaction costs, organic regulation

## Abstract

*With the ongoing growth of the organic sector and the spread of organic production across the EU, the field of organic certification has become a maze of competing labels and logos. This diversity reflects the specific conditions in different regions and countries, but can also lead to confusion for producers and consumers, as well as create a variety of costs. It is imperative to conduct a comprehensive economic analysis of the variety of existing certification systems and their impact on the internal European market for organic goods. This project proposes to combine the experience and knowledge of both researchers and SMEs to analyse the implementation of organic certification systems and to estimate all relevant expenditures or transaction costs for different certification systems along the organic food supply chain. Benefits of certification will also be analysed, using data on consumers' recognition and willingness to pay for different organic logos and trademarks. Finally, recommendations will be drawn for the EU Commission, national competent authorities and private actors in organic food and farming on how to increase effectiveness and efficiency of organic certification.*

## Project Overview and Objectives

Certification is a key element of organic farming systems today, because only certified organic products may be labelled as such, thereby gaining access to the organic market and earning premium prices. Conceptually, the main benefit of organic certification systems is to assure everyone within the organic supply chain, and particularly the consumer, of the integrity of organic products. This is necessary because 'organic' is defined by the process of its production rather than characteristics of the end product alone (e.g. residue levels) and the supply chain of organic food is subject to imperfect information and opportunistic behaviour (such as fraud).

Moreover, organic certification systems involve costs. A proportion of the higher cost of organic products may result from the costs of certification along the supply chain, through inspection of the farmers, the processors, the wholesalers, the importers and, in cases where products are repacked, also the retailers. Currently, some of these costs may be due to inefficient design of organic certification systems and lack of mutual recognition among certifiers. In any case, it can be assumed that the total cost of the organic certification system in Europe is substantial; however, no reliable estimates exist. In general, very little information on this sector is publicly available and a general overview of key aspects and the functioning of the organic certification system is missing. This is particularly problematic in light of the current revision for the

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legal provision for organic production in the EU (European Union) and associated countries.

For this reason, this project has been proposed under the Seventh Framework Programme of the European Commission. It is the aim of the project to evaluate organic food certification systems in Europe, in order to provide research-based recommendations on how to improve these systems in terms of efficiency and transparency. This is also likely to strengthen the competitiveness of the European organic food sector because it will reduce the incidence of non-compliance and thus increase consumer trust.

The project will be divided into the following key objectives:

1. Provide a comprehensive review of organic certification systems and standard setting procedures, including a database on key data, a review of relevant international regulations, an overview on publicly available certification prices, and an estimate of the size of the certification sector.
2. Analyse the implementation of organic certification systems and assess all relevant expenditure and transaction costs for different certification systems along the organic food supply chain.
3. Investigate the main benefits of certification systems, both qualitatively and quantitatively, in terms of consumers' recognition and willingness to pay for different organic logos and trademarks.
4. Improve risk-based certification systems and increase cost effectiveness of certification, through the application of economic models.
5. Develop recommendations for the EU Commission, national competent authorities and private actors in organic food and farming on how to increase the effectiveness and efficiency of organic certification.
6. Include stakeholders' views in the assessment of organic certification systems and share the project results with them and the public.

### **Proposed Methodology**

Since the amount of literature directly referring to organic certification systems is limited, it is helpful to examine more general literature on food quality and other certification processes which goes beyond organic food and farming and thus integrates other aspects into the discussion. A comprehensive overview on the economic literature on food quality assurance and certification systems (both organic and conventional) is given by Burrell et al. (2006). Focusing on methodology, they identify 13 relevant research questions that address, among other issues, what are the benefits and costs of quality assurance/certification schemes, what is the optimal mix of public and private funding for such systems, what are producers' attitudes towards them, and what are consumers' views of various labels and levels of quality? The framework of this project will to some degree mirror these questions, as can be seen in the key objectives mentioned above. The project will be divided into six work packages (WP), of which each will be dedicated to achieving one of these objectives.

Once a baseline has been developed, compiling all available data on the current state of organic certification in the EU (WP 1), the next step will be to identify and analyse the costs of certification (WP 2). The starting point of a thorough cost estimate must



be a classification of all kinds of transaction costs resulting from certification at different levels of the supply chain. The concept of transaction cost economics (Coase, 1937; Williamson 1979, 1985) is a widely used approach to analyse the costs incurred when exchanging goods and services. Alternatively, McCann et al. (2005) suggest a comprehensive typology and discuss measurement methodologies for transaction costs in the field of environmental policy. This framework may also be helpful in conducting a transaction cost analysis of the organic sector. In order to assess administrative burdens, the Netherlands introduced a 'Standard Cost Model (SCM)' in 2002. This model is now used to assess the administrative costs of EU legislation (Commission of the European Communities 2005). In this project, the SCM will be applied to the analysis of the costs of organic certification, being itself a direct consequence of EEC Reg. 2092/91.

Benefits of certification will then be examined in relation to consumer recognition and willingness to pay (WP 3). One method for gathering ideas to begin to understand consumers' awareness and perception of different organic standards and the corresponding buying behaviour is to start with a qualitative market research study. This will involve an overview of existing organic labels standing for different standards and certification systems, achieved through a market inventory conducted by small observational study. Focus group discussion will then be used to collect a wide range of consumers' opinions and views. The combined results of the market inventory and focus group discussions will provide the necessary background information to design an appropriate quantitative consumer research study.

In WP 4, data collected from the two previous work packages will be statistically analysed and used to develop novel economic models for inspection systems. Bayesian modelling will be applied to determine how to increase effectiveness and efficiency of inspection, with regard to risk of non-compliance. A heuristic model of organic certification will also be developed that links all relevant factors determining non-compliance related damages, as well as compliance costs and transaction costs of certification.

During the course of the project, results will be discussed with various stakeholders, particularly in terms of their applicability. This input from the stakeholder will be integrated into the compilation and synthesis of all results and the forming of recommendations for the EU Commission and pertinent national authorities (WP 5).

### **Project Consortium**

The project consortium consists of ten partner institutions from seven different European countries. Although eight of the ten project partners focus on scientific research, two SMEs are also part of the consortium and will bring extremely valuable experiences and perspectives to the project.

A basic idea in the consortium formation is that the partners need on the one hand, a common ground in order to work effectively together and, on the other hand, must be diverse in background (science vs. business), scientific and methodological capabilities, regional spread and other factors, in order to form a complementary partnership.

The members of the project consortium are:

- University of Hohenheim (UHOH), Institute of Farm Management, Stuttgart (DE)

- Research Institute of Organic Agriculture (FiBL), Socio-Economics/International Cooperation Department, Frick (CH)
- Polytechnic University of Marche, Dipartimento di Ingegneria Informatica, Gestionale e dell'Automazione (DIIGA), Italy
- University of Kassel, Faculty of Organic Agricultural Sciences, Department of Agricultural and Food Marketing, Germany
- Institute for Marketecology (IMO), Switzerland
- University of Ege, Faculty of Agriculture, Department of Agricultural Economics, Turkey
- Danish Research Centre for Organic Food and Farming - Aarhus University, Denmark
- Czech University of Life Sciences Prague, Faculty of Economics and Management, Czech Republic
- Institute for Ethical and Environmental Certification (ICEA), Italy
- Aberystwyth University, Institute of Rural Studies, United Kingdom

This choice of partners ensures that the project will have the advantage of particular expertise in a wide range of fields relevant to this study, including: previous experience with all aspects of organic certification and policy, comprehensive knowledge of economic modelling and analysis, as well as experience in consumer and market research, participatory methods, dissemination and stakeholder involvement. The results of the project and the subsequent recommendations will not only be shared with the European Commission and national/regional governments for the purposes of policy development, but also disseminated at the stakeholder level through workshops and pertinent newsletters, to the scientific community through scientific publications and congresses, and finally to the general public by means of a freely accessible website.

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# IFOAM principles in the light of different ethical concepts

Freyer, B.<sup>1</sup>

Key words: ethics, IFOAM-principles, organic agriculture, values

## Abstract

*The IFOAM principles of health, ecology, fairness and care are a product of debates on ethical values done by the organic movement from the last years. The paper discusses how the values are embedded and linked with ethical concepts. Furthermore, the question of how to transfer these values into practice is reflected.*

## Introduction and objectives

There is an increasing trend towards conventionalisation and an increasing debate to peg enterprises on ethical values as well as a search for instruments to implement values into practical reality. The organic movement is challenged to (re)define their values and find ways to formulate them into practice. One important result of ethical debates is the four IFOAM principles. A question however remains to be addressed: how are the IFOAM principles embedded or linked with ethical concepts<sup>2</sup>, and whether the principles offer a new perspective for the ethical debate in general. To give some insights in this debate I reflect the background of ethics, and how the IFOAM principles are related to different ethical concepts.

## Ethics

*Socrates* (470-399 B.C.) main topic was the reflection on "the right path of life". *Aristotle* (384-322 B.C.) recognized ethics as an independent philosophical discipline. Ethics is a part of practical philosophy, besides economy and policy. Ethics is a science on moral acting, in a sense of good living, fair acting, and an aptitude to make reasonable decisions and judgement. Morality means moral norms, value-based judgement and institutions, and the task of ethics is the philosophical investigation of what is moral (Pieper 1994: 27). Ethics focuses on the theory of explaining norm systems and action rules. Ethics attempts to address such questions as: what values and norms, aims and purposes should humans orient their actions on. Norms and aims vary for individuals and depend on what is acceptable by in his specific society, group and himself (his own moral integrity). The issue of ethics is the effort to prove each moral concept, to argue and approve its valid. Ethics also aim to find a supreme and reasoned principle, which is qualified to assess and rank values, norms and aims and if necessary, to add them into new perspectives; which finally to contribute to an optimisation of humans (and nature) living together in harmony.

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<sup>2</sup> The focus is on occidental ethics

## Linkage between ethic and IFOAM principles

The function of ethics is to strengthen the coexistence of humans, and encompasses the well being of the individual and the community. This is also the overall aim of the four IFOAM principles, based on the values of health, ecology, fairness and care have been formulated as normative and ethical guidelines (Luttikholt 2007). The four principles could be described as "moral norms for the behaviour of all stakeholders who are part of the organic food chain system". The idea is that at least all accept and follow these principles and orient their actions towards them. All human beings who are part of the system are responsible to fulfil these values (care). They should not differentiate between human and nature but should consider all in totality (health; wholeness and integrity of living systems) (IFOAM 2007). The principles are holistic in a sense that they integrate the whole planet (space) as well as secure a future to coming generations (fairness). Nevertheless humans become a specific focus of attention (care). At least the values are concerned with associations of living systems (ecology) and reintegration of any living being. The question is, how do these values relate to ethical concepts?

## Ethical concepts and IFOAM principles

The framework of the following reflections is given by the two concepts; anthropocentric ethics and physiocentric ethics, with a selective focus on their specific differentiations. In anthropocentric ethics, humans are on the top of the life pyramid (impressed / *res cogitans*) in demarcation to the other world (material / *res extensa*) (*Descartes* 1596-1650). *Kant's* (1724-1804) Categorical Imperative "Act only according to that maxim whereby you can at the same time will that it should become a universal law". It is in the tradition of anthropocentric ethics to follow the deontologic ethics where an action is based on guiding principles rather than the consequences of the action. This approach focuses on the rightness or wrongness of actions themselves. Utilitarianism excludes interests of plants and animals (Frey 1980) but partial pathocentric ethic includes the interests of animals which are subject to suffering (*Bentham's* 1748-1832). *Kant's* approach further includes the human responsibility for animals, but he didn't attributed to animals any rights or an own value. This position is not in line with the IFOAM principles. In contrary *Kant's* idea, that ethical rules "bind you to your duty" (Waller 2005: 23) could be a perspective of IFOAM principles. Utilitarianism as one concept of consequentialism follows the idea that any action that produces positive consequences is a morally right action, briefly, the ends justify the means; or rather, the rightness of an action is determined by its consequences (Flew 1979: 73). There is a debate, if utilitarianism follows more a human centred, strong anthropocentric, hedonistic and egoistic approach or more a responsible attitude, also including the well being of society and nature as a whole (see Peet 1999; Daly 1995). Egocentric ethic, based on ego, was developed in the 17th century, and came up with nature-science revolution and the rise of capitalism. The fundamental issue is the individual with his own interests, with the assumption that what is good for the individual is also good for society. This position is mainly in conflict with several interpretations of IFOAM principles, at least, because it follows the competition approach of liberal economy. As a means to get out of this competitiveness, *Hobbes* (1588-1679) recommended a contract of association between parties (Merchant 1991: 135). In this sense, the IFOAM principles are in agreement, as they offer a basis for a contract between all stakeholders involved in the whole movement. Gradually, modifications of anthropocentric ethics has systematically lead to physiocentric ethical concepts (Pfordten 1996: 21). This ethical

approach integrates ecosystems. Their living and inanimate components are in the responsibility of human being (biocentrism, holism, ecocentrism, pathocentrism). Biocentrism is a normative ethic which attributes independent moral value to all living beings whereas the ecocentrism includes the entire ecosystem. Moderate biocentrism means that we have to protect the whole living nature and all forms of life are equally valuable and humans are not on the top of the hierarchy of living organisms. *Bentham* represents the pathocentric ethic, where all organisms which are able to suffer, are to be protected in a certain sense. Zoocentrism integrates higher animals, a position often held by animal-rights-activists. Albert Schweitzer (1875 - 1965) is the main representative of the radical biocentrism, where every organism has the right to live and is to be protected. The most radical position presents the holistic ethic, which accords the inanimate nature the same rights as living organisms. At least all physiocentric ethics are not free of conflicts, because there are several practical restrictions that limit their implementation into daily practice. However, physiocentric ethics have some similarities with the IFOAM principles, which includes all impacts of human acting on nature and try to respect, protect the integrity of the living things and inanimate nature. Besides these general orientations on ethical concepts, there are several disciplinary oriented ethics:

- Bioethic – sustainable dealing with and use of nature
- Social ethic (SE) – rights and duties of individual for other persons
- Economy ethic (part of SE) –profitability and acting which include more than self-interest
- Science ethic – fairplay, incorruptibility
- Peace ethic – exclusion of all destroying actions

IFOAM principles offer interfaces to all these ethics. The ecologic ethic (holistic environmental ethic and other similar concepts) has an outstanding position in the debate of IFOAM principles (see also the holistic environmental ethic; Birnbacher 1991; Jonas 1984; Meyer-Abich 1979). This concept includes the moral responsibility for the whole environment (living and inanimate), the reverence for nature, the categorical imperative to respect and protect higher animals, the minimization of endangering future human existence, the conservation of natural and cultural resources, the integration of future oriented aims of other human beings (subsidiary), and the education to responsible actions. The moral concept of this ecocentric ethic is the cosmos of the individual, human society and the whole environment. Also, religious perspectives are part of this concept since comparable positions can be found in nature religions. These concepts seem to be the main sources for the IFOAM principles and guidelines. Nevertheless, the claim that these are transferable into daily practices, are not without risks for the whole idea.

### **How to transfer the IFOAM principles into practice?**

The task of ethics is not to stress ideologies or to impart any convictions (Pieper 1994). Following the reflections on biogenesis of Piaget, we can only talk about moral understanding and behaviour, if those ethical orientations...”have not the character of a compulsion from outside, but guarantee most of freedom for all members of a community. Only a rule, which fulfil this objective, is a moral rule” (see Pieper 1994: 20). However, those engaged in OA are guided by the following motivations:

- If a farmer is heteronom, he is, as a sense of a duty following the organic standards because he is interested in subsidies, higher prices and higher income (see the ethical background: Pieper 1994: 18, 19)

- Someone could also decide freely to fulfil the guidelines because he stands for the values and realises that they meet his personal convictions and that of nature and society as well

In the first case, to follow organic standards is a means to an end, where the IFOAM principles are not focused, nor important for daily life. Whereas in the second case the principles are the motivation to be an organic farmer. The mission of ethical norms is to give orientation, without obliging, because it is the stakeholders' own initiative to act morally. Without this personal motivation and responsibility, standards and regulations guided by ethical dimensions would not be significant to society. This is the challenge for the organic movement as it searches to translate values into any type of standards and guidelines.

## Conclusions

The values presented with the four IFOAM principles have strong relations to physiocentric ethics. Nevertheless, their position is to delineate and integrate anthropocentric ethics and holistic environmental ethics. "Most ethicists agree that no conclusions about general validity can be drawn from the actual existence of standards. This would be a naturalistic fallacy" (Akademie der Wissenschaften, 1992; Ott, 1999, in WBGU, 2001). At least, "ethical judgements refer to the justifiability of moral instructions for action that may vary from individual to individual and from culture to culture" (Ott, 1999). The IFOAM movement has to continue the debate, following the principles of organic agriculture, to develop and modify their values, as a result of open debates in different environmental, traditional cultural and societal context. Finally, efforts in the education and training sector are important as they lead to the practice of ethical values along the whole organic food chain.

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## Organic sector relationships



# Labour Quality Model for Organic Farming Food Chains

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Key words: Corporate Social Responsibility-concepts, ethic values, labour quality, organic farming

## Abstract

*The debate on labour quality in science is controversial as well as in the organic agriculture community. Therefore, we reviewed literature on different labour quality models and definitions, and had key informant interviews on labour quality issues with stakeholders in a regional oriented organic agriculture bread food chain. We developed a labour quality model with nine quality categories and discussed linkages to labour satisfaction, ethical values and IFOAM principles.*

## Background and objectives of the study

Labour quality with regard to the quality of working life (Hardenacke et al. 1975: 32) could be seen as part of the concept of Corporate Social Responsibility (CSR), which describes and measures the sustainability of companies (e.g. Kopfmüller et al. 2001). Labour quality has numerous definitions and is of high diversity (Dunckel 1999: 24). It is part of the IFOAM principle debate (Luttikholt 2007). Oppermann (2003: 78; Fink-Heßler 2004: 11, 14) concluded that from the sociological point of view, less is known on work and professional conditions in (organic) agriculture. Furthermore, the network "Zukunftsfähige Arbeitsforschung (future oriented labour research)" criticised, the traditional research on labour quality pointing out that it focuses mainly on industrial enterprises and their technical working processes. Therefore, our specific interest was to identify indicators for labour quality in general and organic agriculture food chains specifically.

## Methods

The diverse but overlapping approaches on labour quality and experiences led to the decision, to study the concepts, criteria, indicators and models, on labour quality based on the review of literature.. At the second level, we conducted group discussions with stakeholders in organic bread food chains in small and medium sized enterprises with total of six participants – two farmers, millers and bakers. At the third level,, we synthesized the different indicators identified in literature and from the group discussions and developed them into a model on labour quality.

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The literature review focused on the general definitions of labour quality, results from the different sectors analysis on labour quality, labour quality indicators of freelance, craftsman, and agriculture labour, mills, and bakeries in general and finally with a specific focus in organic regional oriented food chains and labour quality in psychology context (German spoken literature).

At the beginning of group discussion, we provided an overview of the concept of labour quality within the categories of requirements and resources, according to Fuchs et al. (2006: 29). Following this, we asked them about their perceptions of labour quality, using the following guiding questions:

- What do you understand by labour quality?
- What is positive, what is negative?
- Which pictures do you remember spontaneously?

These questions were discussed in groups based on experiences with labour quality in the own enterprise and within the product chain.

## **Results and discussion**

### **- Literature review on labour quality**

Labour quality research is mainly structured in the analysis, assessment and recommendations for reorganising labour activities and systems (Ulich 2005: 63). There are several psychological methodologies to measure labour quality, which enable the analysis and assessment in different lines of business (Dunckel 1999: 11, 24), related to the research question and the focus (Ulich 2005: 53). Most of these approaches are developed for big companies and therefore their use is limited in SME enterprises or need far-reaching adaptations (Pröll 1998: 20). The "salutogenetic subjective labour analysis" as one of these approaches could be seen as a promising set of indicators. It comprises the characteristics of jobs, the workload, and organisational resources of the enterprise, social resources in the labour sector as well as social support (Udris & Rimann 1999: 407). This also applies to the labour assessment criteria models (Ulich 2005: 144), where we also find different approaches (e.g. V. Rosenstiel 2003: 117; Volpert 1990; Ulich 1984; Hacker & Richter 1980). Weaknesses are the lack of clear measuring rules and that there is no common sense on a basic set of criteria (ibid: 118).

Besides the above mentioned approach, the subjective experience of labour described with labour satisfaction and emotions also comprises different areas and definitions (e.g. Fuchs et al. 2006: 41; Ulich 2005: 138; Neuberger & Allerbeck 1978:12; Kirchler & Hölzl 2005: 139). The concept is criticised because of its subjective assessment (Izard 1994). Nevertheless, it has its legitimacy because criteria such as labour pleasure has a overall potential to describe the quality of labour situation as a whole, and is linked with several actions e.g. creative thinking and solution, or independent and self-responsible acting (Fuchs et al. 2006: 75). Additional to these scientific approaches there are several international and national standards and instruments for the assessment of labour (Kurz-Scherf 2005: 194; Meager & Sinclair 2004: 149; Sengenber 2004: 147) including universal ideas on labour quality – freedom, justice, security and dignity. But we found also indicators linked with freelance and craftsman labour, which is a characteristic in agriculture (Brüggemann & Riehle 2005: 33; Schriewer 1999: 8). Freelance: independency, freedom from work and time pressure (Bissels et al. 2006: 99; Protsch 2006: 3); craftsman labour: diverse, creative, self

interest or one's own initiative (Ganzert 2005; Ganzert & Wild 2004; Götz 1997: 24; Schwappach 1986: 117).

Finally, we studied labour quality in organic agriculture as well as regional product chains of organic bread. For the whole organic sector, following indicators were found to be of relevance: working place conditions, labour time, self exploitation, carrier potential, societal acceptance or the relevance of agriculture in society respectively, joy of life and others (see Thomas & Groß 2005; Hilbermann et al. 2003: 37; Jahn et al. 2002: 65; Rösch & Heincke 2001: 99). There is also a broad spectrum in the perceptions of a farmer: e.g. living with and in nature, contrary to industrial jobs, working without norms, workplace and family in one place, self-responsibility (Roeckl 2003; Eitmann & Weinheuer 2005: 3; Fink-Keßler & Hahne 2004: 14). Work as a farmer is ingenious, independent and self-determined (Gottwald 2003: 16; Müller 2002: 40). On the contrary Knickel & Schmidt (1994: 195) reported from physical and psychological stress especially in small scale farms, lack of perspectives, uncertain future of the farm while Beste (2005) added the work load as a result of direct marketing activities. Schulz (2006: 27) and Fuchs (2006: 29) underline fair income and distribution of property.

Literature on labour quality in mills is limited. Responsibility and physical stress were mentioned (AMS Österreich 2006). Individuality, creativity, holistic work and contact with customers (development of an emotional relation) are discussed values of regional oriented bakeries (Schmidlein et al. 2002: 155; Rennenkampff 1999: 268).

#### **- Workshop results**

The workshop, where labour quality was described from different perspectives in the food chain, offered several terms on labour quality, partly in line with literature, partly new dimensions. The specific contribution of the participants was, that living in and with nature is one of the most important motivations and driving factors for labour satisfaction which is a category of emotion psychology (V. Rosenstiel 2003: 64). This is an outstanding value, which explains the pleasure, where organic farmers sense, even if other qualities leave much to be desired. High labour satisfaction with its characteristic emotions e.g. happiness and fun (Friedmann 1952: 352, cit. in Ulich 2005: 142) is therefore close to positive fulfilled labour quality categories.

#### **- Model on labour quality**

In total 35 papers authors / author teams were analysed. At the first level all relevant terms concerning labour quality were selected. The result was a total of 187 terms, including the workshop results. Based on this selection, we synthesized the terms under nine quality categories, which we title as holistic labour quality model:

- **Psychological quality** - Psychological health / stress reducing labour management
- **Physiological quality** - Physiological health in labour processes
- **Subject matter quality** - Holism and diversity of labour
- **Independency quality** - Space for own decision making and organisational participation
- **Organisational quality** - Joint responsibility and transparency
- **Income quality** - Fair income and distribution of properties

- **Development quality** - Personal learning and development
- **Communication quality** - Relations and social interactions - internal, external
- **Social quality** - Social values in the company / farm

To embed the model in a broader environment we discussed how labour quality could be linked with IFOAM principles and ethical values. We assume that if the nine labour quality categories are fulfilled, ethical values e.g. freedom, equality, justice, autonomy, solidarity or dignity (Schulz 2006: 27; Ulich 2005: 210; Udris & Rimann 1999: 407) are fulfilled in a positive sense as well. Furthermore, we hypothesize, that high level of labour quality contributes to a high fulfilment of the IFOAM principles health, ecology, fairness and care in practise. We conclude that in a certain sense, labour quality categories are operationalised IFOAM principles.

## Conclusions

Research on labour quality is conducted for industrial enterprises. Their focus is mainly in technical processes. Different theoretical concepts on labour quality offer a large variety of criteria, as well as our discussions with different members of the bread food chain. Therefore, we synthesised a comprehensive model on labour quality, as a step towards the systematic analysis of labour quality in organic food chains in general. The next step will be to prove and falsify the model with different members of organic food chains. Further discussions in the model are required in context to Corporate Social Responsibility activities in organic farming and the debate on ethical values.

## Acknowledgments

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## Collaborative relationships in the organic wheat supply chain: a case study on three EU Countries

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Key words: organic supply chain analysis, wheat, food quality, food safety.

### Abstract

*The study was conducted as a part of a EU-wide survey on organic supply chains, carried on in 8 European Countries. In this paper we report the results of the study regarding the winter wheat supply chain in Italy, France and Hungary. In depth interviews with key-informants were carried on in 2006 to investigate the relationships within the supply chain. Results show a low level of collaboration among various actors especially on cost and benefits sharing.*

### Introduction

Only few studies describing the structures and performance of organic supply chains were conducted in the past. And no study investigating the effect of supply chains on food quality and safety is available. Nevertheless, according to Bteich and colleagues (2007), there is a very different situation of the level of collaboration inside the winter wheat supply chains throughout Europe. The Hungarian organic market, with an organic market share of 0.07% can not be mentioned as greatly developed (AMC, 2002). Organic wheat farmers in Hungary are usually not associated in marketing initiatives. They sell the wheat to wholesales directly. For lack of storing opportunities they are forced to sell the wheat right after harvesting. Between 90 and 95 % of all the Hungarian wheat goes into export. The wholesalers buy the wheat directly from farmers and ship it to its destination. Only in some cases big farms collect and store the wheat from smaller farmers and sell it with an extra charge to the wholesaler.

In France the communication within the supply chain is relatively slow at a national level because of the divergence and differences of management between regions. Communication is quick at a regional level where it is more organized and effective. Vertical integration between millers and hypermarkets is still rare. Also horizontal alliances are rare, some are registered at the co-operatives level that collect wheat and mill it. In fact, there are many organizations that adhere to the cereals collection.

The level of vertical integration within the Italian cereal supply chain is not very high and mostly it refers to the cooperatives (often characterised by quite high level of integration). The horizontal integration is nevertheless less observed and even if there is a frequent integration between co-operatives of producers and wholesalers, this type of integration does not exist between processors and distributors. In what follows main results are highlighted aiming to contribute to a better understanding of the supply chain performance and the collaboration system of the winter wheat supply chain.

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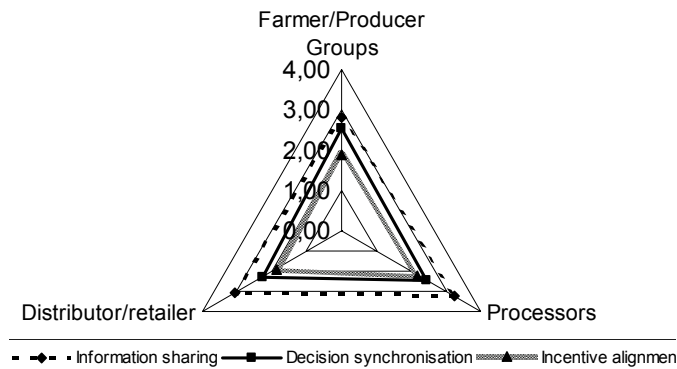
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## Materials and methods

To examine supply chain collaboration, the three dimensions mentioned by Simatupang and Sridharan (2004) – Information sharing, Decision synchronisation and Incentive alignment, were explored. The quality of collaboration between the interviewed actors and their buyers and suppliers was investigated asking them how often they used to collaborate with their immediate downstream (upstream) supply chain members (buyers/suppliers) on some specific issues. Performance was also measured by means of a partial value chain analysis (Simatupang and Sridharan, 2004, Roberts and Stimson, 1997). A case study approach, was developed to collect data by semi-structured interviews with key-informants (25), that is supply chain actors involved in the specific supply chain (producers, packers, processors, transporters, traders, retailers). A “snowballing” technique was used to select interviewees. Once selected some core firms along the chain, subsequent key informants were chosen from their main upstream and downstream partners that is those they mentioned along the chain.

## Results

The winter wheat organic sector is, as expected, at a very different stage in the three countries investigated. France has the oldest supply chains (1962-1988) and Hungary the newest ones (1991-2004). Both the average share of organic winter wheat turnover over total turnover and the share of organic wheat turnover over total organic turnover of the interviewed companies vary drastically between the countries studied. In Italy and in France, manufacturers/processors operate in both organic and non organic production and also process other products; on the other hand producer groups/community produce exclusively organic winter wheat. In Hungary, the processing of organic winter wheat represents the whole organic processing, while farmers/producers produce not only organic winter wheat but also other cultural varieties both organic and conventional.



**Figure 1. Collaboration indexes in the three countries (France, Hungary and Italy)** - indexes contain between 8-12 variables (values range from 1 = never; to 5 = always)

Synthesising the survey results (according to three indexes: information sharing, decision synchronization and incentive alignment) a more homogeneous situation describe the level of collaboration existing among supply chain members in the three countries. Results depict a situation where in general, the level of collaboration for *incentive alignment* with the principle buyer and supplier is the less mentioned aspect while the *information sharing* is the most frequent way of collaboration. In France the collaboration with the supplier is usually much higher than in Italy and Hungary almost for all indexes investigated.

Inside the *information sharing* index the areas in which supply chain members are more available to communicate with their suppliers are: demand forecast, price and price changes, delivery schedules, QMS and traceability procedures. While with the main buyer they prefer to discuss about product quality. In general less collaboration is registered on order state and order tracking.

Concerning the *decision synchronisation* with the supplier, France and Italy seem to indicate more positive connotations than Hungary for almost all the variables especially for joint decision making on origins for raw material. The higher level of willingness to collaborate is evident in certification issues and in product safety and quality as much as price changing and demand forecast. Especially in Hungary decision synchronisation does not seem to be done in collaboration with the principle buyer and figures fluctuate around seldom.

The analysis of *incentives alignment*, mostly referred to cost and benefits sharing, shows a scarce relationship among supply chain members at this indicator level. Referring the analysis to the buyers the highest indices in France are registered on some specific aspects: "delivery guarantee for peak demand", "allowance for product defects" and "shared logistic costs". In Hungary the highest index for collaboration at the level of incentives alignment is registered for "allowance for product defects" and "agreement on order change". In Italy the highest index is for "delivery guaranty for peak demand" too.

## Discussion

The low level of collaboration with respect to cost and risk sharing seems to reflect the power of the various actors at each level in the supply chain and the different margins they receive. The chain is dominated by wholesalers and distributors which are expected to put huge margins on the wheat impose their standards to farmers, millers and bakeries. A great dilemma inside the chains is the dependency of the farmers to prices they receive from their wholesalers

In France mills constitute the most powerful centre of the chain that is directly related to the bakeries and other processing units. In France supermarkets and large distribution are more and more influent and requiring, since they rule and determine the markets demands.

The Hungarian supply chain is dominated by wholesalers which are expected to put huge margins on the wheat. Because of the lack of inland consume the farmers are forced to sell their wheat to traders, which have contact to export markets. The wholesalers are not willing to accept the higher prices of organic production by using organic seeds and having fewer yields. They pay none or only a small extra charge for organic wheat in comparison to the conventional price. Also In Italy among

distributors, hypermarkets are considered to be the leader and main actors of the supply chain, and processors, play also a considerable role deciding the quantity to be processed and the type of the final product.

### **Conclusions**

Considering the little data available and according to the results emerging from this study, it is difficult to say whether the collaboration along the supply chain have an impact on quality and safety. In Italy, alike in France, (but less in Hungary), respondents state that they collaborate on these issues. Information sharing on quality and safety, ranked quite high, suggest further improvements in planning collaboration both with the buyer and supplier (Stolze et al. 2007).

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# Strategies to Induce Cooperation from Farmers in an Organic Food Supply Chain: the Case of Bio Market, Inc., Japan

Taniguchi, Y.<sup>1</sup>

Key words: quality, supply chain, collective reputation, conventionalization, contract

## Abstract

*Organic food supply chains often face a challenge to receive stronger commitment from farmers necessary to access the mainstream food market. This study measured the farmers' effort level by using a proxy indicator, and sought factors that affect the level, based on the data obtained from an organic food supply chain in Japan. Four factors were found: (1) the farmers' self-evaluation on their effort level, (2) satisfaction with the terms of contract, (the farmers' self-evaluation on their product quality, and (4) the farmers' dependence on the chain as a source of income; are related to the effort level realized by an individual farmer. Based on the result, the study has concluded that the measures that lower the self-evaluation of farmers' performance can make the farmers more cooperative with the aims of the chain.*

## Introduction

The Japanese organic food supply chains have historically developed unique rules for the purchase of organic food. The buyers (consumers, wholesalers, etc) are required to pay a fair and fixed price for products, and to purchase the quantity as promised at the beginning of the growing season. Such alternative market system is known as „*teikei*“, „joint purchase“, or „home delivery services“, and has encouraged farmers to join the scheme and boost production. However, the continued growth in production and the increasingly sluggish demand have occasionally created a massive surplus, forcing them to explore buyers outside the existing chain.

The sales expansion to external buyers, however, has not been easy. The mainstream markets, such as supermarkets and restaurant chains, often request good cosmetic quality and stable supply of the products, at the same or lower prices. In the absence of a monetary incentive, it has been difficult for an organic food supply chain to meet the expectation of the buyers in the mainstream channels; the largest problem being the instability of supply (Taniguchi 2003). In addition, many organic food supply chains are reluctant to install a price mechanism as a means to improve farmers' performance. Acknowledging that the national auction house has been a driving force for the capital intensive, large-scale, monoculture production, the stakeholders of the chain believe that the integrity of organic production will be lost if they make the market more competitive.<sup>2</sup>

Theoretically speaking, it is considered that farmers are always tempted to cheat their effort level under the information asymmetry. If they are a part of a supply chain, there is a greater incentive to falsely report the effort level, because they can free-ride on

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<sup>2</sup> Guthman (2004) reports that the organic production is already widely „conventionalized“ in California and the associated problems have been observed.

the „collective reputation“ of the chain. Tirole (1996) argues that an individual member of the chain decides their effort level based on the value of the collective reputation, which is established by the former and existing members of the umbrella before the individual's entry. In other words, the effort level of an individual member is likely to be affected by the past behaviors of the other members in the umbrella. Gergaud and Livat (2004), in support of Tirole's view, empirically showed that the collective reputation is affected by the individual reputation, and vice versa.

Correspondingly, this study applies the theory of collective reputation to the case of organic food supply chains, and examines if the effort level chosen by an individual farmer is affected by the performance of the other farmers in the chain. Then, based on the results, strategies to increase the farmer's effort level are suggested.

## Methodology

This study is based on the case of POFA, an organic food supply chain in Japan led by the wholesaler „Bio Market, Inc.“. The analysis consists of: 1) the calculation of the proxy indicator and examination of the room for improvement in farmers' effort level; and 2) the identification of the characteristics held by farmers who have higher effort level. Preliminary interviews with the stakeholders in the chain, including the farmers, the shop owners, and the wholesaler staff, were made prior to conducting the main analysis.

Farmer's „effort level“ was measured by „deviation,“ which is defined herein as the average absolute difference between the weekly „planned“ quantity and the „actually supplied“ quantity of a product. The „deviation“ was then normalized by dividing them by the average weekly „planned“ quantity. The „deviation“ was calculated for every individual farmer or farmers group in the chain and for a total of 20 major fruits and vegetables, which were supplied in the period between the first week of January 2003 and the last week of 2005. Based on the individual „deviation“ level, farmers were then divided into two groups: the „large deviation“ group (= low effort group), and the „small deviation“ group (= high effort group).

$n = (1, 2, 3, \dots, N)$  : index of week in which products are supplied.

$j = (1, 2, 3, \dots, J)$  : index of farmer.

$i = (1, 2, 3, \dots, 26)$  : index of commodity supplied.

A structured questionnaire was made to grasp characteristics of the farmers in the chain. The questionnaire was mailed on September 15, 2006, to all organic farmers, whether individually or in groups, 87 in total, of which 59 (67%) returned it by the end of the following month. The questionnaire asked farmers to provide self-evaluation on: the level of commitment to the improvement of quality and punctuality of supply (13 questions); and the quality of their own products relative to the average quality level in the chain (1 question). It also asked about the respondent's satisfaction with the terms of the contract with Bio Market (8 questions) and the degree of dependence on the chain as a source of income (1 question). All questions above were evaluated in 5-grades, and each grade was counted as „points earned“ for each question, which were summed up for each question category stated above. The difference of the average points between the two groups was statistically tested.

## Results

Weekly “deviation” for each commodity was 0.47, on average, which means about half of the quantity planned was not delivered or supplied in excess. Standard deviation of the farmer’s “deviation” for 20 product items was on average 0.34, with the median 0.25. Standard deviation for three items exceeded 0.40, suggesting the existence of large gaps in “deviation” levels among the farmers.

The questionnaire result showed that the majority of respondents have the following characteristics: 1) operate as a family farm, 2) manage small scale of farm land (less than 3 ha), 3) put more than 60% of farm land under organic management, 4) depend more than 70% of household income on farming, 5) be relatively young (less than 55 years old), and 6) work in partnership with Bio Market for more than 15 years. Many respondents sell their products also to consumers (directly) and/ or other outlets including: specialized wholesalers, home deliveries, and natural food stores.

Average points earned for each question category (QC) and the t-statistics of the difference between the two groups are shown in Table 1. As evident in the table, the „small deviation“ group tends to: evaluate their own efforts more moderately (QC 1); be more satisfied with the contract with Bio Market (QC 2); rank their own product quality lower in the chain (QC 3); and depend for their income more heavily on the sales to Bio Market (QC 4); than the „large deviation“ group does.

**Tab. 1: Average Points for Each Question Category (QC)**

Question Categories	Small deviation	Large deviation	t-value
1) Self-evaluation of effort level for improvements	37.9	42.2	2.47**
2) Satisfaction with contract with Bio Market	29.0	25.6	2.22*
3) Self-evaluation on the quality of his/her own product relative to other products sold in the chain	3.3	4.0	2.93**
4) Dependence on Bio Market as a sales channel	3.5	2.6	3.21**

\* significant for  $P < 0.05$  \*\* significant for  $P < 0.01$

Note: The points for question categories 1) and 2) are calculated from the sum of the five-grade evaluation, ranging from “not at all (1)” to “strongly yes (5).” Question category 3) is a single question asking for a five-grade evaluation ranging from “very low (1)” to “very high (5).” Question category 4) is also a single question, but is a multiple choice from “Less than 10%,” “10 to 30%,” “30 to 50%,” “50 to 70%,” and “70% or more.”

Contrary to expectation, the results of the QC 1 and QC 2 showed that the farmers who modestly evaluated their own effort level or the quality of their own products tended to deviate less (i.e. make stronger commitment to the chain). One of the possible explanations for this is that the farmers in the “small deviation” group are “unskilled” farmers who feel that it is more costly to leave the chain compared to those in the “large deviation” group. In other words, the “small deviation” group might be more dependent on, and benefit from, the collective reputation of the chain than the other group. Since the perceived cost of switching is higher for the “small deviation” group, the opportunity cost of cheating is likely to be higher, thereby bounding the group stronger to the chain’s policy. The result of the QC 4 complements this assumption; it showed that the “large deviation” group has wider sales channel compared to the “small deviation” group, hinting the “small deviation” group has less bargaining power against Bio Market. Further, the result of the QC 2 is consistent with

the analysis above, because the “large deviation” group, if they are more confident and skilled, would feel unsatisfactory or unfair to being treated equally with those in the other group under the contract with Bio Market.

## **Discussion**

The fact that the ranking of the product quality within the chain is related to the effort level is in line with the idea that the farmers take account of the performance of others in the chain when choosing the effort level, as hypothesized earlier. This study contributed to providing another example that exhibited measures in solving free-riding, even in the absence of monetary measures or punishment rules. One might argue that organic farmers are already making the maximum efforts, and there is no more room for improvements. However, in the preliminary interviews, the stakeholders expressed their concern for the existence of free-riding, and the questionnaire conducted in this study revealed that 30 to 40% of farmers admitted some “deviation” was caused by artificially controllable reasons. Nevertheless, the weakness of this study is an attempt to use “deviation” as a proxy for the farmers’ effort level. Since there are numerous factors that are not captured clearly but may affect the “deviation” level, including unusual weather, and plague of bugs/ diseases, etc, the indicator needs more careful examination and/ or sophistication.

## **Conclusions**

This study has found that the effort level realized by an individual farmer is affected by the effort level by the other members, and supports the view that non-monetary incentive for the greater level of cooperation does exist. The farmers who made more efforts were “modest” in their own performance, which suggests that the effort level of a specific farmer might increase if the chain adopts strategies that can shift the perceived collective reputation upwards, and thereby lower their subjective ranking within the chain. Possible strategies include: organizing tours to model farms, new contract with highly skilled farmers, and the use of promotional materials.

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# Price Premiums for Organic Food from Australia and China

Paull, J.<sup>1</sup>

Keywords: Country of Origin Labelling (CoOL), eco-labels, certified organic, eco, natural, adjunctive labelling, food labels, provenance.

## Abstract

*Australian consumers (N=221) were surveyed to establish their valuations of food, based on provenance, organic status and eco-labelling. For Chinese produce Organic attracted a 6.4% premium, and Certified Organic an 11.6% premium. Australian produce attracted a 7.9% premium for Organic, and a 16.5% premium for Certified Organic. For Chinese produce Natural added a 1.7% premium, and Eco 2.9%, compared to Australian produce which added a 2.6% premium for Natural, and 2.8% for Eco. Chinese produce was devalued by 20.6%, compared to Australian produce (alternatively Australian produce attracted a premium of 26.0% over Chinese product). Respondents who volunteered comments, indicated they were "dubious of" or lacked "trust" in the labelling of food from China; affordability and buying "local" were also issues mentioned by respondents. Certified Organic offers an opportunity for Chinese producers to improve their return on effort, and raise the status of their produce. Adjunctive labelling can add 14.6% to consumer valuations of Chinese produce.*

## Introduction

Chinese agriculture has been described as the world's oldest agriculture (King, 1911). China is now a world leader in organic food production (Paull, 2007). For the Chinese agricultural sector, organic production offers a path to higher returns, lower input costs, environmental benefits, the retention of rural workers in rural areas (Giovanucci, 2005), access to international markets and enhanced prestige.

Labelling is increasingly important for adding value to food. All label elements that are adjuncts to the generic description of the food are candidates for adding consumer value. Adjunctive labelling includes country of origin, organic claims, fair trade claims, regional identification, dietary claims such as *suitable for vegetarians*, health and nutrition claims, and religious conformity claims such as "halal".

Price premiums for organic produce reward farmers for the additional care taken, and contribute to the costs of the certification process. Retail price premiums in Australia for organic food average 80% (Halpin, 2004), without regard to country of origin. Halpin reported the view among retailers that premiums are too high for consumers and that 15% would be more acceptable.

A proliferation of eco-labelling in the market, including "natural" and "organic", causes confusion for consumers according to Wong (2005) who reported that of "organic vegetables" on sale in Hong Kong, only 29% were certified. In some jurisdictions - including Australia - produce can be labeled *Organic* without third party certification.

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Country of Origin Labelling (CoOL) is increasingly important in food retailing. Reported here are the values consumers attributed to food, based on three dimensions of labelling information: country of origin, organic labelling, and other eco-labelling.

## Methodology

This study examined three food labelling variables, each at three levels. Using a factorial design, this generates  $3 \times 3 \times 3 = 27$  treatments or food scenarios. The variables were provenance (*China, Australia, Tasmania*), organic status (*null, Organic, Certified Organic*) and eco-labelling (*null, Natural, Eco*). Each subject valued the 27 generic food scenarios individually, in each case in the range \$5.00 to \$10.00 (on a 21 point scale, stepped in increments of 25 cents), and answered eight demographic questions, and additionally there was an optional comments box. The instrument was presented on the World Wide Web. Subjects were recruited *via* a press release, issued by the Media Office of the University of Tasmania to Australian media, mostly newspapers, which gave a web address, and invited readers to respond to a "survey about food labelling"; none of the variables under investigation (*Organic, Certified Organic, Eco, Natural, Australia, China*) were mentioned in the press release.

## Results

221 respondents completed the survey, and all analysis reported here is based on the full sample. The demographics of the sample are as follows: 75% of respondents were female, 47% were aged 40 or under (Australian population median age is 36 years), 42% reported below average income, 96% were from Australia, 72% completed tertiary education (Australian adult population figure is 58%), 78% were the main food shopper in their household, 3% were affiliated with the organic industry, and 5% reported they never purchased organic food. The average time to complete the survey was 6 minutes. The comments box was used by 81 respondents.

The responses were analysed using ANOVA. The three main effects (Organic, Provenance & Eco) were all significant (Factor-Organic:  $F(2,219) = 178.161$ ,  $p < 0.001$ ; Factor-Provenance:  $F(2,219) = 249.720$ ,  $p < 0.001$ ; Factor-Eco:  $F(2,219) = 55.042$ ,  $p < 0.001$ ). Three of the four interactions were significant: Organic x Provenance  $F(4,217) = 21.783$ ,  $p < 0.001$ ; Provenance x Eco  $F(4,217) = 2.983$ ,  $p = 0.021$ ; Organic x Provenance x Eco:  $F(8,213) = 2.484$ ,  $p = 0.013$ ).

A summary of results for China and Australia are reported here. The mean valuations for the nine China food scenarios and the nine Australia food scenarios are presented in Fig.1. The country of origin (Provenance) factor yielded the largest effect. Respondents attributed to Australia a valuation 26.0% higher than the China valuation. All label elements added value (Fig. 1). *Organic* added 6.4% for China and 7.9% for Australia, *Certified Organic* added 11.6% for China and 16.5% for Australia (Fig. 2). There was a significant interaction ( $p < .05$ ) between provenance and eco-labels (Fig. 3). For China, *Natural* added a 1.7% premium and *Eco* added 2.9%; the corresponding figures for Australia were 2.6% and 2.8% (Fig. 3). All the preceding percentages are based on marginal means. Of the nine China scenarios, the treatment *China, Certified Organic, Natural* attracted the highest premium of 14.6% (Fig. 1). Of the nine Australia scenarios, the treatment *Australia, Certified Organic, Natural* attracted the highest premium of 21.1% (Fig. 1). In the optional comments box, 12 comments referred specifically to food from China, all were negative.

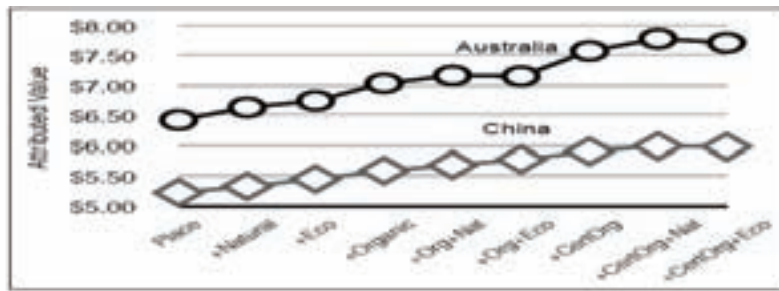


Figure 1: Australia & China: Consumer valuations for nine food labelling scenarios, N=221, cell means.

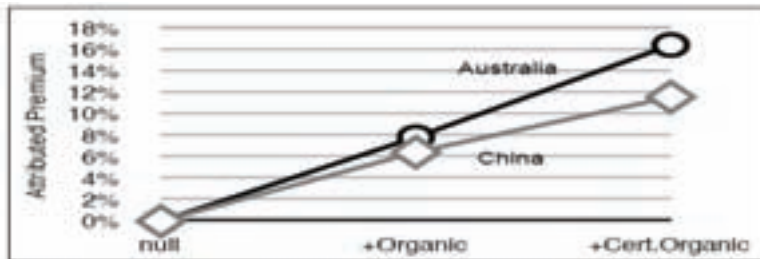


Figure 2: Australia & China: Consumer valuation premiums for *Organic* and *Certified Organic*, N=221, based on marginal means. There is a valuation gap of 4.9% between Australian and Chinese *Certified Organic*.

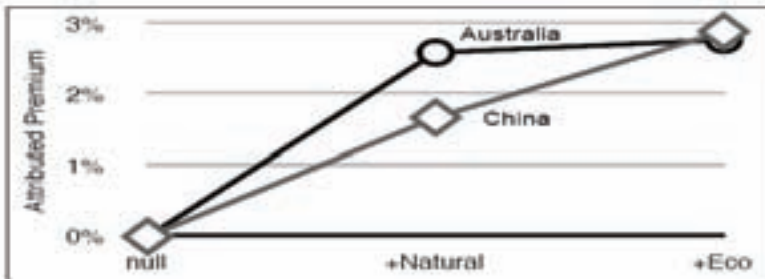


Figure 3: Australia & China: Consumer valuation premiums for *Natural* and *Eco*, N=221, based on marginal means. Eco-labelling adds small but significant value.

### Discussion and Conclusions

Halpin (2004) reported that certified organic premiums averaged 80% in Australia, and that consumers are likely to consider this figure too high. The present study confirmed this, and additionally found that the price premium consumers attribute to organic food is a function of the provenance of the food.

Country of origin (CoOL) has a greater impact on consumer valuations than the organic status of the food. Consumers valued up *Certified Organic*, whether from Australia or China. *Certified Organic* attracted twice the premium of *Organic*, indicating that consumers clearly distinguish between these two different claims. *Certified Organic* derives half its premium for "organic" and half from "certified". Adjunctive labelling of produce added value cumulatively for consumers, for example *Certified Organic*, *Natural* scenarios exceeded the value of *Certified Organic*. The eco-labels *Natural* and *Eco* added statistically significant but monetarily small premiums.

Wai (2006, p. 112) has claimed that Chinese organic standards are "the most stringent in the world", while LeCompte (2007) has reported that "Made in China" attracts more complaints from North American organic consumers than any other single issue. The present study found that Australian consumers devalued Chinese produce, compared to local produce.

Kuhlmann (2007) declared that the opportunity for Chinese organic exports is as ingredients of food processed in first world countries. The issue with this approach is that while manufacturers gain the benefit of cheaper inputs, consumers are likely to remain ignorant of the provenance of the ingredients. In Australia and New Zealand, for example, most processed food now suppresses the origin of the ingredients, by invoking one of the FSANZ (2006) labelling prescriptions, either "*made from local and imported ingredients*" or its inversion "*imported and local*". This practice advantages Chinese organic ingredient exporters over local producers.

For China, organics offers the opportunity to add value to agricultural produce, to move the focus of Chinese produce from price (cheapest) towards quality (best), to increase rural employment opportunities, to bring wealth and renown to rural regions, to reduce reliance on farm inputs, especially imported inputs, to increase reliance on farmer know-how and skill, and to safeguard the health of rural workers, the environment and consumers. China is already a world leader in organics (Paull, 2007). Because of the vast size of China's agricultural output, there is the opportunity for China to redefine the standards of internationally tradable food as *Certified Organic*. Such a lead from China would reap health and environmental benefits for China and the world.

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# Corporate Social Responsibility and Organic Farming – Experiences in Austria

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Key words: Marketing, Corporate Social Responsibility, Organic farming, Ethical values, Food sector

## Abstract

*Although the market for organic products has been growing in Austria for a few years, the rising competition of so called regional, natural or sustainable products should be taken seriously. One solution in times of “conventionalisation” of organic farming could be higher ethical standards in organic farming and more effective communication of ethical values, as it has already been practised by a great number of medium-sized and large enterprises under the name of “Corporate Social Responsibility” (CSR). CSR refers to all services that are beyond legal requirements, performed on a voluntary basis. This article discusses the topic CSR and similar approaches in the Austrian organic sector on the basis of 30 interviews with Austrian organic farmers and processors. Its level of familiarity, its institutionalisation and the farmers’ and processors’ attitudes towards the Anglo-American concept are analysed. The article also points out which CSR services could be performed in the organic food chain by giving concrete examples and presents a typology of three different groups of organic farmers and processors concerning their exposure to written marketing of CSR or similar services.*

## Introduction and objectives

The promotion of regional products and the growing anonymity in the organic supply chain make it more difficult for organic products to keep the status of being something special and unique in the debate on sustainable land use. Therefore, this paper introduces the concept Corporate Social Responsibility, explores its level of familiarity among organic farmers and processors, and their attitudes towards the concept. Besides, the paper describes which CSR services are performed in the organic sector and investigates if these CSR services are also communicated to the consumers in a written form.

We use the neo-institutionalism as our theoretical framework. Therefore, we focus on CSR, IFOAM principles and standards/regulations of organic farming, as well as the actors’ perspective. Our hypotheses are:

- 1) CSR has been an instrument used by large companies so far, not (yet) by small- and medium-sized organic enterprises.
- 2) In order to stand out in the market, innovative organic initiatives perform services that go beyond the regulations.

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- 3) The concept CSR is not (yet) viewed as being compatible with the values of organic farming.

In the tradition of qualitative research, we follow a case study approach where we do not have the objective to get representative results.

## Methods

This explorative study is based on case studies of 30 small and medium-sized enterprises<sup>1</sup> throughout Austria that produce and/or process organic food products and are also responsible for their own marketing. The enterprises or initiatives must have developed a CSR or similar approach, which means that they perform services that go beyond legal standards: the regulation of organic farming (EC 2092/91) and also beyond regulations of the national organic associations. Their focus has to be on organic domestic products.

**Tab. 1: Characterisation of actor sample**

Sample Size	Initiative	Head-count	Exclusively organic?
10	Care farms which are partly also processors	< 50	Yes
14	Family farms and small size farmers' cooperatives	< 50	Yes
3	Small processors	< 50	Yes
3	Medium-sized processors	< 250	No

Whenever available, we analysed written material of the initiatives (e.g. website, leaflet, information on the product, etc.). In addition, phone and face to face interviews were conducted on the basis of a guideline questionnaire with open and closed questions.

## Results and Discussion

### 1. *What is CSR and how is it institutionalised in Austria?*

The concept of CSR has gained importance in Central Europe in the last years. In the business sector, numerous medium-sized and large companies established CSR to demonstrate and communicate ethical values to improve their corporate image. Meanwhile, also numerous Austrian companies include CSR concepts in their corporate strategy. The European Union defines CSR as "a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis".<sup>2</sup> CSR is closely linked to the concept of sustainable development: companies have to be conscious of their economic, ecological and social impacts. RespACT, the Austrian business council for sustainable development, is the leading platform for Corporate Social Responsibility and Sustainable Development in Austria. Its objective is to enhance the implementation and communication of CSR in Austrian companies.<sup>3</sup>

If we focus on the IFOAM principles which have a model function for the whole organic food chain, the crucial question arises: are they obligatory or voluntary? On the one

<sup>1</sup> According to the EU-definition of SME (2003/361/EC)

<sup>2</sup> COM [2001] 366 final

<sup>3</sup> <http://www.respect.at>

hand they are partly integrated into the organic standards and inspected during the control process, but on the other hand the principles transport a lot more than the standards. What we know is that organic farmers as well as processors perform several services which go beyond the standards and regulations, especially in rural areas: In addition to agricultural production and ecological services, organic agriculture acts as an essential stimulator for the region as regards employment and infrastructure. Besides, organic agriculture contributes to the conservation of cultural landscapes, supports social interactions and processes, and promotes socio-cultural activities like the preservation of rural customs. We can conclude that organic agriculture provides several services, which are in line with CSR.

## **2. How familiar are organic farmers and processors with the concept of CSR?**

Hardly any of the interviewed organic farmers and processors knew the term CSR. This might be due to the fact that CSR hardly appears in the Austrian agricultural debate. Terms like eco-social responsibility, developed and promoted by the former minister of agriculture Josef Riegler, or sustainability, are on the contrary well-known. In contrast to the first group, the interviewed medium-sized processors were familiar with CSR and argued that CSR or other ethic approaches had been part of their corporate philosophy for many years (e.g. one company has been supporting a development aid project for more than 20 years now). However, the increasing political, economic and medial attention on these topics and the interest of large international corporations in CSR is a recent development. The interviewed organic processors associated the term CSR mainly with a theoretical concept, a temporary fashion, in short – a concept that is difficult to identify with. They stressed that for them the concrete activities or services were more important than the development of a conceptual CSR approach.

## **3. Which CSR activities are practised in the organic sector and how are they communicated?**

In our case studies, we identified CSR or related activities which focus on ecological, social, cultural, economic or animal welfare aspects. Examples are the support of social projects, work and possibilities of integration for disabled people, the preservation of highly sensitive cultural landscapes and biodiversity, specific protection of the environment, etc. The interviewees were asked if they performed additional services going beyond organic standards and if they communicated them as well. Three groups of initiatives were identified concerning written marketing measures of CSR services:

1. Initiatives performing services that go beyond the organic standards but do not communicate them in a written form.
2. Initiatives claiming to do more than organic in their promotions but that are in reality "only" organic without performing any additional services.
3. Initiatives performing services that go beyond organic that also communicate them to the consumers in a written form.

The case studies revealed that generally marketing in the form of leaflets or websites is not practised by a great majority of the interviewed small organic farmers and processors. Reasons for not using written communication are lack of time, lack of know-how in marketing, or no sales problems. Moreover, some initiatives do not communicate their additional services since the owners take what they do for granted. Others do not want to market their values and beliefs in the form of a CSR concept because they view CSR as a tool used by large companies that want to mask their

unethical behaviour by “green washing”. As regards “care farms” some interesting findings were revealed: They do not want to stress the social aspect of their initiative in their marketing, because for them the most important message they want to deliver to the consumers is the fact that they are producing high quality goods. They do not want to attract consumers who buy their products only because of sympathy for the people working at the “care farms”. They believe that as soon as consumers get interested in their products, they can provide them with more information about the background of the farm. Most interviewed medium-sized processors communicated CSR or similar services in a written form.

## Conclusions

CSR is a well-known concept for medium-sized and large enterprises in the Austrian food sector, whereas the great majority of organic farmers and small organic processors are not familiar with it. However, the case study analysis in Austria reveals that there is a large amount of organic farmers and processors who perform services that go beyond organic guidelines but do not communicate them effectively to the consumers. These CSR or similar activities could be used to highlight organic products produced under higher ethical conditions. Following a neo-institutional perspective, we conclude that there is a type of organic farmers and processors who neither want to follow a utility- nor a norm-oriented CSR approach. They seem to prefer individual concepts for their CSR activities as well as for their personal communication with the consumers to transport their specific values.

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# Factors Affecting Market Outlet Use by U.S. Organic Handlers

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Key words: U.S., organic handlers, market outlets, multinomial logit model.

## Abstract

*The U.S. organic sector has expanded rapidly over the last decade, resulting in significant changes throughout the supply chain. Intermediaries need to move greater quantities of organic food to a growing numbers of retailers. As organic sales continue to increase, intermediaries marketing to several types of outlets may be better placed to adapt to changing market conditions. Data from a survey of U.S. organic handlers is used to identify which characteristics are associated with the number of marketing outlets handlers serve. The analysis finds that handlers with a greater share of organic sales and those certified organic longer are more likely to sell in more than one market outlet, while those selling products locally and regionally rely on fewer outlets.*

## Introduction

Retail sales of organic food in the United States have soared over the last decade, from \$3.6 billion in 1997 to \$15.7 billion in 2006. Growth in the organic sector has provided opportunities for all agents along the supply chain, from organic producers to handlers and retailers. In addition, marketing and retailing of organic foods in the U.S. has shifted dramatically, moving from a focus on direct/local markets and natural products channels to one that is equally divided between natural and conventional channels, with direct markets making up a fraction of sales (Dimitri and Lohr, 2007).

Although nearly all organic commodities pass through the hands of at least one intermediary (also called handlers) on the way from the farmer to the consumer, there is a dearth of literature examining the middle section of the supply chain. Recent research on organic handlers, both in the U.S. and EU, has been based on surveys of limited geographic scope (Austin and Chase, 2004; Banterle and Peri, 2007; Bingen, Osborne, and Reardon, 2007).

Organic handlers play a central role in the industry, packing and shipping, manufacturing and processing, and distributing, wholesaling, and brokering organic products. Their functions are similar to those of their conventional counterparts, with the added requirement that a product's organic integrity must be maintained as it moves along the supply chain, as specified by the U.S. national organic standards.

This paper uses data from a nationwide survey of U.S. organic handlers, undertaken by the U.S. Department of Agriculture's Economic Research Service (ERS), to examine marketing decisions made by U.S. organic handlers.

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## Materials and Methods

The organic handler survey was drafted with input from stakeholders, including certifiers, farmers, processors, academics, and representatives from non-profit organizations. The final survey instrument consisted of 59 questions, covering: operational and business practices, basic characteristics of handling facilities (e.g., gross sales and years certified organic) and relationships with both customers (e.g., marketing outlets used, distance to markets) and suppliers, including types of suppliers, and purchase arrangements (contract versus spot market). The survey was mailed to the population of all U.S. certified organic handling facilities in 2004, with 1,393 organic handlers completing the survey, representing a 63 percent return rate.

Much of the economics literature examining organic food marketing focuses on the producer's marketing decision (see for example, Park and Lohr, 2006). In this paper, we take a slightly different approach, modelling the marketing decisions made by organic handlers regarding the number of outlet types used (nine types of marketing outlets were specified in the survey, including retail, intermediaries, and direct sales). We hypothesize that certain factors influence this choice, such as where a firm sells its products, the share of sales that are organic, and the type of product the firm sells.

**Tab. 1: Descriptive statistics for variables used in the model**

Variable	Description	Mean (SD)
Years certified	Number of years certified organic	4.1 (4.5)
Share organic	Percent of sales that are organic	35.7 (39.7)
Producer-handler	1=also certified organic producer, 0=just organic handler	0.26 (0.44)
Manufacturer	1=at least 50 percent of organic sales under manufacturing function; 0=otherwise	0.51 (0.50)
Wholesaler	1=at least 50 percent of organic sales under wholesaling function; 0=otherwise	0.19 (0.39)
Broker	1=at least 50 percent of organic sales under broking function; 0=otherwise	0.03 (0.17)
Packer/Shipper	1=at least 50 percent of organic sales under packing/shipping function; 0=otherwise	0.11 (0.31)
Sells to retail	Percent of organic sales to retail outlets	25.4 (36.9)
Sells to intermediaries	Percent of organic sales to intermediaries	55.6 (44.7)
Sells to direct/institutions	Percent of organic sales to direct and institutional markets	11.9 (27.3)
Local sales	1=100 percent of organic sales are made locally (within a one hour drive); 0=otherwise	0.10 (0.30)
Regional sales	1=100 percent of organic sales are made regionally (within state/surrounding states); 0=otherwise	0.12 (0.32)
Sells produce	1=one of top 5 products sold is produce; 0=otherwise	0.21 (0.41)
Sells manufactured products	1=one of top 5 products sold is a manufactured product; 0=otherwise	0.40 (0.49)
Sells grains or feed	1=one of top 5 products sold is grains or feed; 0=otherwise	0.06 (0.25)

A three-case multinomial logit model identifying the factors influencing the number of marketing outlets used by organic handlers was estimated. The first (and reference case) is the use of one marketing outlet (such as a natural product retailer, wholesaler, or direct market) for 100 percent of organic sales by an organic handler (N=580). The second is the use of two markets for 100 percent of sales (N=332), and the third case is the use of three or more market outlets for organic sales (N=333). Of the respondent population, 1245 handlers fall into one of these choices.

Explanatory variables include operational characteristics of organic handlers (such as the share of gross sales that are organic and functions) and marketing characteristics (such as products sold and distance to markets) (Tab 1). Geographic variables were excluded as insignificant.

## Results and Discussion

In terms of operational characteristics, similar to Park and Lohr (2006), those handlers with a higher share of organic sales (Options 2 and 3) and more experience in the organic sector (Option 3), represented by years certified organic, were more likely to employ more than just one marketing outlet for all organic sales (Tab 2).

**Tab. 2: Results of the multinomial regression, marketing outlet use**

Explanatory variables	Option 2: Use of two market outlets		Option 3: Use of three or more market outlets	
	Estimated coefficient	z-statistic	Estimated coefficient	z-statistic
Years certified	1.040	1.62	1.078*	2.83
Share organic sales	1.010*	3.58	1.021*	6.48
Producer-handler	1.638*	1.87	0.912	-0.31
Manufacturer	2.043*	2.18	1.647	1.43
Wholesaler	2.967*	2.75	3.732*	3.19
Broker	1.960	1.11	1.299	0.34
Packer/Shipper	2.381	1.92	3.332*	2.52
Sells to retail outlets	1.024*	4.44	1.033*	4.98
Sells to intermediaries	1.001	0.31	0.998	-0.32
Sells to direct/institutions	1.008	1.48	1.020*	3.03
Local sales	0.312*	-2.94	0.215*	-3.41
Regional sales	0.207*	-4.07	0.069*	-4.79
Sells produce	1.248	0.71	1.486	1.14
Sells manufactured products	1.371	1.25	1.596*	1.65
Sells grains or feed	2.217*	2.07	0.349	-1.53

\*indicates significance level of 10 percent or better. Log odds are reported. Base case is use of one marketing avenue for 100 percent of sales. Number of obs = 706;  $X^2(30) = 342.33$ , Prob > chi2 = 0.000; Pseudo R2 = 0.2256.

Not surprising, wholesalers and packers and shippers, as well as those selling manufactured products, are more likely to use more marketing outlets (Option 3). In addition, as the handler's percentage of organic sales to retail and direct/institutional markets increases, so does the facility's likelihood of using three or more marketing

outlets. Finally, as the percentage of organic sales to local and regional markets increases, the likelihood that the handler uses three or more markets decreases.

Handlers also certified as organic producers and functioning as manufacturers and wholesalers were more likely to market to two marketing outlets than those using just one marketing outlet for all sales. Like those using three markets, those selling through retail outlets were more likely to use two outlets, and those selling organic products locally and regionally were less likely to use two marketing outlets. Handlers doing business in grain and feed products were more likely to use two markets than those facilities using only one market.

## Conclusions

Organic handlers play a crucial role in moving organic products along the supply chain, from farm to consumer. Rapid growth in the organic market can have a dramatic impact on individual handlers. Handlers are moving larger quantities of organic food along the supply chain as the types of outlets have shifted from the traditional direct markets to a wider range of outlets. These market changes create marketing risk for companies striving to remain profitable in a more competitive environment. Those utilizing a greater diversity of marketing outlets may be better placed to bear the risk commensurate with rapidly changing markets.

This paper makes use of a new dataset, and is the first effort in understanding the factors that influence the marketing decisions of organic handlers in the United States. The results indicate that experience in the organic sector, the share of organic sales, and functions of the handling facility affect the number of marketing outlets used by organic handlers. In addition, handlers using retail outlets and direct/institutional outlets are more diversified in terms of the number of markets used. Handlers selling to local and regional markets, on the other hand, use fewer outlets. Thus, the analysis suggests that firms marketing beyond the regional area, with a higher share of gross sales in organic products, and with more experience in the organic sector are those best able to, in the face of changing market conditions, supply the rapidly growing organic food market.

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# Opportunities for small organic shops despite the rise of organic supermarkets

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Key words: organic shops, specialised supermarkets, marketing

## Abstract

*Similar to the trend in the German organic food industry as a whole, development on the Berlin organic market is currently very dynamic. As a result, many organic supermarkets and chains are moving to Berlin, creating a major challenge for small Berlin organic shops in particular. We examined the current competitive situation on the natural foods retail market on the basis of a market analysis and interviews with experts. Potential measures for improving the competitive positioning of smaller organic shops were identified. Although to date not many smaller organic shops have been driven from the market, experts and market players expect the structure of the market to change to the detriment of organic shops because organic supermarkets have better competitive advantages in many areas including communication policy, pricing policy, sales floor layout, etc.. However, small organic shops have still not yet totally exploited their full marketing potential, particularly with respect to the sales mix policy and communication policy. For small shops to compete on the market, they need to have a distinct profile, strengthen their function as a local supplier and systematically increase the already high level of customer satisfaction.*

## Introduction

Berlin is one of the largest organic markets in Europe. Sales of organic products in Berlin have risen consistently over the last few years (Scholl, 2007), a trend that was accompanied by a sharp rise in the number of organic supermarkets in Berlin. The result is that organic shops in Berlin face ever increasing competition from within their own industry. These competitors have competitive advantages which have economic consequences for retailers. This study analyzes the development of the organic retail industry in Berlin, how strongly Berlin shop owners feel that their economic existence is threatened by the organic supermarkets and what options they have for improving their competitive position.

## Materials and methods

The market was analysed by counting the businesses listed in the Berlin-Brandenburg organic shopping guide for the years 2004, 2005 and the current address database of the development association for organic agriculture in Berlin-Brandenburg (FÖL).

Guideline based interviews were conducted with experts with the goal of generating the knowledge necessary to explain social change (Meuser and Nagel, 2005) and

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avoid having to carry out time-consuming observation processes (Bogner und Menz, 2005). The experts were 4 owners of organic shops in various districts of Berlin, the managing director of an organic supermarket chain in Berlin, the managing director of a regional wholesaler in Berlin-Brandenburg and the head of an association in Berlin-Brandenburg for promoting organic agriculture. We define organic shops as owner-run shops up to 250 qm in size (Spiller, et. al. 2005) while organic supermarkets are larger than 250 qm, have a modern look and feel and a full range of products with 5,000 to 10,000 individual items (Richter, 2005). The interview guidelines were based on the following hypotheses: 1. The biggest competitor for small shops in Berlin are the organic supermarkets. 2. Small shops have as yet unexploited potential in marketing to improve their competitive position. 3. Regional wholesalers can help smaller shops in Berlin improve their competitive position. The interviews were analyzed in seven sub-steps (Meuser and Nagel, 2005) as follows: a) recording, b) complete transcription without notation based on the actual interviews, c) paraphrasing, d) creation of headings: the text material was consolidated with either more or less detail depending on the hypotheses, e) topic-based comparison: sections from the individual interviews that addressed the same topic were merged f) sociological conceptualization: disengagement from text, abstraction g) theoretical generalization: establishing correlations and identifying standard terms. These detailed and exact processes were chosen to ensure that the results reflected the experts' knowledge and eliminated the influence of the author's personal interpretation of the interviews to the greatest extent possible.

## Results

The market analysis showed that the number of organic supermarkets in Berlin increased from 19 to 32 between 2003 and 2007; in contrast, the number of organic shops fell slightly by 10% from 99 to 90 (FÖL, 2006). According to the interviewees, smaller natural food stores are being driven from the Berlin natural foods retail market. This can be attributed to the tougher competitive situation between organic supermarkets and organic shops. Organic supermarkets have a better competitive position over smaller shops primarily in terms of marketing tools, sales mix policy, pricing policy, location policy, communication policy outside of the sales sites, communication policy within the sales sites, sales floor layout, etc. Reasons are economies of scale in advertising, purchasing, distribution and management. According to the experts, however, competition between the organic supermarkets will also continue to increase over the next few years. Some organic supermarkets will open more branches while others will close. The smaller organic shops, however, still have considerable room for improvement in marketing. One key way to enhance customer loyalty is to strengthen the function of the organic shops as local suppliers. In addition, services play an important role in customer loyalty. These services could include, for example, a snack bar, a delivery service, individual orders and advice, business hours in line with customer needs, etc. Experts also said that there are opportunities for smaller organic shops to improve their competitive position by tailoring their selection of products specifically to their customers and distinguishing themselves through specialty products produced in small quantities that the large organic supermarkets cannot offer because of their standardized production processes. Even though several experts thought pursuing a purchasing collective (from regional wholesalers) to improve pricing was a good idea, an in-depth analysis would be necessary to determine how much work and cost would be involved. Other experts were skeptical and didn't feel this would be realistic. However, some experts would welcome more support from regional wholesalers to improve the competitive

positioning of smaller shops. A network between the shops is deemed practical for exchanging ideas and investigating possibilities for cooperation. To raise awareness about the problems and stimulate discussion within the industry, the interviewees regard it as necessary to inform the public of the structural change the natural foods retail market is undergoing in Berlin either in the press or through the distribution channels used by organic shops.

## **Discussion**

“The organic shops are facing the same fate as the mom-and-pop stores in the 1970s,” was the conclusion Spiller and Gerlach (2006) reached in their study on how dynamic the organic industry is. The experts interviewed also foresaw this trend for the Berlin organic shops even though the analysis of the market structures in Berlin does not as yet indicate a significant structural change in the Berlin natural foods retail market at the expense of the smaller organic shops and only a slight drop in the number of organic shops has been recorded. However, the remaining organic shops have already reported losing revenues and customers to the increasing numbers of organic supermarkets. These results confirm the assessment of Spiller et al. (2005) who considers the organic shops’ strongest competitors to be the organic supermarkets because of their competitive advantages in many areas. The experts consider the better prices of the organic supermarkets to be their main strength. This confirms the Hamm and Wild’s assessment (2006) that “price will be the primary factor in driving competitors from the natural foods retail market in the future”. The shopping atmosphere in organic shops was considered better by the experts than in organic supermarkets. This outcome is consistent with the results of the customer survey in the “Network for natural food stores Munich” project (Pichelbauer, 2007). In addition to the large stores with a full range of products and modern facilities, Braun (2006) gives the small, personal specialty stores the best chances for a successful future. This assessment was shared by the experts for the Berlin market. However, none of the businesses surveyed pursues strategic marketing although this seems advisable particularly for medium-sized, traditional organic shops (Braun, 2006).

The dynamic development in creating new branches of the organic supermarkets and the customer losses associated with this development represents an economic threat for the Berlin organic shops. Strategic marketing could help small organic shops improve their competitive position. Regional wholesalers could give small shops more support here. Thus the hypotheses we set out to examine have been confirmed.

## **Conclusions**

Shop owners should first recognize the value of marketing for the success of their business and undertake the appropriate measures. We recommend further developing core services and competencies with a range of services. An easy way to give the customer additional benefit would be, for example, to sell snacks and hot beverages or open a bistro. Constantly changing the free samples on offer enhance the customer experience and increase revenues. Increasing the percentage of goods certified by German organic associations and communicating to customers the differences in production and processing over other certification guidelines could be another element in creating a distinctive profile. Another option would be to increase the percentage of distributor brands in the range of products. These affordable organic brands for first-time buyers could help win over new customers. Individual, inviting, frequently changing window displays (e.g. large format photos, creative collages of packaging,

etc.) and a distinctive corporate design could catch the eye of people walking by. Visible external advertising which clearly shows the organic label are recommended.

With respect to customer relationship marketing, we would recommend that the organic shops get involved in the cultural and social life of the respective neighborhood, e.g. with sponsored playground festivals, informational events on sociopolitical issues in their shops or by supplying sporting events with beverages. Drawing contests for children whose pictures are then displayed in the shop window or events in the district center (nutritional advice, cooking courses) are other suggestions for more intensive customer relationships. Customer loyalty could also be boosted by enhancing the customer experience in the shop through a direct partnership between the shop and agricultural businesses in Brandenburg and photos or short films about current work, successes and difficulties on the farm, etc. so that the customers get an idea of how production works. Another way to market smaller shops is by becoming members of the Fair und Regional Bio Berlin-Brandenburg association for producers, processors and retailers. And, last but not least, a consistent human resources policy that incorporates regular trainings and intercompany discussions and advice, service and sales psychology are indispensable to the success of an organic shop.

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# The German organic sector from the perspective of social-ecological research on agriculture and nutrition

Nölting, B.<sup>1</sup>

Key words: social conditions, development of organic agriculture, education-consulting-knowledge transfer, consumer protection, sustainable development.

## Abstract

*Social-ecological research analyses agriculture and nutrition from the perspective of sustainable development. This interdisciplinary and transdisciplinary approach embeds the organic sector in a broad societal and ecological context, integrating normative aspects into its research methodology. New insights from six German research projects are presented.*

## Introduction: Social-ecological research on agriculture and nutrition

Far-reaching transformations can be observed in the field of “agriculture and nutrition”, but not every developmental path leads toward sustainable development. Undoubtedly, organic agriculture and food industries can contribute toward sustainable development in manifold ways (Halberg et al. 2006). However, not every organic enterprise is necessarily sustainable. The organic sector represents one important option, amongst others, for achieving a more sustainable agriculture and nutrition. This paper deals with questions concerning what role the still relatively small organic sector can and should play in the vast field of “agriculture and nutrition”.

This contribution draws on results from the Social-Ecological Research Programme of the German Ministry of Education and Research. Social-ecological research is a type of sustainability research which integrates knowledge derived from different disciplines and practical experiences in order to elaborate feasible solutions for sustainability problems. Six research projects using this approach of social-ecological research analysed the field of “agriculture and nutrition”, covering conventional and organic agriculture, food processing, marketing and consumption, and cooperated in a research network (tab. 1).

**Tab. 1: Topics of the projects from the social-ecological research network**

Projects	Agriculture	Processing	Marketing	Consumption	Policy
Food change			✓	✓	✓
OSSENA	✓ (regional)	✓	✓	✓	
Turnaround in consumption	✓ (organic)	✓	✓	✓	✓
Regional wealth	✓ (organic)	✓	✓		(✓)
AgChange	✓				✓
PartizipA	✓				✓

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## The methodological approach of social-ecological research

The conceptual and methodological approach of the network projects<sup>1</sup> has the following three primary characteristics. 1) These research projects referred explicitly to the *normative concept* of sustainability, clarifying which of the rival definitions of sustainable agriculture and nutrition they held and what their position on these conflicts and debates was. 2) The researchers took an *integrative perspective* on sustainability problems combining agricultural and nutritional research with regard to the whole value-added chain and its linkages with nutrition. 3) *Participatory approaches* included practitioners, stakeholders etc. in order to link the analysis closely with real world problems as a basis for developing practical solutions.

In sum, the projects, discussing their results in the research network, did not focus on single, disconnected aspects of organic and conventional agriculture and nutrition, but rather analysed relevant sustainability problems in relation to the framework conditions as well as to their particular context. The integrative approach and an intense relation with practitioners complement one another, thus going beyond disciplinary research.

## Some results from social-ecological research projects

Some exemplary results with regard to organic food production and consumption in Germany are presented here (for more information see Nölting/Schäfer 2007 and the project websites). They can be assigned to the three main components of the field of "agriculture and nutrition": 1) enterprises from food production; 2) consumers and nutrition; and 3) policies and discourses as framework conditions.

*From sustainable food to sustainable enterprises:* The project "Regional wealth" analysed the contribution of enterprises from the organic food-chain towards quality of life and sustainable development in the Northeast German region of Berlin-Brandenburg. One method was a close stakeholder participation including trans-disciplinary workshops, joint decisions about indicators, and an advisory council of practitioners from the organic sector. Due to this participative approach, the results show that organic companies are not only engaged in environmental protection – even beyond the organic standards – and create jobs and income. Further, the research revealed "invisible" social effects such as a transfer of knowledge and experiences about sustainable agriculture and healthy nutrition to consumers, the participation in regional networks, and the stabilisation of social resources in rural areas (Schäfer 2007). The project "Turnaround in consumption" compared organic farms in two German regions and developed a typology of organic farmers according to region, motivation and economic specialisation. The results reveal that organic farmers are also involved in diverse activities (e.g. tourism, natural protection, marketing) that foster rural development. This typology helps identifying and addressing the "right" farmers for specific projects of rural development (Engel et al. 2006).

Both projects point out that entrepreneurial activities entail more than just employing a sustainable mode of production (e.g. environmentally friendly, fair) and creating

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<sup>1</sup> See [www.sozial-oekologische-forschung.org/en/154.php](http://www.sozial-oekologische-forschung.org/en/154.php). The projects are: *Food change* ([www.ernaehrungswende.de](http://www.ernaehrungswende.de)); *OSSENA – Nutritional quality as quality of life* ([www.ossena-net.de](http://www.ossena-net.de)); *From the turnaround in agrarian policy to a turnaround in consumption patterns?* ([www.konsumwende.de](http://www.konsumwende.de)); *Regional wealth reconsidered* ([www.regionalerwohlstand.de](http://www.regionalerwohlstand.de)); *PartizipA - Participative modelling, analysis of actors and ecosystems in agro-intensive regions* ([www.partizipA.net](http://www.partizipA.net)); *AgChange – conflicts in the new agricultural policy* ([www.agchange.de](http://www.agchange.de)).

sustainable products (e.g. healthy). Additionally, the integrative and participative approaches stress the impact of the enterprises on society beyond the market as well as the importance of the social embeddedness of organic firms. In fact, the social contexts of organic firms and their positions within the market are corresponding factors, e.g. a sustainable profile can be an asset for marketing. In this regard, however, trends in the German food market, such as severe price competition, are a drawback for sustainable food production.

*Taking the perspective of consumers seriously:* The projects “Food change” and “OSSENA” show that consumers do not orient their nutritional practices solely toward achieving economic cost-benefit-maximisation or comprehensive information. As “competent” consumers, they rather manage their nutrition within the constraints of a complex everyday life and according to deeply rooted nutritional cultures and patterns, which makes changes in nutritional habits very difficult. Adopting a participatory and gender sensitive approach, the project “Food change” focused on the everyday perspectives of consumers other than the perspectives from e.g. marketing, nutrition or health experts. The findings show that consumers need simple solutions for sustainable nutrition that easily fit in their everyday life. Organic food is only one element of combined, easily accessible offers of sustainable nutrition; other elements are fair trade, regional food, less meat, competences in cooking and healthy eating, adequate options of out-of-home-eating etc. (Eberle et al. 2006). These findings are also reflected in the research project “Turnaround in consumption” that developed an integrated model of action that addresses the perceptions, knowledge, motivations and actions of consumers simultaneously, in order to motivate them toward eating more organic food. Such a campaign will only be successful, however, if it addresses the specific experiences of the target group and their everyday life context, instead of inundating them with information and “preaching” the right diet.

*Discourses and policies:* Necessary changes for sustainable agriculture and nutrition entail re-formulation of policy goals and redistribution of resources and chances. Such alterations arouse conflicts, and there is a fierce struggle going on in Germany over redesigning policy strategies and re-framing public discourses on agriculture and nutrition. Disputes about organic agriculture and genetically modified organisms are at the heart of such conflicts. The projects “PartizipA” and “AgChange” – using participatory methods, such as group model-building or participatory sustainability impact assessment – suggest that conflict does not necessarily obstruct finding solutions, but can rather be a starting point for constructive problem solving. By including debates on normative aspects and valuations in the analysis as well as involving stakeholders, the projects were able to use the diversity of perspectives as well as normative conflicts as a source of knowledge and motivation.

## **Discussion of the results and conclusions for organic research**

The results and recommendations of the network projects point out that sustainability problems cannot be resolved by single measures such as organic food production and consumption. The researchers, often together with practitioners, formulated and experimented with manifold instruments and strategies. Even though practitioners were not always able to directly implement these recommendations, social-ecological research produces knowledge at the interface of society and science. This robust research perspective embeds organic food production and consumption in a broad societal context, examining them in light of sustainable development. Its strength lies in employing an interdisciplinary and transdisciplinary mode of analysis of food production and nutrition which can also provide new insights for specialised organic

research. It helps to link the organic sector with the vast field of "agriculture and nutrition" which is dominated by conventional production and faces manifold sustainability problems (health/obesity, environment, biodiversity, market concentration, nutritional culture etc.). Organic food production cannot resolve these problems alone because of its relatively small size and because it addresses only some of these problems. However, the results from social-ecological research suggest that the social context of organic enterprises and consumers, their motivation and valuations, heterogeneous actor networks, conflicts over policies etc. can have a potential for sustainable development even beyond organic agriculture. It points toward topics for further research, such as the following:

1. Having started as a social movement that tried to change society, the organic sector has been familiar with the debate on normative implications and value judgments since its origin. However, these discussions seem to have grown less important during the phase of differentiation and professionalisation over the last years. The organic sector, and those who research it, should again revisit and take up the debate with regard to sustainable development; it has to clarify its normative orientations within the whole value-added chain and the role of organic agriculture in society in general.

2. Sustainable nutrition entails more than organic food. Consumers need room for manoeuvre, competences in nutritional understanding, and management strategies concerning how to handle nutrition in everyday life and in the framework of existing nutritional cultures. Since sustainable nutrition means more than individual choice (at the market), consumers need professional assistance and empowerment. In this respect, it seems worthwhile to explore the potential of organic food consumption further.

3. Political conflicts and controversial discourses about (organic) agriculture and nutrition should inspire societal learning on sustainability. Research should identify the most effective procedures and strategies for societal learning and how they can be made fruitful for further development of the organic sector and increasing its contribution toward sustainable nutrition.

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# The Prospects of Organic Agriculture Development in the Chosen Regions of Poland – Podkarpacie and Kurpie.

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Key words: organic agriculture, development, Kurpie, Podkarpacie, Poland

## Abstract

*Organic farming is developing dynamically in the European Union. In Poland its growth is dynamic but still not on a wide scale. The area of organic farms has just exceeded 1%. Research shows that the main obstacles of the dynamic development of organic farming are lack of properly educated young farmers, lack of efficient distribution system of organic products in Poland and abroad and a lot of small farms of low productivity.*

## Introduction

Organic farming not only provides high quality produce, but at the same time is a crucial element of multifunctional development of agricultural areas, in other words sustainable development (Knickel et al. 2006). Organic farming is developing in Poland. According to Main Inspectorate of Market Quality of Agriculture Products and Foodstuffs (GIJHAR-S) there is a constant increase in number of organic farms. (www.ijhar-s.gov.pl). Poland is a country in which historical events and political conditions do not foster a dynamic increase in consumers' organic awareness. Poland is on the fifth place in the world after the USA, Argentina, Italy and Canada in terms of increase of organic land area (Willer and Yussefi, 2007). Even though the organic utilised agricultural area rose up to more than 80 000 in 2004, although, it is still a bit below 1% of all UAA. As a result, a supply of organic products on the domestic market has increased; still, the demand keeps its fairly low level (Żakowska – Biemans, 2005).

Organic production is a chance for a number of small, not very specialized farms. Due to difficult climate conditions, poor soils, not good economic and social conditions, regular farming production is very close to organic production which makes it easier to convert into an organic one. However, there is a need for financial, organizational and educational support for organic agriculture production and for improvement of market organization of organic products (Runowski, 1996; Runowski 2003). The Kurpie region is located in the north-eastern part of Poland called "The Green Lungs of Poland". There are a large number of small low income farms and the soils are poor. Lack of big cities and unpolluted environment comprise excellent conditions for organic farming development. This part of Poland is especially suitable for milk production. Nevertheless, it is still underdeveloped in terms of tourism (Bołtromiuk, 2001; Toryfter, 2002). The Podkarpacie region is similar in those respects although it is situated in southern-east Poland. There are a lot of environmentally sensitive areas. Agriculture is based on family ownership and dairy production (Sołtysiak, 2002).

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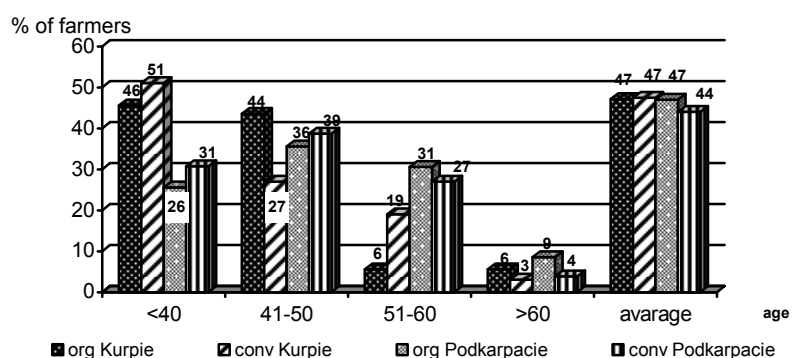
The aim of the research was to present the possibilities and barriers for development of organic farming in those regions and present the practical outcome of the situation.

## Materials and Methods

The paper is a review of the current situation of organic farming in the Kurpie and the Podkarpacie regions among organic and conventional farmers. The research has been conducted in the form of a personal interview – a questionnaire, which included both opened and closed questions. There were two types of questionnaires: respectively for organic and conventional farmers. The results included in the paper come from the research done in 2006 and 2007. In the Kurpie region there were 72 farmers questioned: 35 organic (9 during conversion) and 37 conventional. In the Podkarpacie region there were 96 questionnaires: 63 organic and 33 conventional.

## Results

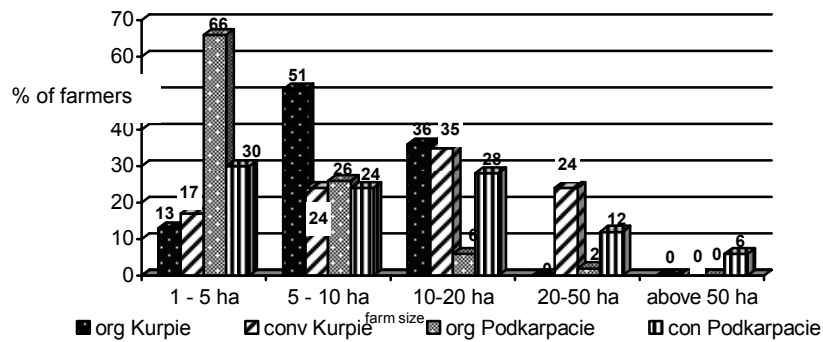
The average age of organic and conventional farmers is similar in the Kurpie region whereas in the Podkarpacie region organic farmers are older than conventional (fig.1). In the group up to the age of 40 there are more conventional farmers in both regions (about 5%) whereas in the group over 60 there are more organic farmers in both regions (about 5%).



**Figure 1: Age of organic and conventional farmers in Kurpie and Podkarpacie 2006/2007**

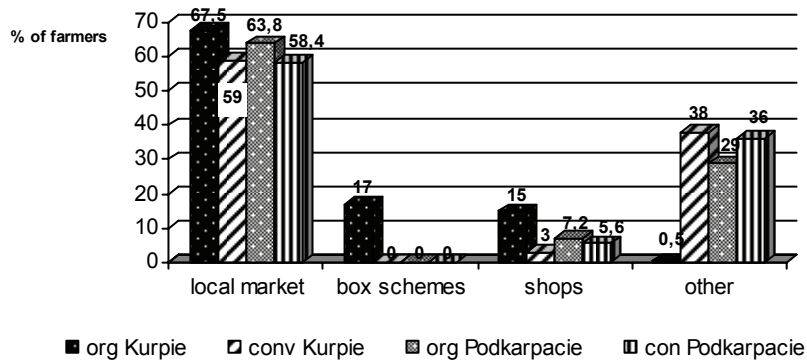
In both regions the majority of organic farms are the small ones, i.e. the size do not exceed 20 ha (fig. 2). However, in the Podkarpacie region there are 66% of farms that belong to the group of 1 – 5 ha. In the Kurpie region 51% of farms have 5 – 10 ha.

Horizontal integration is one of the factors that let farmers improve their situation on the market, e.g. better access to distribution channels. The regions are different in this respect (fig.3). In the Podkarpacie region farmers are better organized, i.e. 88% belongs to seven different kinds of farmers' organizations whereas in the Kurpie region 42% belongs to 2 farmers' groups.



**Figure 2: Participation organic farmers in farmers' associations**

Selling products on the local market dominates in both cases (fig. 3). However organic farmers seem to use direct sales more often than conventional ones. Moreover, among organic farmers in the Kurpie region box schemes and selling products directly to the different kinds of shops is better developed.



**Figure 3: Distribution of organic product**

**Discussion**

As indicated by earlier research, both regions are perfect in terms of environmental conditions for development of organic farming (Sołtysiak et al 2002, Toryfter 2002). One of the main factors stimulating growth of organic farming are young well educated farmers who proved to be more dynamic and ready for changes and improvements (Runowski 1996, 2003). Therefore in the researched regions there is a need to introduce incentives which will influence the lowering of the average age of the

farmers, and will encourage the young ones to stay in the country. One of them might be financial support, especially during the conversion period and after for further development and modernization. Presented results prove (Slabe et al, 2006), that well organized market is one of the key conditions for development of organic sector. They also show that the farmers from the small farms, regardless of their association with production groups or other organizations, are not capable to develop the production to the extend allowing them to go beyond the local market. Organic farmers from the Kurpie region, for example, despite the fact that they are worse organized, show better creativity when it comes to sales methods (box schemes). It may be related to the fact that there is a significantly bigger number of the young farmers (below 40) in the Kurpie region in comparison to the population of farmers from the Podkarpacie region. A lot of small low productivity farms, lack of connection between producers and processors and lack of well organized distribution channels for organic products were listed by the farmers in both regions as the main factors which hamper the development of organic farming.

## Conclusions

1. Development of organic farming is a chance for sustainable development in the Kurpie and the Podkarpacie regions. Both regions have suitable environmental qualities for the development of organic farming, but they need suitable forms of support in order to encourage them to stay in the country.
2. The main obstacles for organic agriculture development are: small size of organic farms, their low productivity and lack of young well educated farmers.
3. The young age of farmers is a much stronger influence regarding their creativity and looking for new methods of sales than their participation and membership in producers' associations and organizations.

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# Agromere: how to integrate urban agriculture in the development of the Dutch city of Almere?

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Key words: Urban agriculture, sustainable cities, stakeholder management

## Abstract

Urban agriculture produces green city areas with as an extra dimension providing food, energy, care, education or recreation for the civilians. And thus it can contribute to a more sustainable and liveable cities. The objective of the project Agromere is to create a process which will lead to a new residential quarter where agriculture is fully integrated in city live. Agromere is situated in the fast growing city of Almere, the Netherlands. In a combined stakeholder and design process a township is designed which integrates living (5,000 inhabitants) with urban agriculture on 250 ha. During this process an enthusiastic network of stakeholders has been established which developed innovating and unique ideas on urban farming. The potential for organic farming in the city is high because of its emphasis on animal welfare and consumer relations.

## Introduction

Nowadays more than 50% of the world population (3,3 milliard people) is living in cities (Martine, 2007). In the Netherlands this percentage is already more than 75%. In the Dutch urban environment people become estranged of food production, nature and the basic values of rural live, like quietness, darkness and the rhythm of seasons. Is it possible to (re-)introduce agriculture in city development and so contribute to a more sustainable and liveable city? Urban farming is already working in both developing and developed cities worldwide, including the Netherlands (Dekking et al, 2007; Van Veenhuizen, 2006). In most cases urban farming is about local food production and green environment. In addition to this urban agriculture can fulfil more of the city needs, like health care, elderly services, child care and education. Farming could also contribute to the shape and management of the green fringe of the city. Moreover, it can function as energy supplier, water buffer and processor of city waste.

Agromere -an imaginary quarter of the city of Almere (180,00 inhabitants)- is a good example of how urban agriculture can be applied in city design. Almere has to expand because of the growing need of new houses in Western part of the Netherlands and in absence of other places to build. In 2030 with 400,000 inhabitants Almere will be one of the major cities in the Netherlands.

## Materials and methods

The objective of the case Agromere is to create a process which will lead eventually to a new residential quarter where agriculture is fully integrated in city live. The assumption is that it is essential when important stakeholders participate in this

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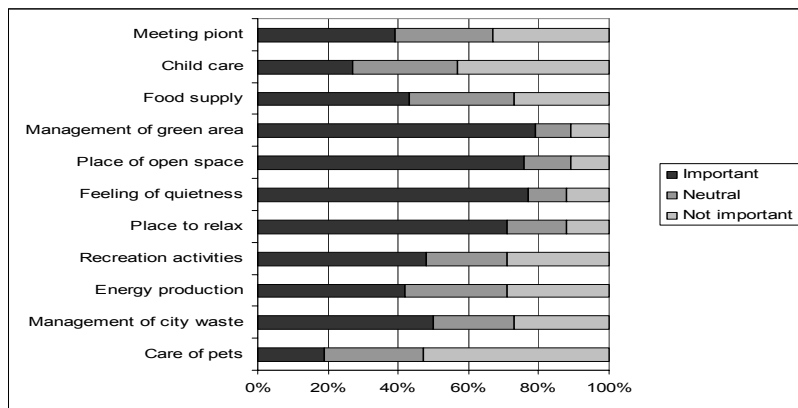
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process and fully contribute to the final result. Eventually, the stakeholders have to adapt urban farming as an added value in sustainable city development. In order to guarantee this, we combined the **DEED** framework (Giller, 2005) and the stakeholder approach (Freeman, 1984). Here, the iterative cycle of investigation starts from **Description** and cycles through **Explanatory**, **Exploratory** and **Design** phases. Each of these activities feeds into the negotiation between stakeholders, which forms the core of this approach. These stakeholders represent, the Ministry of agriculture, local farmers, city counsel of Almere and Zeewolde (nearby town), the province of Flevoland, nature conservation organisations and commercial city developers. To explore also the needs of the citizens of Almere, two quantitative surveys were carried out. In the 2005 survey, 342 citizens (ad random selected in two city quarters) were interviewed by telephone to discover the demand for agriculture in Almere (Stobbelaar et al, 2006). In 2007 an internet survey, using the consumer panel of the municipality of Almere (N=562), explored the demands on urban agriculture as it would be part of the neighbourhood (Engelen, 2007).

## Results

**Description phase:** The North east of Almere (app. 2,500 ha) is a polder landscape reclaimed about 50 years ago. Agriculture (most large scale arable farming) is the main land use activity nowadays. In this area the city of Almere needs to expand with 20 to 60,000 houses. At present, agriculture is excluded in the development plans. **Explanation phase:** Agromere started in 2005 with creating a multi stakeholder network in Almere. All of these stakeholders have different claims and interests on the area of north east of Almere: houses, nature, cultural history, industry, water housholding, infrastructure and agriculture. To explain these claims, the major drivers behind these different claims were described and later discussed in a workshop with the stakeholders. **Exploration phase:** The approach of future scenario's was used to cross these present claims and interests. Future scenario's are based on the assumption that it is important to develop systems or designs which are prepared to deal with future uncertainties, rather than to build on known certainties (Van der Heijden, 2005). All stakeholders were interviewed on possible uncertainties on developing Almere North east and the role of urban farming in this development. The stakeholders defined technology and locality as the most important uncertainties. Based on the extremes of these uncertainties we created in cooperation with the stakeholders four concepts for urban farming: Topspot, Ecocity, Agripel and Farmers village. These four concepts were used as a tool in the process towards joined images on urban agriculture, they were not a goal in itself. Subsequently these four were confronted with the claims and interests of the stakeholders. The stakeholders choose a combination of Ecocity and Farmers village as the most appropriate.

The two surveys are showing that inhabitants have an open mind for agriculture in their direct surrounding. Respondents gave urban farming an important role in maintaining green areas, keeping quietness and open spaces in the city. Food supply, energy production and waste management were mentioned as important functions (fig. 1). One third of the respondents appreciate a distance to the farm of less than 500 m. Animal welfare on the farm is important for two third of the respondents, an organic way of production for one third. Preferred activities at the farm are shopping, walking, visiting a restaurant and having an educational tour.



**Figure 1: Important functions of urban farming to respondents (N=562) in Almere (NL). Source: Engelen, 2007.**

Design phase: In this fourth step we outlined the village of Agromere with app. 5,000 inhabitants (or 2,300 households) on 250 ha of land. For houses and infrastructure 80 ha is used. These are normal figures in current Dutch city planning. On the remaining 170 ha, four urban organic farms are situated: a community supported vegetable farm (CSA), a dairy farm with nature-education, a greenhouse farm, with restaurant and school and an arable farm with health care and village-shop. Each of those four is related to each other by (re) using products, services, raw materials and waste.

### Discussion

The Agromere case shows that spatial planning can be done interactively without using too much of the sparse land. In Agromere, the open space normally used for parks, play grounds and ponds, now gets an urban agrarian function. The amount of open space in the village remains still the same. The two surveys confirm that the inhabitants of Almere perceive the added value of (urban) agriculture as city green. The potential for organic farming in city live is high because of its emphasis on animal welfare and consumer relations (Stobbelaar & Van Veluw, 2006). Remarkably was that the enthusiasm of the respondents for urban farming was growing during the questioning indicating that more information on the added value of urban farming is necessary. A comparable survey in 2007 in Amsterdam (N=1062, not published) confirms this assumption.

Successful planning of urban farming requires the involvement of a wide range of actors stakeholders (Dubbeling and Merzthal, 2006). The DEED framework, the two surveys and the Future Scenario approach were helpful in this combined stakeholder and design process. At the start, stakeholders had no idea of urban farming and the way it can fit city planning. During the process an enthusiastic network of stakeholders (together with research) has been created which developed innovating and unique ideas on urban farming. We continue developing the outlines of Agromere in cooperation with the stakeholders because of by the summer of 2008 the municipality of Almere has to launch the developing plans for Almere North east. Urban agriculture is now a serious option in these developing plans.

## Conclusions

The outline of Agromere indicates that a participative design process of urban farming is needed to commit stakeholders to this new concept. Without this process urban farming will not be a natural part of the spatial planning and city development of Almere. The Dutch citizens are still aware of the added value of agriculture in their lives, but there is a need to inform them further about this added value of urban (organic) agriculture.

## Acknowledgments

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# The New 'Local': A Global Review of Using Geographical Indications

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Key Words: Geographical Indications, appellations, small farmers, developing countries, standards, tradition, culture, environment.

## Introduction

What do Parmigiano cheese, Bordeaux, Idaho potatoes, Basmati rice, and Darjeeling tea have in common? As the concept of 'local' sourcing and marketing becomes more important, these Geographical Indications (GIs) or appellations are a potentially unique form of competitive advantage available even for small farmers and enterprises. A GI legally identifies and formally recognizes a good as originating in a delimited territory, or region where a noted quality, reputation or other characteristic of the good is essentially attributable to its geographical origin and/or the human or natural factors there.

Organic standards, though valuable, may not offer the most appropriate way of safeguarding the actual provenance of local foods and conveying this to consumers in the marketplace. However, in more than a hundred nations, GIs are recognized as a unique expression of local agro-ecological and even cultural characteristics that have come to be valued as signals of high quality and local traditions. In many cases GIs can readily combine with organic certifications and thus provide a unique combination of assurance to consumers.

## Description and Methods

A multinational team<sup>2</sup> has reviewed nearly 200 published studies on the experience in the EU, US, and elsewhere as well as assessed, via nine original case studies, what different popular origins have done with their GIs in Guatemala, Jamaica, Mexico, Ethiopia, India, Colombia, Kona, and Mongolia. The goal is to provide an objective 'Guide' to understanding, forming, and using GIs effectively (to be published by the UN's International Trade Center).

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<sup>1</sup> Work undertaken for the UN International Trade Center. The full document will be available in mid 2008. Author contact: D@DGiovanucci.net

<sup>2</sup> In addition to the project leader Daniele Giovanucci, the research team includes:

Catarina Illsley (Head, GEA Grupo de Estudios Ambientales)

Tim Josling (Professor Emeritus Stanford University)

William Kerr (Agricultural Economics chair at University of Saskatchewan and editor of the Journal of International Law and Trade Policy)

Bernard O'Connor (EU Attorney and Professor of Law, author of 'Agriculture in WTO Law' and 'The Law of Geographical Indications').

Dwijen Rangnekar (Senior Fellow at the Centre for the Study of Globalisation and Regionalisation and the School of Law Warwick University)

The literature review documents, among other things, the considerable success of many origins that have formal GIs to confirm and convey their local attributes to the market. This is measured by difference in revenue and employment for formally recognized GIs when compared to similar products in those regions.

In addition to reviewing the practical pros and cons of different approaches to GIs, the review will also explain the costs and benefits and provide information to assess the different instruments available. so that developing country producers, communities, policymakers and technical ministries for agriculture, commerce, intellectual property, etc. face unique challenges and barriers to creating effective GIs. For e.g. to protect their GIs requires an understanding of the application of complex legal issues that differ considerably in different markets. One result of the review is a basic set of guidelines informing stakeholders about what to consider when undertaking the development of a GI.

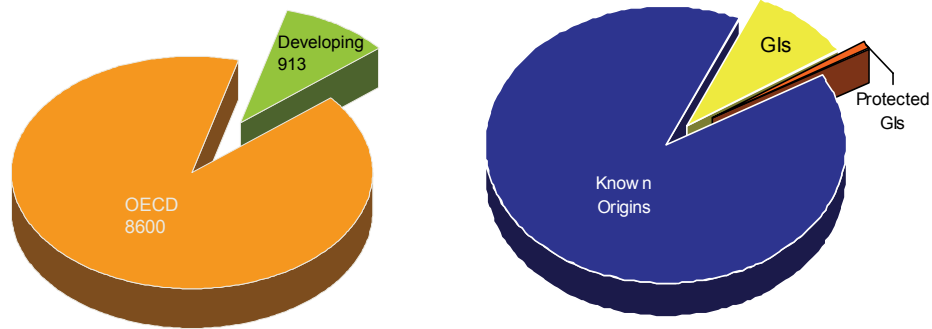
### **Key Conclusions of the studies**

Geographical Indications can prove to be a valuable asset for organic producers and marketers because GIs can complement and are in alignment with the precepts of organic agriculture. They can foster market-based support for local traditions and cultures. They provide an excellent framework for broad-based and equitable rural development at the regional level. Viable GIs are essentially building a legally protected brand and a reputation in the marketplace. They are not easy to achieve nor easy but also not easy to erode because they depend less on common factors of competition in the field of agrifood production such as costs of production.

Developed Nations have many well known GIs including: Scotch, Roquefort, Champagne, Parmigiano, Cognac, Feta, Kona, Vidalia, Port, and Bourbon. In contrast, developing nations have relatively few, but their success has increased the level of interest in them as a way of protecting the concept of local production in a manner that is harmonious with existing international trade regulations such as those of the WTO and particularly the TRIPS Agreement. Among the better known are: Ceylon tea, Pampas beef, Tequila, Basmati, Darjeeling, Blue Mountain, Tellicherry, and Café de Colombia.

### **Distribution of Geographic Indicators**

Although most of the protected GIs exist in developed nations, a far greater number of candidates to become GIs are known in developing nations. Most are neither formally demarcated nor protected by laws. Yet the market already recognizes Cambodian Kampong pepper, Morocco Argan oil, Nicaragua's Chontaleno cheese, and Rooibos from South Africa.



- Nearly 10,000 protected GIs
- Developing countries all together have less than 10% of these
- EU 27 = 5,250 Protected GIs
- US = 950 Protected GIs

Such locally recognized origins offer a number of potential **unexplored opportunities**. There may be considerable benefits available from tapping into evolving consumer preferences for local foods that simultaneously offer a measure of quality assurance – as most GIs meet high standards, including, in some cases, for organic production. One question remains unanswered: will locally-oriented consumers also value the tradition and local cultural aspects of foods that are produced far from their markets?

GIs have **developmental** characteristics. They emphasize the local. They value the cultural aspects and traditional methods that are intrinsic to the production and processing of a product. They also value the land and its particular agro-ecological characteristics that make GI products unique. As such, they are also in accord with organic principles.

GIs are in alignment with **emerging trade demands** for quality, traceability, and food safety. They typically, though not always:

- Apply standards
- Use certification systems that can interface with others such as organics
- Tend to be traceable due to their uniqueness especially with the advent of low-cost DNA tracing

- Often implement appropriate processing technology

In these ways GIs can serve as conceptual frameworks to drive an **integrated** form of rural development. The institutional structures that are part of many successful GIs may be beneficial to local and regional governance as well as to organic certification management.

But, GIs are not easy to achieve.

- Success is often measured in decades and requires patient application and sustained commitment of resources.
- Issues of equitable participation among the producers and enterprises in a GI region are critical to consider, and not easy to accomplish
- Besides organizational and institutional structures to establish and maintain the GI, there may be ongoing operational costs to consider:
  - dissemination
  - marketing
  - monitoring and management (separate legal enforcement)
- Most of the successes from developing countries have come on top of a
- long-standing popular product and via further marketing by strong partners.

The potential long-term value can be extraordinary nonetheless and not only on the economic level (jobs, greater income, ancillary development such as tourism) but also on a cultural and local level in terms of the recognition of customary and value-adding traditions that convey a sense of a people and their relationship to a region.



## **Organic marketing and organisation in developing countries**

# Shaded Coffee: A way to Increase Sustainability in Brazilian Organic Coffee plantations

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Key Words: Shaded Coffee, Organic Agriculture, Sustainability, Coffee Quality, Chemical Elemental Composition

## Abstract

*Consumption of specialty coffee, mainly organic coffee, increases worldwide following the tendency of consuming social and ecological sustainable products. Brazil is the world largest coffee producer, with an average of 2,300,000 tons of green coffee in the last 5 years. Cultivation of organic coffee and shaded coffee are common in Central America, while in Brazil both conventional and organic coffee are cultivated in the full sun system. The full sun system is criticized due to the lack of biodiversity and high demand for inputs. Shaded coffee system has more biodiversity, recycles and fix more chemical elements, such as N, P, K, Ca and C, having a great potential to mitigate the global warming, being consequently more sustainable. In Brazil, shaded coffee system is not well trusted and known as less productive. Seeking for organic coffee sustainability, this work evaluates productivity, coffee quality and chemical composition of coffee beans from two distinct organic coffee systems: shaded and full sun, in the largest arabica coffee producing region of the world, south of Minas Gerais State, Brazil. For productivity and coffee quality there was no statistical difference, although there was a tendency of superiority for the shaded treatment. For coffee beans composition, the shaded system presented higher K values. Considering the results obtained, the shaded system can be suited to increase organic coffee sustainability in this region of Brazil.*

## Introduction

Concerns of the society with life quality, environmental and social aspects of agricultural production continually increases. The organic agriculture fully attends this need of the society and the demand for its products rises globally generating market opportunities for producers worldwide.

The International Federation of Organic Agriculture Movements (IFOAM, 2007) estimates that the global organic market in 2006 reached 30 billions Euros and that the total area of production was of 31 millions hectares.

Coffee sector worldly represents a market of US\$ 70 billion/year, only behind oil (Loureiro & Lotade, 2005). Consumption of specialty coffees, such as organics, gourmets and fair trade is increasing intensively. According to Illy (2005), consumption of conventional coffee increases at a rate of 1,5% a year while specialty increases at a rate of 12% a year.

Although Brazil is the largest world coffee producer its organic coffee production is comparatively small, being the sixth largest producer in 2002 and 2003. In the 2004

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crop the Brazilian organic coffee production has risen significantly reaching around 15,000 tons. (Souza et al., 2005).

Mexico has been the largest world organic coffee producer, with an average of 30,000 ton in 2003 and 2004. Peru has also increased its production and nowadays Mexico and Peru are the two world leading organic coffee producers, being most of their production from shaded systems (Lernoud & Piovano, 2004).

In most producing countries, coffee is cultivated in shaded systems, being Brazil one of the largest exceptions (Bacon, 2005). Researchers, producers and society fear for the sustainability of these production systems ecologically simplified and highly dependent from inputs. Coffee plantations with high vegetal biodiversity are environmentally balanced, with reduced pressure from pests, stable climate conditions, humidity during the dry periods, lower soil erosion and lixiviation, higher rates of nutrients cycling and better coffee quality (Altieri, 1999).

The use of shade coffee trees for C sequestration and reduction of N fertilization has a huge potential for mitigation of the global warming (Montagnini & Nair, 2004). This potential is even greater in Brazil where most of the coffee plantations are in the full sun system.

Therefore it is needed to study the few shaded systems in Brazil, evaluate its potential and establish new techniques and policies to stimulate the increase of biodiversity and the sustainability in Brazilian coffee plantations (Ricci et al., 2002)

### **Materials and methods**

The study was conducted at Jacarandá Organic Coffee Farm, Machado town, south of Minas Gerais state, Brazil. The farm is certified since 1992 by the Instituto Biodinâmico de Desenvolvimento Rural (IBD), an accredited IFOAM member. The experimental field is cultivated with Arabica coffee plants, Mundo Novo variety. Shading is provided by a native leguminous tree *Platycyamus regnellii*. Three blocks were set and the two treatments were: (i) shaded and (ii) full sun. Four repetitions were established, resulting in 24 plots. Each plot was composed by two coffee plants.

The coffee beans were manually harvested and the volume (l) from each plot was quantified on the same day. Coffee from each plot was naturally (with skin and pulp) sun dried. Samples were brought to the Radioisotopes Laboratory (LRI), Piracicaba – CENA/USP where beans were mechanically peeled in a “coffee huler equipment”, oven-dried and then ground. Test portions were irradiated in the nuclear research reactor IEA – R1m of the Instituto de Pesquisas Energéticas e Nucleares, (IPEN/CENEN), São Paulo. The induced radioactivity was measured with detectors after 3, 7, 20 and 28 days of decay time. Determination of chemical elements was carried out by  $k_0$ -INAA using the *Quantu* software package (Bacchi and Fernandes, 2003).

The quality coffee determination took place at the Laboratory of Classification and Cupping Quality from the Brazilian Agriculture Ministry (MAPA-Rio de Janeiro). Three quality parameters were evaluated by the coffee experts: (1) Screen size proportion of the beans, (2) Type determination (number of defects) and (3) Cupping of the coffee drink (flavour and aroma).



The data were statistically evaluated through the SAS program. Univariate tests included ANOVA to test the hypothesis of similarity to all the parameters evaluated. Tukey test at 95% was applied for multiple comparison among the averages.

## Results

Table 1 below shows the results of the work for productivity, coffee quality and chemical composition of the beans.

**Tab. 1: Average results and standard deviations for production (in liters of coffee), cup drinking quality, percentage of screen 14 and up (size of beans), type in points (number of defects) and coffee beans elemental concentration for Ca, Fe, K and Zn ( $\mu\text{g g}^{-1}$ ) for the shaded and for the full sun treatments.**

	Prod. / plot (l)	Cup quality	% Screen 14 and up	Type in points	Ca	Fe	K	Zn
<b>Shaded (n=12)</b>	36.4a	1.83a	84.9a	-84.2a	1140a	24a	16200a	7.2a
<b>SD</b>	20.24	0.8348	4.87	46.8	120	3	900	1.0
<b>Full sun (n=12)</b>	33.9a	1.67a	83.6a	-89.2a	1080a	24a	15100b	7a
<b>SD</b>	18.31	0.77	3.22	56.23	140	2	1200	0.9

Means followed by the same letter are not significantly different ( $P < 0.05$ ) by Yukey test

## Discussion

The results of production from Table 1 present no statistical difference among the treatments, although the shaded system shows slightly higher volumes than the full sun. Higher production for shaded system was also observed by Ricci et al. (2002). Important to consider that the tree studied in this paper *Platycyamus regnellii* lose its leaves during the winter while in the work carried by Ricci et al. (2002) the trees were pruned in the winter. This reinforces observation from producers that the shade trees have to lose the leaves in the period of short and cold days (winter) in order to obtain a good coffee production.

The higher concentration of K on coffee beans may be a consequence of a higher concentration of K on the soil of the shaded system. As this element is very mobile in the soil and in the plant it was absorbed by the coffee plant in larger quantities in the shaded system. Moreover, this higher concentration of K in the shaded system may also be related to larger volume of coffee roots, resulted of lower soil temperature (Rena et al., 1986). The possible higher concentration of K in the soil may be a result of lower leaching and erosion (Rena et al., 1986). Besides, this system may also count with the recycling of nutrients carried by the shade tree, originated through the absorption of nutrients by the roots and latter falling of its leaves on the soil of (Theodoro, 2001).

As it can be seen in Table 1, no statistical differences were observed among the two systems of production for cupping quality, size of the beans and type. Although, there is a tendency of superiority for the shaded treatment to these parameters. This reinforces the smaller number of defects obtained by Ricci et al. (2002) and the better

cupping quality and larger size of the beans obtained by Matiello (2002) and Rena et al. (1996) for the shaded coffee.

A wider interpretation and correlation of the results suggests that the higher values of K obtained for coffee beans from the shaded treatment must have had influence over the productivity and coffee quality. The K element is for long considered the element of the quality in plant nutrition (Malavolta, 1989) and also the most important element for coffee drinking quality (Silva, 2002).

## Conclusions

The shaded organic coffee treatment presented the best results for productivity, coffee quality and chemical composition of the beans, therefore, being recommended for this region of Brazil.

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# Consumers' Awareness, Demands and Preferences for Organic Vegetables: A Survey Study in Shiraz, Iran

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Key words: organic vegetables, awareness, demand, preference

## Abstract

*Some Iranian vegetable producers use a lot of chemicals, but not in a safe way or at the optimum level. There are several reports about chemical residues in vegetables that have serious side effects on human health and the environment in that country. On other hand, many Iranian farmers traditionally use organic production practices, but organic cultivation in Iran is not in accordance with international regulations. Since vegetables are the most important category of organic products, and since the future of organic agriculture will largely depend on consumer demand, a survey of 470 respondents was performed in Shiraz regarding their level of awareness about organic vegetables, their tendency to consume of organic vegetables, the effect of proper appearance of vegetables on the tendency to purchase organic vegetables and the importance of the organic label and certification of organic vegetables. Results showed that about half of the respondents have knowledge of organic vegetables and that their tendency to consume organic vegetable is very high. The results also showed that proper appearance does not effect the tendency to purchase organic vegetables, and that almost all consumers prefer to purchase organic vegetables labelled as certified. It is suggested that organic vegetable production be introduced and supported by the Iranian government.*

## Introduction

Some Iranian vegetable producers use a lot of chemicals, but not in a safe way or at optimum level. In addition, there are several reports of chemical residues in vegetables. On the other hand, many farmers in Iran have traditionally used organic practices for a long time. Data shows that 113,659 ha of field crops and 125,802 ha of horticultural land in Iran are cultivated organically, but not according to international regulations or guidelines such as those of IFOAM. (Ghorbani et al., 2007).

Burgeoning consumer interest in organically grown foods has opened new market opportunities for producers (Dimitri and Greene., 2002), and in recent years consumer demand for organically grown food has also increased (Soler et al., 2002).

The future of organic agriculture will to a large extent depend on consumer demand. Thus, a consumer-oriented approach to understanding organic food demand is important. (Bonti-Ankomah and Yiridoe., 2006).

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Hartman Survey Group (2002) reported that vegetables are the most important organic product and they are top-selling of organic product in USA. So investigation on organic vegetables and their market is very important.

The purpose of this study was to determine the level of public awareness about organic vegetables and the tendency for their consumption, the effect of proper appearance of vegetables on the tendency to purchase organic vegetables, and eventually, the importance of organic vegetable labelling and certification.

### Materials and methods

The data in this study came from 470 surveys in the city of Shiraz in southern Iran. The study was conducted using the random sampling method and data was analyzed by the chi square analysis.

### Results

#### a) Sample description

470 respondents were interviewed by means of a questionnaire. The sample consisted of 300 women (63.83%) and 170 men (36.17%). The average age of the respondents was 30.5 years; 60.6% had a university education.

#### b) Consumer awareness

To determine awareness level, consumers were asked "Do you know what organic vegetables are?" Table 1 shows that 46.59 percent of respondents answered "Yes".

**Tab. 1: Consumers awareness of organic foods**

Do you know what an organic vegetable is?	frequency	Percentage	X <sup>2</sup>	
Yes (aware)	219	46.59	2.179	n.s.
No (unaware)	251	53.41		

\*\* indicates statistical significance at the 0.5% level

We examined the results derived from the questionnaires using chi-square analysis. With the probability of 0.995 ( $\alpha=0.005$ ) and  $df=470$ , we cannot reject the  $H_0$  hypothesis. The chi-square analysis showed that there is no significant difference between the responses "Yes" and "No". In other words, about half of the population is aware of what an organic vegetable is. Therefore we can say that awareness level concerning organic vegetables is in the acceptable range.

#### c) Consumer tendency for consumption of organic vegetables

Some information was presented to the all respondents, and their resulting tendency was assessed as illustrated in Table 2.

**Tab. 2: Consumers tendency for consumption of organic vegetables**

Do you have a tendency to consume organic vegetables?	frequency	Percentage	$\chi^2$	
Yes	436	92.76	343.8	**
No	34	7.24		

\*\* indicates statistical significance at the 0.5% level

As illustrated in table 2, the chi-square analysis results shows with a probability of 0.995 ( $\alpha=0.005$ ) and  $df=470$ , there is enough evidence to reject the  $H_0$  hypothesis. Hence, there is a significant difference between responses. Results showed that the tendency for organic vegetables is very high, so it seems that the government and producers can invest on organic production.

d) Effect of proper appearance on the tendency to purchase organic vegetables

To determine this factor, consumers were asked: "Do you have a tendency to buy an organic vegetable that do not have proper appearance instead of non-organic vegetable with proper appearance?". As shown in table 3, from the calculated chi-square statistic, with the probability of 0.995 ( $\alpha=0.005$ ) and  $df=470$ , there is enough evidence to reject the  $H_0$  hypothesis. So, there is significant difference between the answers. The results show that "proper appearance" cannot have a significant effect on the tendency for purchasing organic vegetables; this would be a valuable advantage for the organic producers.

**Tab. 3: Effect of "proper appearance" of vegetables on tendency for purchasing organic vegetables**

Do you have the tendency to buy an organic vegetable without proper appearance instead of a non-organic vegetable with proper appearance?	frequency	Percentage	$\chi^2$	
Yes	344	73.19	101.1	**
No	126	26.81		

\*\* indicates statistical significance at the 0.5% level

e) Determining the importance of "organic vegetable labelling" and certification of organic vegetables

To determine the importance of "organic vegetable labelling" and certification of organic vegetables, consumers were asked "Do you prefer to purchase an organic vegetable with an organic label by the governmental health or agriculture sector?" Table 4, results derived from the calculated chi square statistic and the  $df=470$ , with the probability of 0.995 ( $\alpha=0.005$ ) show that there is enough evidence to reject the  $H_0$  hypothesis. In other word, there is significant difference in the population of the group who answered "Yes" and the group who answered "No" to the question in the whole population. The results should alert government and producers to make global organic vegetable production regulations more applicable in Iran.

**Tab. 4: Consumers trend for consumption of organic vegetables with organic label by the governmental health or agriculture sector**

Do you prefer to purchase an organic vegetable with an "organic label" by the governmental health or agriculture sector?	frequency	Percentage	X2	
Yes	458	97.45	423.2	**
No	12	2.55		

\*\* indicates statistical significance at the 0.5% level

### Discussion and conclusions

According to the results, about half of the respondents have knowledge related to the organic vegetables. In addition, the tendency for organic vegetable consumption is very high. These very positive factors allow governments and producers to invest in organic cultivation and take advantage of a new and promising market. Also results show that "proper appearance" does not have a significant effect on the tendency to purchase organic vegetables; this would be a valuable advantage for organic producers because producers who wants to change their system from conventional to organic are very worried about "non-proper vegetables' appearance" in organic cultivation and its effect on their market. As the results showed, almost all of the consumers prefer to purchase an organic vegetable with a governmental certified "organic" label. These results should alert governments and producers to make global organic vegetable production regulations more applicable in Iran.

It is proposed that organic vegetable production must to be introduced and supported by Iranian governments. Governments can increase the tendency for consumption of organic vegetables by increasing public awareness (such as programs and advertisements in TV) and governmental rewards and subsidy for organic producers.

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## Market Integration Shape Organic Farmers' Organisation

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### Abstract

*Increasing consumption of organic products in globalised food chains will require the involvement of thousands more smallholder farmers in many regions of the world. A study of Egypt, China and Uganda identified the three key factors of property rights regimes, cultural differences and social organisation as determinants of the supply chain organisation and farmers' degree of direct integration in the export markets. Patterns are emerging where smallholder farmers are being socially and economically linked to larger farmers who may do some processing before the raw materials are handed over to the contracting company. Where transactions costs are high, local communities may develop and contract out the land directly to exporting companies who farm using employees. Four organisational patterns are identified which each leads to different types of livelihood benefits for the producers; preliminary results indicate that income and a reliable market access are the dominant benefits.*

### Introduction

There is an increased conversion to organic farming on a global scale. The organic food systems are transforming groups of loosely coordinated market actors to globalised systems of regulated trading linking socially and spatially distant sites of production and consumption.

Although certified organic products make up a minor share of the world food market (1-2%), agricultural development organisations, such as IFAD and FAO, as well as many NGOs, increasingly see organic farming as a beneficial development pathway for smallholder farmers (Egelyng and Høgh-Jensen, 2006).

The primary drivers of conversion are an increased demand for organic products in the rich countries of the North and increasing domestic markets in large cities. This paper reports an investigation of consequences on farmers mode of market integration

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and their ways of organising themselves to meet the requested market requirements for organic products.

### **Materials and methods**

A cross-sectional study approach (Yin, 2003) was chosen and strategic cases selected in China, Egypt and Uganda, due to these countries major role in global export oriented food supply chains. Cases were selected that reflects diversity in the global export integration at all sites. Open-ended interviews were conducted with farmers and key-informants in all cases. A questionnaire was developed and enumerators were used to collect data from approx. 20 farmers per case area (Mikkelsen, 2005). In addition, field data were collected and observations made as part of several ongoing field studies. The analytical frame for data interpretation was based on the Sustainable Livelihood Framework approach as developed by DFID (2007).

### **Results and Discussion**

#### *Organisation of the product chain*

Four distinct organisational patterns emerged during the investigation of the organic product chain in the selected countries. First, in North East China, a private organic company aided local soybean producers in all aspects of production – from cultivation to certification. The company then purchased the produce directly from farmers prior to export. An important aspect of this case was that the company only approached farmers with sufficient and easy accessible land holdings. This approach traversed the traditional and administrative village structure and it was basically contract farming with select farmers in the area suitable for organic production. Secondly, in Mid-East China (Shangdong region), an organic company works together with villages as an entity, essentially making a contract with the village. In this way the village hierarchical power structure is used by the company to control production. Thirdly, smallholders farming less than one hectare for organic export either depend upon non-market forces (for example NGO's) for market linkages or upon businessmen for certification. Fourthly, exporting companies or traders may produce their own commodities on land they own or rent around large metropolises like Shanghai. Such cases also include contracted farms operated by farmers and supervised by companies.

In Egypt all four structures in farmers' way of organising were found, with farm size an important determinant of product chain structure. Large capital intensive organic farms, like those located upon reclaimed desert, normally have direct links to export markets. This direct linkage diminishes with decreasing farm size thus resulting in more steps in the chain and alienating small farmers from the final step in the chain. For example, some small farmers in Egypt supply to larger farmers, who may process a bit before supplying to the companies or to traders.

The second and third structure in farmers' way of organising resembles the case of Uganda; a developing country with a diversified organic production structure where various development agencies play active roles. The background of the organisation driving the organic agriculture initiatives influences the organisation of the production chain. It is in the interest of private sector players to organise farmers in such a way that cost are kept as low as possible. As in practice the private sector owns the organic certificate, the degree of production and marketing autonomy of small producers is low. Recent NGO involvement has contributed to the debate about



options to organise the production chain in favour of smallholder farmers, especially through the participatory guarantee systems, where the farmer group themselves owns the organic certificate. Among the consequences of this debate are attempts to outsource some of the private sector activities to farmers, such as processing and value addition in general. Moreover, the type of the organic commodity influence the organisation of the production chain as the demands, requirements and capabilities of farmers to handle high value crops differs from low value / high quantity crops.

#### *GO and NGO involvement*

The level and scale of enforcement of farmers' property rights varies between countries. In Egypt and Uganda government has very limited if any involvement in the organic sector. In contrast, in peri-urban areas of Shanghai local government involvement in the organic product chain was evident in reaction to abandonment of small farms, invests in infrastructure for large scale production and then rents out the land to companies who run the farms based on farm labour. In Uganda, organic agricultural training and education is spearheaded by the informal sector and development organisations offer externally funded and market-led initiatives. NGOs and the private sector organise and conduct training, education and research with the support of external donors. This support of development organisations has given Uganda a significant break-through to the international organic market through export of coffee, vanilla, cotton, dried sweet bananas, mangoes and pineapples. Recently, research institutions and universities have started seeing the need for conducting research in the organic sector.

#### *Farmers' livelihood*

The manner in which farmers are organised is crucial for the benefits they may accrue from organic farming. The role of the size of their property is important. As described above, smallholder farmers' linkages to the market may be weak where middlemen are involved, reducing their financial gain. The organic farmers in the case area in NE China had larger land holdings than the conventional farms in the area, providing them not only entry to the organic market but also increased profits. Most conventional farmers in the area (with exactly the same cropping systems yet on smaller land holdings) had never even heard of organic farming. They sold produce on the local market or to the government. Indications are therefore that the '*village model*' of certification has the possibility of supporting all farmer types.

Involvement in the organic production chain was found beneficial to local organic associations. It facilitated smallholder certification and their access to markets on a large scale and enabled better economical benefits. Such local organic associations can help train farmers and enable experiences sharing in social acceptable ways. In Uganda, local organisations have enabled smallholder farmers to do their own research to reach an optimal quality of the desired product (Mursal, 2007).

All cases in the three countries indicate that that livelihood benefits that farmers derive through certified organic agriculture are skewed towards monetary benefits. In Uganda, agricultural growth has benefited poor people most where land ownership has been relatively equitable. Land ownership often remains inequitable, reducing the potential of organic agriculture to reduce poverty. Therefore well defined and secure property rights are very important in encouraging farmers to invest in their production systems. In Egypt, some organic farmers' organisations were organised by companies or traders in order to guarantee organic products supply flow for their export activities but without support to farmers' right needs and market linkages.

### *Organisation to get the market access*

A number of trends can be identified from the ways in which the product chains are structured in the case areas. Generally, farmers are highly reliant upon organic companies that can ensure quantity and quality requirements for the export markets. In particular small scale farmers are dependent upon companies, when the state and civil society organizations are absent. The size of land-holdings and the type of production structure plays a pivotal role in farmers' market access.

Transaction costs influence the economic organization between smallholder farmers and organic companies. In the case of Shandong region, both organic companies and smallholder farmers had decreased their transaction costs by contracting. "Organic" companies have an excellent knowledge of markets, quick access to capital and new technologies. On the other hand, small farmers have a good knowledge level regarding vegetable production, access to lands and cheap labour. By contracting, both of the contractors have eliminated "*uncertainty*" problems, small farmers secured their markets and organic companies secured quantity and quality of their organic products. In the Shandong case, smallholder farmers have increased their household income by adopting organic agriculture and secured their market by contracting with "organic" companies. Anecdotal evidence indicates that some farmers, who used to seek off-farm income, are coming back to the villages as organic agriculture offers an acceptable income. The opportunity costs on-farm and off-farm is the main factor whether to involve in organic agriculture (Sultan, 2007).

### **Conclusions**

The rapidly growing organic markets in Japan, Europe and USA offer a significant opportunity for farmers in low-income regions to produce and sell high value products. The current study demonstrates four organisational patterns with which the farmers reach the global organic market chain. For the farmers, the opportunity costs on-farm and off-farm, property rights, the social relations to the other actors in the chain, and cultural boundaries seems the main factors determining the involvement in organic agriculture.

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# Accessing the World Market for Organic Food and Beverages from Nigeria

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Key words: Export, Nigeria, market opportunities, organic food, organic beverages

## Abstract

*A study in 2005-2006 assessed the opportunities for and constraints to Nigeria accessing the international organic market. The study comprised semi-structured interviews with agricultural produce exporters and government officials in Nigeria, and with representatives of certification agencies in the UK, and focus group discussions with farmers' groups in Ogun State, Nigeria. Fresh and canned pineapple and mango, ginger, and herbs and spices were ranked as having very high potential for Nigeria in the international market. Fruit juice concentrates, palm oil, cashew nuts, honey and cotton were among those products classified as high potential. Constraints identified included lack of awareness of organic farming techniques, high certification costs, lack of institutional support, enabling policies, infrastructure, and marketing facilities, limited access to capital and inability to capture economies of scale.*

## Introduction

The demand for organic food and beverages in industrialised countries continues to increase and a significant proportion of this is met from developing countries. This is especially true for tropical beverages, fruits, spices and some off-season temperate vegetables (FAO 2001, Barrett *et al.* 2002, UNCTAD 2003). There is good evidence of the ability of smallholder farmers to be competitive in products such as coffee, cotton and cocoa (Barrett *et al.* 2001) and also in herbs, spices and some horticultural products (Coulter *et al.* 1999). In spite of the opportunities, there are challenging obstacles to developing countries accessing the global organic market (Harris 1998; Barrett *et al.*, 2001, 2002). Therefore, the focus of the present study was to identify opportunities and constraints to the development of organic agriculture in Nigeria oriented towards export and to evaluate the potential for specific products that can be produced organically in Nigeria.

## Materials and methods

Opportunities and challenges for organic exports from Nigeria were explored using secondary data sources, semi-structured interviews and focus group discussions. Ten agricultural produce exporters and twelve government officials in Nigeria, and two UK officials of certification agencies were interviewed using open-ended questions. International buyers of organic products, certification agents in the EU and reputable non-governmental organisations involved in organic agriculture farming in developing

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countries were also contacted informally to obtain their opinions on the opportunities and limitations of organic exports from Nigeria.

A focus group discussion was also held with five government Agricultural extension officers and representatives from two farmers' groups in each of the four ecological/geopolitical zones of Ogun State, Nigeria: Abeokuta, Ijebu-Ode, Ilaro and Ikenne. The discussions were held in a farmers' meeting room at the Ogun State Agricultural Development Programme head office in Abeokuta, Ogun State and were moderated by the lead researcher.

## **Results and discussion**

Organic agriculture is at present poorly developed in Nigeria, though there are recent moves for the production of certified organic crops. The Nigerian farming system was perceived as "organic by default". Respondents noted a lack of policy or regulation covering organic agriculture in Nigeria and were apprehensive about the high cost of certification by foreign regulating bodies. Concerns were also expressed that farmers lacked knowledge of organic techniques and certification. From the exporters' point of view, opportunities existed for the export of tropical produce, diversification of the traditional export basket, increased export revenue and subsequent foreign investment in organic sector. However, it was thought that considerable efforts would be required to assure confidence of potential buyers in organic products emanating from Nigeria. Availability and timeliness of market information, lack of infrastructure and marketing facilities, limited access to capital and inability to capture economies of scale were all considered major obstacles.

Regarding the relative potential of products for export, USAID (2002a), emphasised the opportunity the organic fruit and vegetable sector presents to producers and exporters in Nigeria. Table 1 shows an assessment of the export potential of some products from Nigeria. Products with export potential characterised as very high and high are primarily those for which there are significant shortages in organic supply and production is mostly restricted to the tropical developing countries. For example, there are a limited number of countries involved in exporting fresh and canned organic pineapple and mango. On the other hand, the production potential of Nigeria for these products is high. For instance, Nigeria is already one of the world leading producers of pineapple, mango, cashew, papaya and oil palm and these crops grow well with little or no use of agrochemicals. Also, the country is already involved in international trade in conventional forms of these products, with the advantage of established relationships with importers in the major markets.

For some of the products listed in Table 1, such as cashew, the general conditions in terms of quality, logistics, price and reliability are not very different for the organic and conventional segments. For cashew in Nigeria, USAID (2002b) concludes that "the majority of Nigeria's production is considered 'organic by neglect' i.e. no chemical pesticides and/or fertilizers." It is therefore quite feasible to target both markets at the same time.

For products rated as moderate potential in Table 1 such as cocoa, coffee and sesame, the organic markets, particularly in Europe and the US have the potential to be oversupplied. Although Nigeria is a leading producer and supplier of the conventional cocoa and sesame, it would need to compete significantly on price and quality bases against other countries that already have well established relationships with organic buyers. The market for organic sesame is relatively large and has shown

medium annual growth rate of around 5% recently. Unfortunately, it is oversupplied, which has caused prices to fluctuate by as much as 50% (EPOPA, 2005). In 2001, Nigeria became the largest supplier of sesame to the world's largest importer of sesame, namely Japan. Being a major player in the conventional sesame market, Nigeria can take an advantage of its position in the market to carve a niche in the organic sector as well. Other opportunities for Nigeria in the organic market are the production, processing and supply of speciality products such as honey, herbs, leather products, hides and skins.

**Tab. 1: Potential of selected Nigerian organic products in the international market**

Potential	Products
Very high	Fresh and canned pineapple and mango, peanuts, herbs and spices, ginger and ginger oil
High	Fruit juices, concentrates and pulps including papaya and mango, cane sugar, cashew nuts, palm oil, honey, cotton
Moderate	Cocoa, coffee, sesame, rice
Low	Bananas and plantain, vegetables, tomato pulp and puree, beef and chicken products
Very low	Citrus

For some products classified as low and very low potential, the market may be oversupplied, or have a slow growth rate, if any at all. And where demand exists, established exporting countries are more likely to take that advantage. For products such as citrus for instance, several countries are already significant producers and exporters, including EU and other industrialised countries with which Nigeria could not compete effectively.

In the case of bananas, until 1999, organic production came almost exclusively from small-scale banana farmers. However, large-scale plantations in the Dominican Republic and Ecuador have recently started exporting organic bananas (Barcus, 2001). Despite a growth in demand, the rate of production and level of investment and export from these well-established South American exporting countries makes the chances for Nigeria in the organic banana market very slim. For beef and chicken, imports from Nigeria are prohibited in Europe, either as organic or conventional, as a result of health and safety measures. However, opportunity may exist in the Gulf States for these products.

## Conclusion

This study revealed that the formal organic industry in Nigeria is relatively underdeveloped, although much agricultural production in Nigeria may be described as "organic by default" with potential for increased yield from optimised organic farming. Additional potential benefits were thought to be environmental conservation, economic self-reliance, employment generation and reduced rural-urban migration. Fresh and canned pineapple and mango, ginger, and herbs and spices were ranked as having very high potential for Nigeria in the international market. Fruit juice concentrates, palm oil, cashew nuts and honey were among those products classified as high potential. Among the main constraints identified were farmers' lack of awareness of organic farming techniques, high certification costs, risk aversion, lack of

institutional support, enabling policies, infrastructure, and marketing facilities, limited access to capital and inability to capture economies of scale.

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# Perceived Constraints and Opportunities for Brazilian Smallholders Going Organic: a case of coffee in the state of Minas Gerais

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Key words: Brazil, Organic Agriculture, barriers, opportunities, certification.

## Abstract

*This paper presents the findings of an analysis of the perceived rationales of smallholders for declining or entering organically certified coffee production, in the case Poço Fundo region, Minas Gerais. Based on group interviews and questionnaires, the rationale for farmers who declined organic production were found to be avoidance of perceived risk of harvest failure associated with the process of conversion from conventional to organic coffee production. Rationales for farmers who entered organic production included non-market benefits such as environmental quality and life quality enhancement.*

## Introduction

Brazil has the strongest economy in Latin America, and yet rank a global second in income inequality, with a Gini-coefficient of 0.57 (World Bank, 2006). Any major reduction of this inequality requires policies targeting poor households, including smallholder agriculture (OECD 2005).

The organic sector in Brazil grew immensely over the past decade with annual growth of 30 - 50%. The country now has 19.000 organic producers, of which 90% are on smallholdings (Lernoud & Piovano, 2007), producing 70% of the total organic production (Darolt, 2005)

Organic agriculture has perceived potential to contribute to sustainable development and smallholders' livelihood. While certified products may help smallholders gain market access and induce price premiums, use of organic methods may bring additional, non-market, on-farm and intra household benefits. Compliance assessed organics, therefore, are increasingly considered a potential instrument for rural development in Brazil.

Coffee production is one of the economic cornerstones of national development, according to the Brazilian Ministry of Agriculture (MAPA). The vast majority of coffee farms belongs to smallholders, and is important for maintaining rural livelihoods.

On this background, the overall objective of this study is to explore the rationales of smallholder coffee producers for entering organic production under certification schemes.

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## Materials and methods

The study was conducted in Poço Fundo, Minas Gerais, Brazil, during an overall period in Brazil from January 2007 through to May 2007. The study focused on a cooperative, COOPFAM, consisting of 215 smallholder coffee producers, whereof 115 farmers are organic and Fairtrade certified and 100 are only Fairtrade certified.

Data was collected using semi-structured interviews, Participatory Rural Appraisal (PRA) and questionnaires. The PRA exercises were based on a story line, a "post-it" exercise and a group interview with subsequent discussion. The "post-it" exercise enabled the participants to make a visual and dynamic ranking of constraints and benefits of organic production. The outcome the PRA exercises was used for questionnaire construction. Overall, 100 questionnaires were distributed and 40 completed questionnaires were gathered. As the total sample size is small, the findings can be seen as indications, not statistically significant. Within the questionnaire, two ranking matrices were constructed (on the basis of the post-it exercise) to enable the farmers to rank benefits and constraints (five factors in each ranking matrix was provided).

Semi-structured interviews were conducted to gather qualitative information about the cooperative and to get more in-depth information concerning the questionnaire answers. Furthermore, semi-structured interviews were used to gather data from key informants from the Ministry of Agriculture, an export promotion agency and a certification body about certified organic goods and producers in Brazil<sup>1</sup>.

## Results

The organic farmers in COOPFAM are BSC-ÖKO Garantie certified as well as Fairtrade certified by Fairtrade Labelling Organization International (FLO). Through BSC-ÖKO Garantie the cooperative is smallholder group certified using an Internal Control System (ICS).

Group certification gives opportunities for smallholder farmers to enter the international market, as the cost of inspection from certification bodies, which is often seen as a constraint, is reduced. The cost reduction depends on the structure of the ICS as well as infrastructure in the area (Gwendal Bellocq, IBD). In the case of COOPFAM, the overall organic certification cost is reduced by 30% due to group certification and ICS.

**Tab. 1: Benefits of certified organic coffee production.**

Enhanced life quality	28%
Environment preservation	27%
Market guarantee/Market stability	18%
Higher price of coffee	14%
Better coffee quality	13%

Source: Questionnaire results – from ranking matrix; COOPFAM, Minas Gerais, Brazil, 2007.

<sup>1</sup> Key informants included Gwendal Bellocq Instituto Biodinâmico (IBD); Ming Liu (Organics-Brazil); Luiz Carlos Rebelatto dos Santos, Ministry of Agricultural Development (MDA).



Organic coffee farmers in COOPFAM perceive enhanced quality of life and environmental benefits as the most significant factors when converting to organic coffee production, whereas the quality and price of the coffee were seen as the least important benefits (fig. 1).

Farmers expressed that local environmental preservation, through absence of agrochemical input, was important for family and personal health, as they had experienced health problems amongst friends and family members due to chemical use in the fields. Pesticide use is often done without proper restrictions in Brazil, leading to (severe) health problems (Ming Liu, Organics-Brasil).

Organic Fairtrade coffee gave 48% higher price premiums per coffee bag (60kg) than that of a nearby cooperative producing conventional coffee. Overall, from one hectare coffee fields, the organic producer could harvest, on average, 25 bags, whereas the conventional producer in the same area could harvest 30 bags. Thereby, per hectare, the organic producers had an increased premium, compared to conventional producers, of 23% (harvest of 2006). Through semi-structured interviews, and interviews with office personal from the two cooperatives, it was noted that the production costs were higher for the organic producers compared to conventional coffee producers in Poço Fundo, leading to lower net revenue for organic/Fairtrade farmers (25% reduction).

**Tab. 2: Difficulties of certified organic coffee production.**

Insufficient funding	24%
Conversion period	22%
More work with organic production	20%
Difficulties getting knowledge of org. management	18%
Bureaucracy/difficulties with documentation	16%

Source: Questionnaire results – ranking matrix; COOPFAM, Minas Gerais, Brazil, 2007.

Overall, farmers found limited financial credit as well as the conversion period to be central constraints when converting from conventional to organic coffee production (fig. 2). Through an interview, a farmer explained that he had planted everything over again in his field when converting as the conventional coffee plants could not survive organic management. Outcomes like his have made farmers in the cooperative risk averse towards converting to organic management.

Concerning perceived “bureaucratic” aspects of certification, the farmers could get help from the cooperative and this was therefore not perceived as particularly difficult. Some farmers stressed that without this help, this could have been a major constraint.

In Brazil, there is emerging a desire from smallholder farmers to move away from bureaucratic certification schemes, with highly complicated and administration intense third party documentation, to a more socio-oriented control, Participatory Guarantee System (PGS). The Brazilian organic law, 10.831, recognizes alternative guarantee systems for direct marketing, and this is especially emerging in the South of Brazil (Luiz dos Santos, MDA).

## Discussion and Conclusions

The results indicate that major rationales for farmers in COOPFAM, Poço Fundo, converting to organic farming include (local) public good benefits such as (community level) environmental benefits and private (household) benefits – such as avoidance of health problems associated with pesticide use – and thus enhanced life quality. It was stressed that risk of crop failure and financial deficits were seen as main constraints when converting to organic production. Despite lower net revenues for the organic/Fairtrade producers, they chose organic production as it seemed to give a more stable income as well as reducing the negative effects of agrochemicals.

The farmers of COOPFAM experienced yield decrease when converting to organic. The farming system had, before conversion, been high-external-input intensive. A study in Mexico showed that when coffee producers converted to organic production from low-external-input systems, the production maintained its yield or even increased in yield as much as 67%. At the same time, the coffee producers in Mexico obtained price premiums, had low production costs, and overall gained higher net revenue (Dimiani, 2002).

Through producing in a cooperative the farmers of COOPFAM gained reductions in the cost of certification. As the reduction depends on the ICS organization, infrastructure and distances (travel expenses to third party inspector) these benefits can be harder to obtain in Northern parts of Brazil where farmers are scattered over a wider area and the farms are further away from the main certification agencies which are mainly situated in Sao Paulo.

Overall, farmers may have different rationales for entering the organic market, depending on their former production system, organisation of cooperative, conversion related risk assessment and their perceptions of benefits.

## Acknowledgments

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# Socio-Economic Effects of Organic Agriculture in Africa

Lyons, K.<sup>1</sup> & Burch, D.<sup>2</sup>

Key words: global South; socio-economic impacts; food security; rural development.

## Abstract

*The African continent has experienced significant growth in the organic sector in recent years. This paper draws from in-depth interviews with fifty organic farmers across four selected countries – Egypt, Ghana, Kenya and Uganda – to document the socio-economic impacts associated with the uptake of organic farming practices. Our results demonstrate five benefits for farmers, farm families and surrounding communities arising from entry into organics: increased farm incomes; expanded marketing opportunities; empowerment of farmers; health benefits, and; sustaining environments. Our paper concludes with a series of recommendations to assist the on-going expansion of organics in Africa.*

## Introduction

The global South represents a burgeoning site for organic production, with around two thirds of new entrants to organics located in countries of the South (Parrott and Marsden, 2002). A number of African nations have experienced significant growth in organic production and the uptake of organic farming principles. The International Federation of Organic Agriculture Movements (IFOAM) has supported the expansion of organic agriculture in countries of the South for a number of years through its “IFOAM Goes Organic” (I-GO) Program, and in 2004 established an office on the African continent to assist local capacity building and training in organic agriculture across this region. This paper reports on a project commissioned by IFOAM to document the uptake of organic agriculture across Africa (Lyons and Burch, 2007). Through an analysis of case studies from Egypt, Ghana, Kenya and Uganda, we evaluate the socio-economic benefits for farmers and surrounding communities associated with conversion to organic practices. We conclude with a series of recommendations about future research and advocacy directions to assist on-going expansion of organics in the South.

## Organic Agriculture in Africa

Recent research estimates around one percent of the world's certified organic land is in Africa, while African farmers comprise almost 10 percent of certified organic farmers (Parrott *et al.*, 2006; Willer and Yussefi, 2007). Africa's organic agriculture industry appears most developed in the East, and around fifty percent of Africa's certified organic farmers are located in Uganda alone. In addition, about twenty percent of organic farmers are in South Africa, while nineteen percent are located in the North Africa region, and five percent in the West (Parrott and Elzakker, 2003). It is important

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to note these figures refer to the certified organic sector. Prior research suggests the informal or *de facto* organic sector comprises a much larger – and less well understood – component of the African organic movement.

Farmers in Africa produce a diversity of organic crops (see Parrott *et al.*, 2006). The majority of certified organic produce is destined for export markets, and accessing these markets is dependent on organic certification. At the time of writing, Tunisia was the only African country with certification comparable to the EU organic standard – the destination for the majority of Africa's organic produce. As a result, the majority of African farmers rely on international organic certification services. This uptake of external standards and inspection services has been critiqued for establishing new forms of dependence for African farmers (Parrott and Elzakker, 2003). East African countries have recently formalised an East African organic standard, thereby establishing a regional organic certification service. This offers significant opportunities to improve the conditions of trade for East African farmers, by reducing costs and dependence on external auditors.

### **Research Methods**

The data presented in this report draw from in-depth interviews with a range of actors engaged in the organic sector across four selected countries: Egypt; Ghana; Kenya; and Uganda. Interviews were conducted with fifty women and men organic farmers, as well as representatives from NGOs, government departments and development agencies. A non-random sample of women and men organic farmers was approached to participate in this study. Farmers were selected to ensure a diversity of participants. African farmers' experiences of going organic vary considerably, and it was important to ensure that sampling procedures would capture this diversity. For example, we sought to include the perspectives of: both women and men; those certified and non-certified; those engaged in a range of crop and livestock production; those selling into export and domestic markets, as well as those unable to find markets for their organic produce; as well as large and small scale farm operations.

### **Impacts Associated with the Uptake of Organic Agriculture in Africa**

The main reasons farmers in Africa make the switch to organic production are in many respects, the same as those that motivate farmers in developed countries: the desire to produce wholesome chemical-free food in a sustainable manner; the wish to reduce the reliance on expensive and increasingly scarce carbon-based energy-intensive farming methods; and the need to produce food commodities that will find a ready market and ensure a good income for the farmer (Lockie *et al.*, 2006). In the African situation all of these issues are important, but some are more critical than others. While African farmers would benefit by avoiding the use of capital-intensive and chemical-intensive farming methods, the ability of organic agriculture to deliver a higher price to farmers for the crops they produce is particularly important – the global trading system is heavily weighted against the agricultural economies of the South. Moreover, the possibility of receiving a premium for organic produce is not only a major incentive to individual farmers (and to small farmers in particular), but also provides greater opportunities for communities to become more self-reliant, and to generate new education and economic opportunities. At the same time, organic agriculture offers new opportunities to maintain soil quality, enhance the productive base of agriculture, maintain biodiversity, as well as enhancing the control by farmers of inputs such as seeds.

We provide a summary here of the main impacts farmers associate with the uptake of organic farming:

1. *Increasing farm incomes:* Farmers frequently stated that organic farming resulted in a reduction in the cost of farming, as they were able to replace expensive external inputs (including fertilisers and seeds) with organic inputs generally produced on the farm. Organic farmers were already familiar with composting, green manure crops and animal manure, and were able to utilise these inputs – at no cost – to maintain the organic farm. For some farmers, entry into organics also created new opportunities for on-farm income generating activities, by supporting the diversification of farming activities (eg. poultry rearing supplied both manure for the farm, as well as income through the sale of eggs and meat).
2. *Expanding market opportunities:* Farmers also frequently stated that conversion to organic farming methods created new opportunities to participate equitably in international trade. Organics also created new market opportunities on the domestic market for farmers in some countries where there was a growing domestic demand for organic produce. The domestic market in Egypt, South Africa, Uganda, Kenya and Tanzania are all currently experiencing significant growth.
3. *Empowering farmers:* Farmers reported receiving various levels of support during the conversion to organic farming methods. For example, farmers had participated in organic training programs, and had become members of local and/or national groups that provided a range of supports (including growing advice, market information etc). By joining an organic group for the purposes of group organic certification (via an Internal Control System (ICS)), farmers also gained access to communal equipment, as well as transport for their produce. Some farmers also stated that group certification provided new opportunities for collective bargaining power with buyers.
4. *Health benefits:* The uptake of organic farming techniques enabled farmers to avoid exposure to hazardous agricultural chemicals. In addition, many farmers reported increases in rates of year round productivity on the farm, as well as increased incomes generated from the sale of organic produce. Both of these factors have improved the capacity of farmers to feed their families.
5. *Sustaining environments:* The adoption of new organic farming techniques, including mulching, biological pest controls and crop rotations, has brought environmental benefits to both agricultural landscapes and surrounding environments.

## Conclusions

The results of this research demonstrate there is a range of social and environmental benefits associated with the uptake of organic farming in Africa. This paper concludes with a number of recommendations to ensure these benefits are realised, and to ensure these benefits are realised by the broadest number of farmers. These recommendations include:

1. Expand donor and development agency support across *all* regions in Africa - to cover organic certification costs and development of international market links;

2. Expand domestic organic markets by providing financial and institutional support to local NGOs to engage in advocacy efforts to build local consumer recognition and demand for organic produce;
3. Build international recognition of national and regional African organic standards;
4. Support environmentally responsible value adding opportunities – including solar drying fruit facilities. These may further increase farmer incomes;
5. Simplify and make transparent organic global commodity chains as a strategy to ensure farmers receive a fair payment for their produce;
6. Promote both certified and non-certified organic farming methods as a strategy to improve household food security. NGO organic training efforts purposely target some of their campaigns to vulnerable communities – including the food insecure, poor, and those farming on marginal land;
7. Target some organic training programs expressly towards women;
8. Include indigenous knowledges about sustainable agriculture into understandings of organic agriculture in Africa. This offers the opportunity to increase the successful uptake of organic techniques, as well as avoiding the imposition of western values;

These recommendations will support the development of organic farming in Africa in ways that bring social and environmental benefits to the greatest number of farmers.

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## **Cross-disciplinary Studies in Livelihood impacts of Organic Agriculture**



# Agroforestry systems and food security among smallholder farmers of the Brazilian Amazon: A strategy for environmental global crisis<sup>1</sup>

Abreu, S. de L.<sup>2</sup> & Watanabe, M.A.<sup>3</sup>

Key words: Food security, agrobiodiversity, small farmers, deforestation, ethical values

## Abstract

*The Amazon is known for its environmental importance for the climatic equilibrium, for its abundance and richness in biodiversity and its preservation is important to reduce global heating. Nevertheless, little research has analysed the possible positive role of the local farm population for environmental conservation. The paper investigates the possibility to conciliate the environmental conservation with the small farming expansion in the Amazon, to build agrobiodiversity, and at the same time improve food security. This social practice consequently would contribute to the reduction of deforestation and could thus falsify the old diagnosis of incriminating the poor farmers for forest and soil destruction. The study was conducted by the Associação de Produtores Alternativos, localized in territory of Ouro Preto d' Oeste, Rondônia, in the Southwest of the Amazon. The study documented a number of forest preservation and agroecological methods used and concludes that institutional support to strengthening of social organization and local sustainable development projects is fundamental for the consolidation and amplification of the ecological experiences in the Amazon.*

## Introduction

Among several Brazilian Amazon localities, there are emergency of agroecological experiences, having as basis the support to the development of agroforest systems, henceforward AF. The Amazon is inhabited by different social categories many of which are types of small farmers or forest people, such as cattle breeders and farmers, riverine people, rubber tappers, Brazil nut collectors and quilombolas. Because of unsustainable land use with monoculture and annual crops leading to soil depreciation farming populations have continuously moved on to clear more forest, leading to one of the classical problems of Amazonian deforestation (Fearnside, 1990). However, such negative experiences during the 1990'ties led some farmers in Ouro Preto d'Oeste, Rondônia, Southwest Amazon to experiment with agro-forestry practices combining a diversity of livestock, annual crops with cultivated trees and use of wild forest for products such as cacao, cupuacu, acai, pupunha (reference..). Along

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<sup>1</sup> This article is an integrant part of a research project results named "Percepções e representações sociais do meio ambiente e das práticas agroambientais em pólos pioneiros do Proambiente da Amazônia", which belongs to Embrapa – Brazilian Agricultural Research Enterprise.

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<sup>3</sup> As above

with this a number of products collected from the wild forest have been certified as organic and/or fair trade and –together with certified crops- contribute to the families' income. If such practices are more sustainable in terms of stability in food production and preservation of soil fertility these systems may help reduce the deforestation of Amazonian forests. The conversion process is fruit of the emergence of a critical environmental consciousness based upon in an ecological ethic, motivated by multiple elements: strong organization of political group previous experience with environmental problems, social necessity of survivorship, and ecological appeal realized by the small farmers during the interaction process with ecological entities articulated with global society. The development of the agroforest systems was conducted with the support of the Catholic Church entities non-governmental organizations and local public institutions. Since 2004, this governmental program recognizes and predisposes to remunerate the environmental services rendered by small farmers through the stimulation of the adoption of the sustainable production systems, valorization of environmental services rendered by small farmers community and forest recuperation. The environmental services can be of diverse nature: reduction of deforestation and land burning, reconstruction of devastated areas, protection with revegetation of hydrological resources and others. The aim of this paper is to assess the degree of food self sufficiency and variation in food utilisation and agro-biodiversity among organic agro-forestry farmers in Amazonia and to discuss how this type of farming may contribute to the preservation of natural forests in Amazonia.

### **Material and methods**

After almost a decade of experiences with agroforest systems development, our research covered the biodiversity of small farmers established in Ouro Preto d'Oeste, Rondônia. More than 250 families are presently members of and association of alternative producers and 1000 others are in conversion. The collected material is the result of field survey conducted in several occasions: in 2005 a questionnaire was administered to 50 households, and following this, tape recorded interviews with 28 farmers, heads of associations and local environmentalists and politicians were conducted in 2006 and 2007. Tables containing the list of annual and perennial cultures conducted by the farmers were elaborated, as well as those related to animals raised in the production unities. The area with annual cultures and the number of plants of each species of perennial cultures and the number of each livestock species were established from the questionnaire. The food produced and consumed by the families was listed. The items belonging to feeding these farmers were compared with food items of riverine people from several localities of Acre, Amazon and Pará states using literature surveys. Comparisons were also made with the diet and the agrobiodiversity of the rubber tappers living in two protected in the Acre state: the *Reserva Extrativista Chico Mendes* and inhabitants of *Parque Nacional da Serra do Divisor* and surroundings.

### **Results and discussion**

These two dimensions (the speech and practices), we classified the ecological sensitivity of the social agents according to the table below:

TIPOLOGY OF THE SOCIAL PERCEPTIONS AND PRACTICES IN THE TERRITORY	SENSITIVITY TO SUSTAINABILITY PRINCIPLES
	<b>Low sensitivity</b> (Productivist).
Modern activity	Cattle rancher's vision: Economy oriented to activity expansion and wealth accumulation. There is no adhesion to sustainable development.
	<b>High sensitivity</b> (Modern and Ecological)
Modern activity	Issue is an opportunity to production valorization
	<b>Low sensitivity</b> (Productivist)
Traditional activity	Conscious of environmental question as a market opportunity and to income augmentation.
	<b>High sensitivity</b> (Modern and Ecological)
Traditional activity	Behavior based on ecological tradition compromised with Logic ecological.

Source: Field data collection, Abreu & Watanabe (12/2007).

In this work we point out the familiar farmer's contribution who use low impact technology and with reduced utilization of external inputs. The farmers classified as of traditional activity and of high ecological modernity are those who cultivate 22 vegetable species and 26 fruit species, what guarantee a diversified food source. This social group needs institutional support in order to advance in terms of agroecological transition. They sell the surplus for fair trade system.

We observe that the productive activities types in Ouro Preto do Oeste, thus most of the families (98%), use some portion of their land for different types of agroforestral production often in combination with pasture and livestock. While most of the farmers actively preserve wild forest for environmental protection along rivers and around lakes following a public programme "Pro-ambiente", 50% of the families explore the wild forest for products used for home consumption and marketed as organic or fair trade products.

The most cultivated annual species in Ouro Preto d'Oeste were: rice, beans, maize, cassava, pineapple and sugar cane. Perennial cultures most frequently cultivated were: banana, citrus, mango, cashew, cocoa, coffee, papaya, avocado, *açaí*, *pupunha*, *cupuaçu*, coconut and others. A major proportion of the annual species are cultivated by women near their homestead and the fruit trees are cultivated around the houses or collected in the forest and are destined for domestic use. Fruit surplus like banana, papaya, *pupunha*, *cupuaçu* and coconut are destined for commercialization. The coffee and cocoa are typically cultivated for income generation. The major part of the annual cultures is cultivated for their home consumption, like cassava flour, rice and beans. The major part of maize production is destined for feeding domestic animals or consumed by the families as fresh (green) maize; the grain surplus are commercialized with neighbors or exchanged (escambo) with other products or with other local services.

The small farmers from Ouro Preto d'Oeste have as a difference from the other local communities, the insertion in the global market. The APA's products like honey, heart of palm, native fruit juices are commercialized in local farmers markets, in the Brazilian

organic market (Sao Paolo, Rio de J) and overseas exported through Alter Eco (an international organization).

From the observed agrobiodiversity in the annual and perennial cultures, in the animal raising, and in the destination of these products for consuming (besides that ones destined to market), it indicates that these small farmers community enjoy a rich and diversified food, and are almost 100% self sufficient in food and only purchase items such as sugar and salt.

Another part of grain production is precariously stored in rustically-constructed granaries as seeds for next cultivation season. Because of these practices the small farmers, riverine people and rubber tappers of the Amazon have important role as guardians and perpetuators of a rich variety of germplasm of the cultures like cassava and other species destined to feeding (Amorozo, 2002).

The present study is part of a thematic research whose scope involves several localities of this country, aims to understand the Brazilian agrarian ecologization process, where it is studied the diversity of social models of production recognized by Brazilian legislation of 2003: Organic, biodynamic, permaculture, agroforests, etc. (Bellon & Abreu, 2005). It was observed that it is needed to deepen and qualify the contents of the different styles of ecologically based farming, aiming to understand their functionalities, related to food sovereignty, to the contribution to agrobiodiversity or linked to environmental conservation and environmental service rendering.

### **Conclusions**

Amazonian rural populations depend upon, for their feeding, the products from annual and perennial cultures, products collected from the forest, products from animal raised in the production unities and hunting.

Thus, the small farmers cultivate diversified agroforestry systems, which express synchronously cultural values based in an ecological ethics, in the search of food security and finally they are providing environmental services. Moreover, they share with the global ecological society the principles of social development and ecological respect following the principles of organic agriculture as defined by IFOAM. Thus, reduction in deforestation and local landscape reconstruction can be reached with the development of diversified agroforestry systems and amplification of food security. The possibility of marketing part of the forest products as fair trade and certified organic add to the economic viability of these systems but the environmental services should be paid by the governmental organizations.

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# Organic agriculture and rural livelihoods in Karnataka, India

Lukas, M.<sup>1</sup> & Cahn, M.<sup>2</sup>

Organic agriculture, sustainable livelihoods, rural development, India, Karnataka

## Abstract

*The research explored the effects a change from conventional to organic farming had on the livelihoods of a group of farmers in Karnataka, South India. It involved semi-structured interviews with organic farmers, NGOs, consumers, marketing organisations, and the State Agricultural Department. The farmers in the case study perceived that they had improved their livelihoods over the long term by the conversion from conventional to organic farming. Reduced costs for external inputs and reduced labour requirements together with similar or higher yields and premium prices resulted in higher net-farm incomes. The conversion to organic farming reduced the reliance on credits and the risk of crop failure due to pests, diseases and droughts, thereby reducing vulnerability. In addition, the farmers mentioned enhanced natural assets, reduced risk of pesticide poisonings, improved food safety, higher levels of self-sufficiency, and the access to networks supporting knowledge exchange and political participation as important benefits of the conversion. However, almost all the case study farmers noted that the conversion period was difficult due to temporarily declining yields and a lack of information and experiences. This is likely to be a major constraint preventing asset-poor farmers from adopting organic agriculture.*

## Introduction

Agriculture is the most important livelihood strategy in India, with two thirds of the country's workforce depending on farming. Most farmers are small and marginal farmers cultivating areas of less than two hectares. Increasing land fragmentation, diminishing natural assets, high costs for external farm inputs, indebtedness, and pesticide-related health issues have threatened the livelihoods of many farming families (NCF 2006, MSSRF & WFP 2004, Ninan & Chandrashekar 1993). While incomes in urban areas have risen, farm incomes in real terms have declined in many parts of India during the past decade. Since the 1990s, a growing number of farmers have adopted organic agriculture to improve the economic viability of farming and combat negative social and environmental side effects of conventional farming (Parrot & Marsden 2002, UNDP 1992). Organic farmers' groups and NGOs have formed an 'organic grassroots movement' that supports organic farmers, establishes organic marketing channels and tries to influence policies. However, institutional and scientific support for organic farmers has been limited until recently. A proper understanding of the effects, potential and constraints of organic farming is necessary as a basis for political decision making, the design of support strategies for farmers and further research. Therefore, the aim of the research was to explore changes in the livelihoods of a group of farmers in Karnataka, India that had converted from conventional to organic farming.

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## Methodology

The research was inductive and qualitative, although some quantitative data was used to support qualitative findings. Issues that were not considered before were able to emerge, and aspects that were not able to be quantified were explored in depth. Semi-structured face to face interviews were carried out with 15 farmers who had converted from conventional<sup>1</sup> to organic agriculture. They were asked about income sources, land ownership, their motivations for adopting organic farming, factors that had supported the conversion, and their perceptions of what effects the conversion had on their assets, their livelihood outcomes, including income, health, nutrition and self-sufficiency, their vulnerability, and their external environment, including policies, institutions, and processes. The interviews were held in the farmers' fields and/or in their homes providing the opportunity to gather additional information by observation. After ten interviews, no additional information was obtained, indicating that the important issues had been covered.

Most organic farmers in India are not certified or registered in any way, but organised in farmers' groups or supported by local NGOs. Therefore, collaboration with GREEN Foundation, an NGO supporting small and marginal farmers in Karnataka, and Sahaja Samrudha, the Organic Farmers' Association of Karnataka, was chosen as a way to identify a sample of farmers. GREEN Foundation provided background information and Sahaja Samrudha the contacts to organic farmers. The selection of eight of the 15 interviewed farmers was based on a contact list provided by Sahaja Samrudha. These eight respondents provided the contacts to seven other organic farmers in their communities who could be subsequently interviewed.

In addition to the interviews with organic farmers, background information was gathered through a review of literature and NGO documents and semi-structured face to face interviews with representatives of NGOs, marketing organisations, consumers, and the State Agricultural Department.

## Results

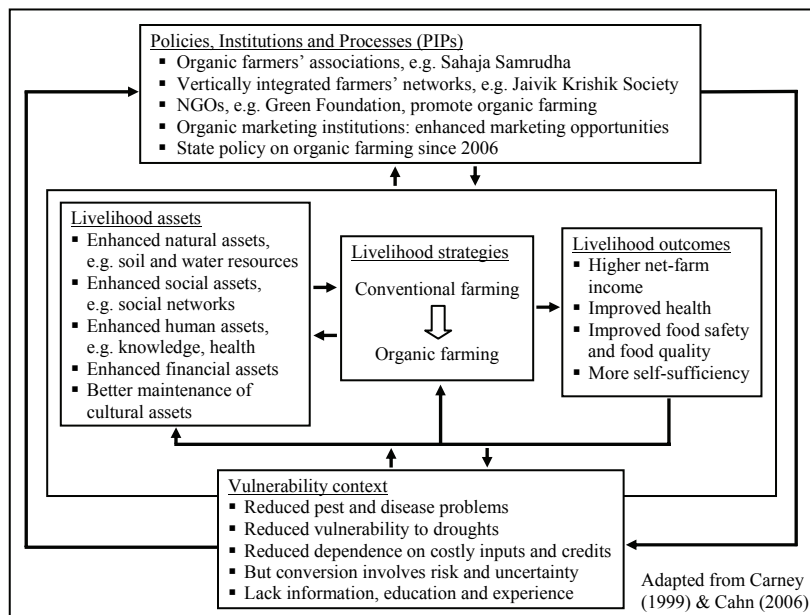
The major motivation for the interviewed farmers to adopt organic agriculture was their negative experiences with conventional farming, e.g. deteriorating natural assets, continuous pest and disease problems, high costs for external farm inputs, and health problems that were related to the use of pesticides. The field research identified two major assets or processes that facilitated the adoption of organic farming as a livelihood strategy: firstly, education and information, and secondly, material assets, e.g. large land holdings, savings or off-farm incomes, helping to overcome the conversion period. Figure 1 summarises the case study farmers' perceptions of the effects the change from conventional to organic farming had on their livelihoods.

The interviewed farmers perceived enhanced natural assets, e.g. improved soil structure, improved water holding capacity and increased abundance of beneficial organisms, as a positive effect of the conversion to organic agriculture. Enhanced natural assets were said to allow production with less amounts of external inputs. Through encouraging farmers to experiment and actively enhance their knowledge, and through providing access to organic farmers' networks that support knowledge

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<sup>1</sup> 'Conventional farming' or 'conventional agriculture' is a form of agriculture that includes the use of synthetic fertilisers and pesticides

exchange and social contacts, a conversion to organic farming improved the interviewed farmers' human and social assets. Organic farming was said to be more in harmony with cultural values and contributed to the preservation and continuous development of indigenous knowledge, an important element of cultural assets.



**Figure 1: Summary of the effects a conversion from conventional to organic farming had on the livelihoods of the interviewed farmers in the case study**

Reduced use of costly external farm inputs and lower labour requirements reduced production costs on all farms in the case study. This together with similar, or in some cases, higher yields improved net-farm incomes. Improved net-farm incomes enhanced the farmers' financial assets, contributed to reduced vulnerability, and provided the potential for investments in physical assets, such as drip irrigation systems. The exclusion of synthetic pesticides was said to improve food safety, to eliminate the risk of health hazards through exposure to pesticides, and hence to improve human health. Improved health is not only a livelihood outcome, but also an important human asset, in that it determines the ability to labour. Many of the interviewed farmers perceived higher levels of self-sufficiency as an important benefit of organic farming. They pointed out that the conversion to organic farming reduced their costs for farm inputs and thus the need for credit, which is a major source of vulnerability for farmers in Karnataka. In addition, many farmers in the case study perceived that the conversion had reduced their vulnerability to pests, diseases and droughts over the long term.

Until the early 1990s, institutional and political structures and processes did not provide any support for organic farmers. Since then, a growing number of farmers have adopted organic farming, and together they have changed the political and institutional environment. Organic farmers' associations and vertical networks provide

platforms for the exchange of knowledge and expertise, and enable farmers to influence policies. The creation of separate organic marketing channels has improved marketing opportunities, and a number of NGOs and a recently introduced state policy support organic farming. The interviewed farmers perceived that the change from conventional to organic farming had improved their livelihood sustainability, not only environmentally, but also economically and socially. Without exception, all farmers expressed satisfaction regarding their decision to convert to organic farming.

However, the conversion process itself involved high levels of risk and uncertainty, and in many cases, farmers faced the problem of temporarily lower yields for a conversion period of one to three years. In addition, organic farming was said to require more knowledge about agro-ecological processes than conventional farming, which can be a major constraint for farmers to successfully adopt organic agriculture.

## **Discussion and conclusion**

The organic farmers in the case study perceived that the conversion from conventional to organic agriculture had improved their livelihoods in a range of ways. They pointed out that over the long term the conversion had improved their net-farm incomes, reduced the risk of pesticide poisonings, led to more self-sufficiency, improved food safety and reduced vulnerability, and improved the access to networks supporting knowledge exchange and political participation. However, risk and uncertainty related to the conversion period, such as temporarily declining yields and the lack of experiences and information, were mentioned as major constraints preventing in particular asset-poor households from adopting organic farming. To date, lack of institutional extension and educational material on organic agriculture require farmers to rely on their own knowledge and farmers' networks. This was highlighted as self-sufficiency in knowledge and expertise by knowledgeable farmers, but might be a major source of risk and uncertainty for others.

## **Acknowledgments**

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# Impacts of Institutional Arrangements on the Profitability and Profit Efficiency of Organic Rice in Thailand

Setboonsarng, S.<sup>1</sup>, Leung, P.S.<sup>2</sup> & Cai, J.<sup>3</sup>

Key words: Thailand, poverty reduction, institutional arrangement, NGO, profit, profit efficiency

## Abstract

*This study assesses the performance of organic small farmers in Thailand under different institutional arrangements and over time. It was found that while organic farmers were significantly more profitable and profit efficient than conventional farmers, the level of profitability varies under different intermediaries. Farmers organized by NGOs on degraded marginal land showed a pattern of increasing profit and profit efficiency over time, after the transition period. On the other hand, farmers organized by a private sector firm on newly opened forest land exhibited a pattern of stable profit and increasing yields over time. The results showed that farmers under non-profit NGOs received the highest level of profit, followed by farmers under the private firm and finally the for-profit NGO. These findings suggest that while organic agriculture can increase the economic performance of small farmers, institutional arrangement is an important factor in realizing the broader benefits of organic agriculture for poverty reduction.*

## Introduction

It is becoming clear to small farmers, NGOs and governments alike that the Green Revolution has led to stagnating yield, ecological degradation and worsening rural socio-economic conditions, particularly in marginal areas. Increasingly, countries such as Thailand are promoting organic agriculture (OA) to reverse these negative effects and reduce poverty. Although there is abundant anecdotal evidence of the broad benefits of OA, empirical evidence to support these claims is limited. To fill this gap, this study assesses the profitability and profit efficiency of OA farms over time and under different institutional arrangements, using household survey data from small farms in Thailand.

## Data and Methodology

The 2002 survey covered 445 rice farms (223 organic and 222 conventional farms) in the Northeast and North regions. The organic farmers are under contract farming arrangements and are categorized based on contract partner (Table 1). The OA farms contracted by the non-profit and profit-oriented NGOs are located on degraded land in the Northeast region and practiced conventional agriculture (CA) until OA was

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introduced in the 1980s. In contrast, OA farms contracted by the private firm were organized on newly opened forest land in the North region.

The OA farms are also categorized into three groups according to stage of certification. 'Certified' farmers are certified according to international certification standards. 'Initial' farmers have one to two years experience in OA, while 'transitional' farmers have two to four years experience in OA and in principle should not use agrochemicals. Recognizing the importance of institutional arrangements in contract farming (Glover, 1984; Vellema, 2005), this study employs profit frontier methodology to assess the extent of their impact. This method is used extensively in efficiency studies in agriculture to portrays the maximum variable profit obtainable by a farm given the prices of inputs, outputs and production technology (Bravo-Ureta and Pinheiro, 1993; Setboonsarng et al, 2006).

**Tab. 1: Characteristics of sample farms**

	Private Firm	Profit-oriented NGO	Non-profit NGO	Total Organic	Non-contract/Conventional
No. of farms	83	52	88	223	222
Age of household head (years)	48.2	47.8	49.2	48.5*	50.8
Education of HH head (years)	2.72	3.13	2.83	2.86*	2.36
Land allocated to rice (ha/farm)	2.20	2.37	1.99	2.15*	1.71
Chemical fertilizer (kg/ha)	50	0	0	19*	179
Organic fertilizer (kg/ha)	840	2,31	3,04	2,05*	803
Pesticides/herbicides (kg/ha)	60	0	0	22*	72

\* indicates difference between total organic and conventional is significant at  $p < 0.05$

## Results and Discussion

The profitability and profit efficiency are summarized in Table 2. OA farmers had a significantly higher profit over cash costs in the overall sample, generating US\$434 per hectare, compared to US\$287 per hectare for CA farmers.

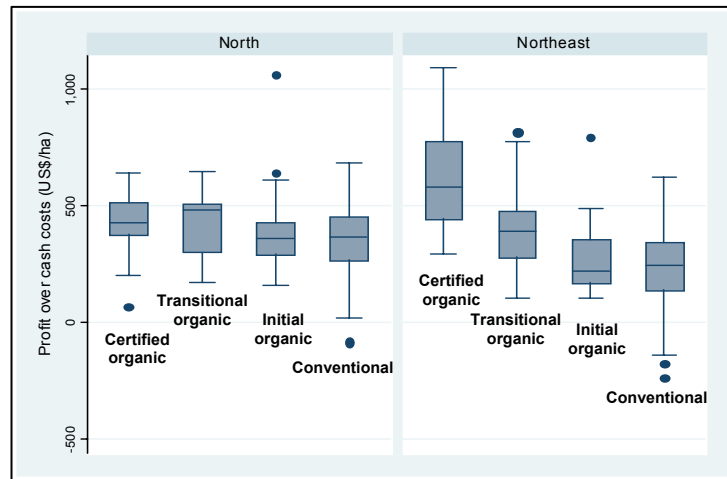
**Tab. 2: Profitability and profit efficiency of rice farming in sample farms**

	Contract Partner (region)	Yield (kg/ha)	Profit (US\$/ha)	Profit Efficiency
Organic	Private Firm (N)	2,940*	420*	0.76
	For-Profit NGO (NE)	2,316	400*	0.70
	Non-profit NGO (NE)	2,169*	468*	0.69
	All Organic	2,492	434*	0.72*
Conventional	Conventional (N)	2,862	356	0.76
	Conventional (NE)	2,138	244	0.56
	All Conventional	2,415	287	0.64

\* indicates difference with total conventional is significant at  $p < 0.05$

Table 2 also shows the profit and profit efficiency of farmers under different contract partners, suggesting the strong impact of institutional arrangement. OA farmers facilitated by the non-profit NGO were the most profitable, followed by farmers organized by the private firm and farmers under the profit-oriented NGO.

There is considerable profit inefficiency among the sample farmers, as shown in Table 2. Profit efficiency is defined as the ratio of the observed profit to the potential maximum attainable profit. Although on average farmers could increase their profit by more than 30%, organic farmers were significantly more profit efficient than conventional farmers, as contract partners provided inputs and training to OA farmers. OA farmers organized by the private firm on newly opened land in the North (N) were more profit efficient than organic farmers on degraded land in the Northeast (NE). However, farmers under NGOs in the NE experienced dramatic gains in efficiency over time, as farmers in the certified group are significantly more profit efficient than the initial OA farmers and conventional farmers. This may be attributed to increasing yields and lower labor inputs over time as ecosystems are restored.



**Figure 1: Profitability by Organic Status (US\$/ha)**

Figure 1 shows the levels of profit in different stages of transition. While levels of profit of OA farmers on newly opened land in the North were similar overtime, the level of profit increased dramatically among OA farmers in degraded land of the NE. It is interesting to note that initial OA farms in the NE are less profitable than CA farms due to the immediate drop in yield after stopping agrochemical use. This profitability pattern can also be explained by the price premiums provided by the different contract partners. The private sector firm offered a fixed margin of US\$0.02 above the market price rice at harvesting time, while the NGOs offered a price premium based on negotiation with the farmers, ranging from US\$0.03 to \$0.09 above market price. The rice price for certified OA in the NE was higher than the price for transitional and initial OA, and nearly double the price for CA. It is noted that while there was no report of agrochemical use under NGO contracts, some farmers under the private firm

reportedly used agrochemicals, due in part to ineffective monitoring by the firm (Table 1).

## Conclusions

The study shows a distinctive development path under different institutional arrangements in different agro-ecosystems. Under NGOs on the degraded land of the NE, OA profit was initially low but increased dramatically over time as ecosystems restored themselves. As non-profit NGOs aim to achieve both social and financial goals, they offer a better price and more training and monitoring to farmers. Made possible by assistance from donors, these institutional supports effectively kept the farms chemical-free during the transition years, allowing them to become more profitable in the long run. Under the private firm on new forest land in the North, OA farms had higher profits than CA farms; however, price differentiation was minimal, as OA practices are not strictly enforced and the system does not effectively reward farmers who followed strict OA practices. Although the NGOs and private firm export rice at similar prices, it appears that farmers under the non-profit NGO receive a larger share of the organic price premium and benefit more financially and socially than farmers under the private firm or profit-oriented NGO. This analysis suggests that institutional arrangement is an important factor in the success of organic agriculture development and poverty reduction. While organic farming can be an effective mechanism to enhance the profitability of small farmers, its potential economic, environmental and health benefits are likely to be greater under an arrangement which has broad social objectives rather than a narrow financial focus. The findings of this study suggest that external supports to farmers are crucial during the initial and transitional stages of OA, and that non-profit NGOs appear to be the most effective institutional partner to facilitate OA adoption. This successful model should be adopted by governments and donors as a strategy to scale up OA development to achieve both environmental restoration and poverty reduction.

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# Organic Agriculture as Livelihood Strategy: A Case Study in a Rural Community of Southern Brazil.

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Key words: Brazil, Organic Agriculture, Agroecological Income, Livelihood Strategy, Market and Non-Market Values, Community.

## Abstract

*This paper presents the findings of a case study of a Brazilian community pursuing a livelihood strategy based on certified organic agriculture. Using the sustainable rural livelihoods framework, the paper identifies three different organic livelihood strategies involving varying degrees of capitals. The paper concludes that understanding the implications of these different organic strategies and their rationales is a prerequisite for policy-makers to tailor policies and programmes aiming to assist rural communities benefit from organic agriculture as a vehicle for advancing rural development.*

## Introduction

Organic foods and textiles are gaining market shares throughout the world. This is true not only from a global market perspective seeing organic volumes and market values exchanged internationally and in domestic and local markets. It is also true from a perspective seeing organics as a livelihood strategy involving non-market values and perhaps symbolizing a glocalization option: a chance to cope with globalization based on opportunities arising from a mix of global and local (Egelyng 2006). In southern Brazil organics are becoming an attractive option for rural residents to generate income and improve their livelihoods (Oltamari et.al 2002). This paper analyses organic agriculture as such a (community level) livelihood strategy. Inspired by the livelihood approach, particularly its ecological economics (natural capitals, environmental services and incomes) and social capital (networks) dimensions, the paper provides an analysis of market and non-market rationales for individual farmers as well as their communities to “go organic” and pursue organic agriculture as a rural developmental pathway.

## Materials and methods

This paper draws upon yearlong field research in Santa Rosa, a community of small family farmers in the state of Santa Catarina in southern Brazil. More specifically, it focuses on socio-ecological implications of certified organic agriculture for local livelihood strategies. Data were collected using a variety of methods. These included participant observation, open-ended interviews, archival research and surveys (both quantitative and qualitative). The sustainable rural livelihoods framework (Scoones, 1998) is the approach used in our analysis.

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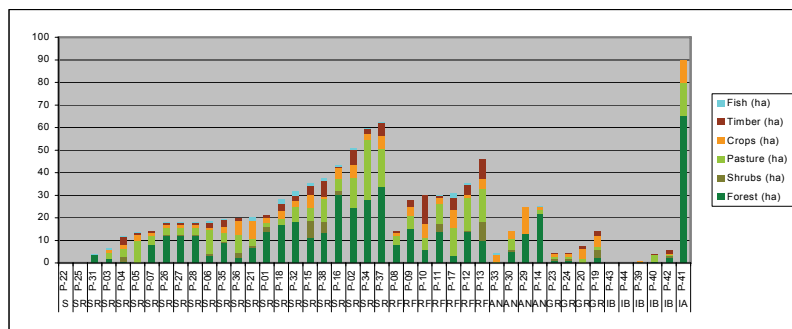
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## Results

Today a copyrighted trademark for formally certified organic foods, AGRECO is the outcome of professionals and entrepreneurs born in Santa Rosa who, with relatives and friends still farming in the community, established a local association in 1996, to promote “the quality of life of small family farmers through organic agriculture” – AGRECO. A project for small-scale agro-industrialization and a local association for agri-tourism supporting farmers and local residents developing tourism linked to organics part of the story as well as international development agencies, non-profit organizations, and prestigious academic institutions, supporting sustainable agriculture programs in Santa Rosa. Today, AGRECO operates in six different municipalities commercialising a variety of foods (cheese, honey, sugar, canned vegetables, jellies, etc). In 2003 its producers became “properly” certified organic - and Santa Rosa’s agri-tourism program keeps expanding.

The 44 certified productive units analysed have different agro-ecological patterns and farms sizes (figure 1). Farm size ranges from less than a hectare (farmers producing honey ‘renting’ the use of a forest area for their hives) to farms over 40 hectares (up to 90). Most of these are connected to a local agro industry (sugar, jellies, canned foods, cheese). In addition to size, land use patterns also vary significantly among farmers. While some producers devote significant portions of the farm to timber (eucalyptus and/or pine trees), others do not manage this resource. Despite this variability, farmers across municipalities do share two common land use trends: agroecological diversification and preservation of areas with native Atlantic forest.



**Figure 1: Farm size and land use: six “AGRECO” municipalities.**

Besides differences in size and land use, local organic producers are diverse in terms of their livelihood strategies. Table 1 (below) shows three basic typologies of organic producers found in Santa Rosa. The main differences across these different types of organic ‘practices’ are the relevance of agroecological income in the household, and their position in the socio-economic network of organic activists, business communities, consumers and farmers. (Agro-ecological income can be defined as benefits flowing from practising organic methods, for instance in terms of extra wildlife to harvest or extra output resulting from conservation biological control where a biodiverse non-sprayed farm eventually provide habitat and food sources to beneficials, which help control pests). Family farmers (type 1) rely extensively on the agroecological resources of the farm for productive and reproductive functions, and they have lower levels of economic and social capital – less income and less

education, less influential connections and less access to information. Family farms are located outside the 'downtown' of the village (the *praça*), often in places of difficult access, i.e hilly terrain, dirt roads and limited communications. In contrast, most mixed households (type 2) work with tourism and hire labor to plant, weed, harvest, and process). In mixed households, at least one adult work off-farm in local jobs as teachers or municipal employees. Joining organic production does not prevent such households from establishing residency in the *praça*, which in practical terms means direct access to local services (phone, bus, stores, school, bank, pharmacy, etc) and networks (associations, gatherings, etc). A third category of organic households, which we refer to as "instrumental retreats", corresponds to households which do not obtain significant agroecological income from organic production, but rather they use the 'farm' for personal, recreational, community service, and/or political articulation in the community. This category comprises professionals residing outside Santa Rosa, including absentee owners, who sympathize with the local association for organic farming. These 'instrumental retreats', which are also certified organic and part of the local association for organic farming, are partially productive. Some have fruit trees, or chicken, or hives. However, this category of organic agriculture may be better understood as spaces of social exchange. Meetings, assemblies, workshops, and symposia are articulated by these organic 'producers', who contribute with their knowledge and connections to the advancement of organic farming in the region.

**Tab. 1: Household typologies among Santa Rosa's certified organic producers.**

Criteria	Family farm	Mixed household	Instrumental retreat
Off-farm income	Sporadic	Regular	Always
Off-farm work	Agriculture (if any)	Local services	Professionals/entrepreneurs
Self-consumption	High	Low	Not relevant
Tourism	Not common	Most of them	Private/informal
Participation	Low	Medium	High
Organization	Nuclear family	Nuclear/individuals	Individuals
Residency	Farm	Town	Town/City
Labour	Family	Family/hired	hired
Services	Poor	Standard	Depending on use
Education	Primary	Primary/Secondary	College/Graduate

## Discussion

A decade after a local association for organic farming was established in the region, three different typologies of certified organic producers can be identified in the community of Santa Rosa: family farms, mixed households, and instrumental retreats. These three types of 'producers' do not differ so much in terms of their agroecological practices (diversification), but in relation to the role that the income resulting from organic production plays in the households. This in turn is deeply correlated to the

capacity of the household to access social and economic capitals. Households depending almost exclusively on agricultural incomes do not fully participate in the decision-making process of the association(s) they belong to and have less educational resources – a characteristic shared with non-organic small family farmers in the region such as tobacco producers. In contrast, organics have also fostered new typologies; the mixed household and the instrumental retreat. In mixed households, “organics” are an alternative extra source of income, and the tendency is to rely on services (tourism) rather than small-scale agro-industrialization. In instrumental retreats, unlike in the two previous types, organics are not that much of a productive, but a political tool. These institutional spaces serve to connect urban residents involved in AGRECO to the local reality of the producers. At the same time, retreats open the rich socio-economic networks of the urban/global society to the rural community.

## **Conclusions**

The diversity of organic ‘productions’ found in the community of Santa Rosa can be interpreted as a response to adopt and adapt organics as a livelihood strategy in a rural community of small family farmers (Moreno-Penaranda, 2006). The three different ways in which organics occur in the community are deeply interrelated. While small organic family farmers manage the agroecological resources and their processing into foods, mixed households ‘use’ organics to develop alternative sources of rural income, such as agri-tourism. Both types of households are connected to the broader institutional, social, and financial dimension of organics through the networks of academics, entrepreneurs and other professionals involved in the experience. Given the complexity of these interactions, we argue that the role of organics as a livelihood strategy can be interpreted as a strategy to adapt organics to the local community. A policy to transform certified organics into an instrument of social change in rural communities ultimately depends on understanding the functioning of these networks.

## **Acknowledgments**

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# Profitability of Organic Agriculture in a Transition Economy: the Case of Organic Contract Rice Farming in Lao PDR

Setboonsarng, S.<sup>1</sup>, Stefan, A.<sup>2</sup>, Leung, P.S.<sup>3</sup> & Cai, J.<sup>4</sup>

Key words: Laos, rice, contract farming, switching regression, profitability

## Abstract

*Poverty is prevalent among smallholder farmers in transition economies where market failures prevail and where the capacity of the public sector is limited. This study assesses the potential of organic contract farming as a private sector institutional arrangement to reduce rural poverty. Contract farming appears to facilitate market linkages for smallholder farmers to produce organic rice for export markets while providing necessary technical supports. Using an endogenous switching regression model to assess the profitability of organic contract farms and conventional farms in Lao PDR, it was found that organic farmers under contract earn significantly higher profit than conventional farms. The findings also showed that organic contract farming tends to provide the greatest increase in income to farmers with below average performance. These findings suggest that contract farming can be an effective mechanism to facilitate the development of organic agriculture and an effective tool to improve the profitability and raise incomes of small farmers, thereby reducing poverty in rural areas with limited market development.*

## Introduction

Agriculture is the dominant sector of the Lao economy, accounting for nearly half of the country's GDP and employing 77% of the national workforce (UNDP/NSC, 2006). Almost all of the country's agricultural output is produced on small family farms. Despite the importance of agriculture to the national economy, an estimated 87% of the country's poor live in households headed by farmers (NSC, 1999). The vast majority of farmers practice subsistence rice farming and lack access to the incentives and supports necessary to improve their productivity and income. The major constraint to agricultural development continues to be low market integration as the country transitions to a market-oriented economy.

Contract farming has been promoted as a strategy to facilitate Lao PDR's comparative advantage in organic agriculture and connect small farmers to rapidly growing export markets (Setboonsarng et al., 2006; Eaton, 2001). As the majority of traditional crops are produced without the use of agro-chemicals, conversion to organic production requires only marginal improvements on the existing technology. A number of organizations have established contract farming agreements with small farmers to

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produce organic crops for export. This study assesses the profitability of organic rice production under contract and compares the performance of small farmers with and without contract arrangements.

## Data and Methodology

The 2004 household survey covered 585 rice farms (332 contract and 253 conventional farms) in Vientiane Province. The sampled contract farms produced organic Japanese *koshihikari* rice for export under contract with the private sector firm Lao Arrowny Co. Ltd. The contracted farmers receive a premium price for growing Japanese rice and are assisted by the firm on seed, organic fertilizer and technical assistance. In contrast, the sampled conventional farmers primarily planted traditional varieties for consumption or for sale in local markets.

To compare the performance of contract and conventional farmers, this study employs an endogenous switching regression model (Lokshin and Sajaia, 2004) to account for unobservable selection biases in farmers' decision to join the contract:

If  $\gamma Z_i + u_i > 0$ , farmer  $i$  chooses to join the contract, which is described by  $I_i = 1$ ;

If  $\gamma Z_i + u_i \leq 0$ , farmer  $i$  chooses not to join the contract, which is described by  $I_i = 0$ ;

Farmer  $i$ 's profitability with the contract ( $I_i = 1$ ) is  $y_{1i} = \beta_1 X_{1i} + \varepsilon_{1i}$ ;

Farmer  $i$ 's profitability without the contract ( $I_i = 0$ ) is  $y_{0i} = \beta_0 X_{0i} + \varepsilon_{0i}$ ;

In the model,  $Z_i$  is a vector of farm characteristics that affect farmers' decision to join the contract, including family size, land size, value of production assets, value of consumption assets, value of transportation assets and distance from farm to market.  $X_{1i}$  and  $X_{0i}$  are two vectors of farm characteristics that affect farmers' performance under the contract and without the contract, including farm size, family size and value of production assets.  $y_{1i}$  and  $y_{0i}$  are dependent variables measuring farmers' profitability;  $\gamma$ ,  $\beta_1$  and  $\beta_0$  are vectors of parameters subject to estimation; and  $u_i$ ,  $\varepsilon_{1i}$ , and  $\varepsilon_{0i}$  are three random error terms that follow trivariate normal distribution. After the parameters are estimated, the actual and counterfactual expectations of farmers' performance with and without the contract are calculated.

## Results and Discussion

The simple mean comparison of organic contract and conventional farm characteristics are summarized in Table 1. Table 2 shows the mean profitability of commercial rice farming. Profitability is defined here as revenue less cash costs and does not include non-cash costs such as own labor, own seed, etc. Organic contract farmers are able to sell their rice at significantly higher prices than conventional farmers, averaging US\$0.17/kg versus US\$0.14/kg. In addition to receiving higher prices, organic contract farmers also had significantly higher yields than conventional farmers. The yield difference likely reflects the higher efficiency of organic production under contract, as farmers have better access to seed, organic fertilizer and technical assistance facilitated by the contracting firm (Table 1). As a result of higher yields and the price premium for organic rice, contract farmers have a higher mean profitability than conventional farmers, earning an average of US\$304/ha and US\$182/ha, respectively.

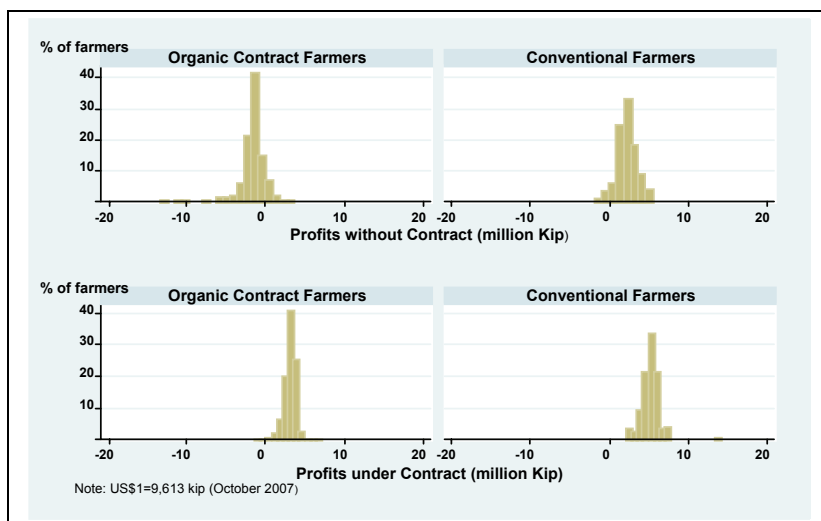
**Tab. 1: Farm characteristics of sample farms**

	Contract	Conventional	p-value
Plant area (ha)	1.11	1.43	0.0327
Distance from farm to market (km)	20.23	22.20	0.2224
Seed expenditure (US\$/ha)	29	8	0.0009
Fertilizer expenditure (US\$/ha)	85	55	0.0567
IPM (% of farmers receiving training)	34	24	0.1174

**Tab. 2: Profitability of commercial rice farming in sample farms**

	Contract	Conventional	p-value
Rice price (US\$/kg)	0.17	0.14	0.0000
Rice yield (kg/ha)	3272	2603	0.0420
Revenue before cash costs (US\$/ha)	545	367	0.0008
Cash costs (US\$/ha)	234	185	0.1102
Profit over cash costs (US\$/ha)	304	182	0.0307

A comparison of the actual and counterfactual profits estimated by the endogenous switching regression reveals more information about the impact of contract farming on farmers' profitability. Figure 1 depicts the distribution of profits of organic contract and conventional farmers under contract and without the contract.



**Figure 1: Counterfactual profitability comparison of organic contract and conventional farmers**

The contract farmers' profits under contract (the southwest graph) are on average higher than their counterfactual profits without the contract (the northwest graph). Joining the contract is estimated to have increased the profits of contract farmers by US\$482. In the case of conventional farmers, the counterfactual profits under contract (the southeast graph) are on average higher than their actual profits outside the contract (the northeast graph). In other words, the profits of conventional farmers would have increased by US\$334 if they had joined the contract.

These results provide empirical evidence that organic contract farming tends to be more profitable than conventional farming and that the observed higher profitability is not simply the result of more profitable farms adopting organic contract farming. In fact, it is interesting to note that contract farmers have below average profitability<sup>1</sup> both under contract and without the contract. In other words, contract farmers are less profitable than conventional farmers, both under contract and without the contract (Figure 1). This suggests that contract farming tends to be more attractive and more beneficial to farmers with relatively low performance.

## Conclusions

The sampled organic rice contract farmers earned significantly higher profits than conventional rice farmers under similar agro-ecosystem and socio-economic conditions. The switching regression comparison also indicates that organic contract farming has the greatest benefits for farmers with relatively poor performance. Contract farming of organic products, in this case Japanese rice, appears to capitalize on the comparative advantages of Laotian farmers who have relatively chemical-free land, excess labor, and traditional knowledge of organic practices. By linking to rapidly growing urban and regional markets for organic products, small farmers were able to improve their incomes while using sustainable agricultural practices. The results of this study suggest that organic contract farming can be an effective institutional mechanism to involve the private sector in reducing rural poverty. The contract arrangement provides farmers with an assured market for their produce and enables them to earn premium prices for high value products. Contract farming appears to be a promising institutional arrangement in rural areas where market failure remains prevalent, particularly in transition economies such as Lao PDR where agricultural production remains primarily subsistence oriented and institutions to facilitate market exchange are in an early stage of development.

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<sup>1</sup> "Average profitability" in this report means the average of the profits of all farmers, irrespective of their actual contract choices, either under the contract or outside of the contract.

# Ancestral Livelihoods in Amazon River Floodplains

Madaleno, I.<sup>1</sup>

Key words: Livelihood Improvements, Socioeconomics, Developing Countries.

## Abstract

*Amazon's historical peasantries, the Caboclos, are the legitimate heirs of aboriginal knowledge, displaying a good repertoire of imaginative forms of natural resources management, adapted to climate change and its extremes in temperature and rainfall. Caboclos are capable of restarting livelihoods and breeding life after each flood, surviving on multiple functions, activities and tasks, maintaining a respectful relationship with the forest and the floodplains, as with numerous waterways that drive away from the Amazon and penetrate the jungle. Vegetable farming uses organic fertilisers, Caboclos tending the alluvial rich soil every time the river falls shorter in order to stock food surplus for the rainy season, to fulfil ongoing household nutritious needs, as to get cash to meet other basic necessities. The fundamental research objective is to recover traditional organic farming and forest management practises along Lower Brazilian Amazon River margins so that they might be presented as models for similar tropical environments.*

## Introduction

Lower Amazon Basin has been experiencing human presence for millennia without irreversible damage to the environment. From the midst of 20<sup>th</sup> Century, however, both the forest and the river margin areas started displaying a number of ecological problems. Overgrazing, over cultivation and deforestation are the main sources of such environmental stresses. Soil erosion is an obvious outcome and is often enhanced by mechanised agriculture, particularly as far as recent (2000's) soybean monoculture is concerned. Tillage of the soil using heavy machinery affects its infiltration capacity, sub-soil being compacted and therefore enhancing overland flow which erodes the loose topsoil. Eroded sediments are easily transported after heavy rainfall whereas the erosion process is further enhanced by the fragility of these formerly primary forest covered soils. The paper case studies a municipality located in Amazon River confluent Tapajós sub-basin revealing successful examples of ethno-development that persist along Amazon River margins, providing the opportunity to discuss multi-functional and ancestral organic farming models.

## Materials and methods

Qualitative research uses images and descriptions whilst quantitative research relies mainly on numbers. The study followed the procedural sequence listed: (i) Literature survey, comprising historical documentation available on the lower Amazon fluvial settings; (ii) Fieldwork, including fifty in-depth interviews to four categories of informants. The first group targeted national, regional and local authorities in order to get a picture of current policy approaches to development. The second group aimed judges and lawmakers, technicians and university scholars whose insight contribution

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was decisive to understand the environmental status of the geographical spaces under scrutiny. The third group involved artisans, traders and service providers from the urban realm, an insight over urban livelihoods and an examination of their perception of the rural realm. Last but not least household surveys were conducted in the floodplains of Nova, Maica and Ituqui Islands, and along the Igarapé-Açu, a water channel located in the mouth of Tapajós where it meets the Amazon River, in the municipality of Santarém. Interviewing paid an important role though, making sampling measurement techniques possible in the four case studies. Furthermore we've used photographic and video graphic techniques in order to register and build a database. The archival, documental and recent scientific literature analysis has been fundamental to fully develop the ongoing ethno-geographic research. Use of a mixed methodology enabled the study to meet its aims of examining community organisation, water and soil management among *Caboclos* whereas the bulk of the research targeted multi-functional rural communities whose sustainable livelihood practices constituted the main objective of the fieldwork.

## Results

Historical documentation encompasses descriptions of settlement, peoples and farming practises as early as the sixteen century, consisting of Amazon River Spanish and Portuguese discovery reports, written by Catholic priests, such as Carvajal in 1542 or Cruz in 1639 (Maderuelo 2002). While most of the river margin tracts were covered with impenetrable rainforest, there is detailed record of highly populated less than 10 metres high island settings where cassava and maize were grown during the dry season, and surplus carefully preserved in deep holes underground during the rainy season, in order to provide enough food for the Amazon Indian communities during inter-cropping periods. About one million residents have been accounted for in the 16<sup>th</sup> century along Lower Amazon River marginal areas, corresponding to an average human density of 14 inhabitants per square kilometre (Madaleno 2007).

European colonisation developed in cycles, such as wood, medicines and spices extractivism, followed by *Hevea* exploitation from the 19<sup>th</sup> Century to the First World War. Farming has never been intensive though, and the economic cycles have respected other species whilst in general they haven't depredated the intended ones. Nevertheless, during the Second World War as the Amazon River was isolated from the remainder Brazilian territory it became accessible for foreign contenders, navigating the Atlantic Ocean. The enormous wealth of the Amazon rainforest and the known soil and subsoil mineral resources led to protectionist measures intended to integrate better the northern territories. Consequently, from the 1950's onwards several terrestrial roads have been drawn, and new rural towns and mineral pole cities have been created by government planning. The perverse effect was that land availability and new accessibilities provoked wide internal migrations, some publicly promoted and subsidised, such as the National Colonization Plans (PIC's 1970-79) and others driven by necessity or greed (Becker 1998).

Deforestation trends have been remarkable from the 1970's onwards as end result, particularly within Para state, to which case-studied Santarém municipality belongs. According to Brazilian Spatial Research Institute (INPE), a total of 5,776,652 ha have been cleared in a 13 year period (1988-2000) in the Amazon basin (Homma 2003). As far as Santarém and the Tapajós River (Amazon tributary) is concerned, deforestation has been increasing in recent years, favoured by corporate investment in ports and local industry amelioration (Cargill), aimed at soybeans production along Route 163, an Amazon rainforest accessibility dating from the 1970's. The trend has been so

intensive that not even National Parks are being preserved (FLONA and RESEX Tapajós), due to National Environmental Agency (IBAMA) disinvestment.

Under such unfavourable historical background, the second research objective was to inquire whether ancestral organic lower Amazon practises had survived to the industrial farming and modernisation trends. Fieldwork has been developed over two subsequent years (2006-2007) in Lower Amazon Nova, Maica and Ituqui fluvial islands as at Igarapé-Açu, located in the municipality of Santarém. All households have been examined during the dry season (from July through December), called on the shack used during the cropping period, for during the rainy season they displace their belongings to safe upland, *terra firme* (located above 10 metres high). That's because water level rises about 7 metres during the floods, total annual precipitation averaging between 1,750 and 2,000 millimetres. With two exceptions of male farmers living on high ground year-round and travelling to the floodplains everyday, during the cropping period, the remainder interviewed households spent about half the year on the fluvial islands and Igarapé-Açu margins ("Great Channel" in *Tupi* language), cleaning-up the soil, sowing, planting, tending both subsistence (10 to 60%) and cash crops, harvesting melons, watermelons, corn, beans, cassava and a dozen different horticulture species in order to sell them on the nearby city markets. Farming tasks are developed on a co-operative manner within the family.

**Tab. 1: Soil fertilisation in case-studied Amazon River floodplains**

Type of fertiliser	Nova Island	Igarapé-Açu	Maicá Island	Ituqui Island	Average/ Total N°
Straw and manure mulching	70%	50%	50%	70%	60%
Tree leftovers	20%	50%	100%	100%	67.5%
Alluvial deposits	100%	100%	100%	100%	100%
Chemicals	10%	0	0	10%	5%
N° of household interviews	10	2	10	10	32
Number of smallholders	30	100	100	800	1030

Source: Santarém municipality and 2006-07 household surveys

Results have shown that organic farming practises persist within *Caboclo* communities, people engaged on traditional horticulture and animal farming activities. Vegetables, melon and watermelons are irrigated, whilst subsistence crop cassava is not, usually tended on higher ground. Organic fertilisers such as tree leftovers ("*estrume de pau*") and a rich mulching of manure amassed with straw, forming powerful compost, are the universal fertilisers in the floodplains (see Table 1). Even though more than half the *Caboclo* population interviewed fertilises the alluvial soil, particularly on the case of Ituqui Island, the largest in surface area (about 20,000 hectares), where two melon, watermelon and tomato crops are grown per dry season, the survey has shown that some crops survive solely on rich alluvial deposits; the number of plot owners that use chemical fertilisers was rather small and it has been registered only on two island settings – Nova and Ituqui.

## Discussion

Residents of Nova, Maica and Ituqui Islands as Igarapé-Açu settlers often constitute enlarged families even though in each shack visited only usually resides a nuclear household. The community presents linear layout along the Amazon River and its numerous channels, the island plots averaging 2 ha. *Caboclos* see nature in an integrative fashion because rivers, forests, fish and wildlife constitute food sources and income, which explains that they tend to preserve local biodiversity for sheer survival needs. A changing pattern is evident at Ituqui Island, though, in favour of commercial fishing, practised to feed households and supplement income in times of hardship. Ituqui is being ravaged by landownership quarrels either, for all marginal Amazon areas are public property, where there is official acceptance of local peasantries farming and recollection activities during the dry season, yet buffalo and cattle husbandry are not allowed for their depredatory effects on the ecosystem. *Caboclos* are usually small scaled chicken, duck, goat, pork and cattle raisers, except at livestock driven Igarapé-Açu, where plot surfaces increase tenfold. Conflicting situations arise when farmers accept to be cowboys during the dry season too, service providers for landlords to whom they've worked for generations during the hardship of the rainy season. Not only they waste farming space for they have to separate the cattle from the farmed areas but their plot becomes the new source of dispute. They have no option however, in order to secure their families on this wild and remote Brazilian territory, ravaged by landownership and natural resource exploitation conflicts. The crops tended along Amazon River floodplains (*várzea*) have a higher yield than highland production. *Caboclos* declared to produce about 1000 watermelons and 1,500 kg of melons on a single harvest. From August through September the first cash crop is available. Vegetable farming during dry season is essential for households' survival because the rainy season is usually a scarcity period. About 10 % households reside in the cities then, living on trade, fishing and services provision whilst the bulk of the interviewed continue with the farming activities upland, complemented with cattle husbandry for rich landowners, as said, and forest extractivism.

## Conclusions

The new wave of globalisation is assigning developing countries a leading role in agriculture production. As the main driver in South America, and for decades a successful food, meat and biofuel producer, Brazil tends to increase its global share. Amazon forest is becoming the 'collateral damage' of such contended process. Even so research has shown that *Caboclos* persevere with their ancestral organic farming along Amazon River floodplains, despised by corporate industrial agriculture because of their vulnerable status, yet models of long-lasting and thriving livelihoods adapted to the shifting rivers. In times of climate excesses continuing and successful survival and environmentally friendly farming practices are a repository of hope in the future.

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## Consumers in a food chain perspective

# Consumers perceptions of combined “fair trade” and “organic agriculture” labels on food products

Daniel, M.1, Sirieix, L.2 & Bricas, N.3

Key words: ethical label, fair trade, organic agriculture, consumers' representations

## Abstract

*Responsible, ethical, sustainable, citizen consumptions, those terms refer to new consumption behaviours more and more present in the market, society debates, or sociological and marketing research. This study is in the line with previous studies made on ethical consumption in the last ten years. We focused on the question “How do consumers perceive the combined « organic agriculture » and « fair trade » labels on the same product?” A qualitative survey, combining interviews and focus groups, showed the high diversity of representations and the interactions linked to those two concepts and their combinations. If the two labels are used by food chain stakeholders as complementary, they have been differently perceived by consumers: more, some consumers perceived some contradictions between them. We can distinguish six different profiles of consumers on the basis of perceived specific interactions: from the total synergy to the contradiction between “organic agriculture” and “fair trade”.*

## Introduction

According to Vermeir and Verbeke (2006), the last two decades have seen a rise in consumer ethical concern, particularly in Europe. These ethical concerns express themselves in the purchase of ethical products and a responsible consumption behaviour. On the ethical food market, organic agriculture (OA) and fair trade (FT) products remain the stars performers in terms of sales growth; besides each of these products can be proposed distinctly or combined to consumers. While the organic movement deals with the environmental questions, fair trade is about social concerns and is supposed to contribute to better life conditions of southern producers. These movements were “alternative trades” for a small part of producers and consumers, they are also now becoming an important business for companies which had the idea to combine those concepts on products (Moreno-Penarada, 2006). If inside the movements, the stakeholders debate on the complementarities or contradictions between these movements, our study investigates if the consumers perceive the compatibility between OA and FT labels.

Recent studies indicate some confusions (De Ferran, 2007) or interactions (Tagbata, 2006) between these two attributes for consumers. This double labelling package could be perceived differently, sometimes negatively by the consumers (Tagbata, 2006). However, the usefulness of these results is limited by the poor description of the origin of those interactions. Thus, our study aims at understanding these

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interactions by revealing the representations (Gallen, 2005) and the trade-off between selfish and altruist values. Personal values are fundamental psychological variables to understand ethical behaviours (Vuylsteke and al., 2002). Many studies show that the main motivation of organic products purchase is, not first the environment (altruist motivation), but health and enjoyment (selfish motivations) (e. g., Henson and Traill, 2000). In fair trade case, several papers mention “the support of small consumer” as the main motivation (Sirieix and Codron, 2004). But we can suppose that these motivations are not homogeneous and that there are also selfish motivations like the originality of an exotic product, the traditional skills respect, a more authentic taste or novelty seeking. Thus, these heterogeneous motivations and the interactions between representations could be a basis for consumer misunderstanding.

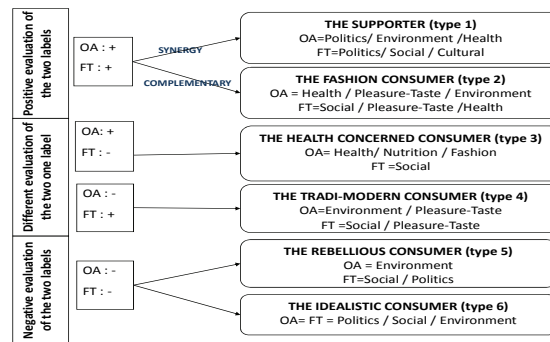
### **Materials and methods**

Our objective is to reveal the diversity of OA and FT representations in order to describe the interactions between these notions for consumers. We used two complementary interview styles: the individual interview and the focus group. In all, we interviewed 45 persons in order to have a very heterogeneous sample. We paid attention to socio demographic data (17 men and 28 women, age from .22 to 70, different working activities), consumption behaviour (OA or FT buyers or not) and involvement (in environmental or social associations or not ). Based on thematic and individual analysis, the data allowed us to put in light the diversity of the consumers' representations and finally, six types of combined OA and FT representations.

### **Results**

We collected all the consumers FT and OA representations: movements, ethical-labels, consumers and producers representations. In general, the OA representations were complex, very heterogeneous and linked to a high diversity of vocabulary. We made a distinction from the most individualistic to the most altruistic ones: health, nutrition, fashion, taste-pleasure, environmental representations and finally political and social representations. In the same way, we collected the FT representations. Even if the vocabulary was less complex than in OA representations, as supposed in the main hypothesis, fair trade product purchase motivations were very heterogeneous. We can distinguish the natural, pleasure, social, cultural and political representations.

Once identified these representations, we examined their combinations. This study revealed that not all consumers favourably perceive the combined OA and FT labels on the same products. We interpreted the perceived complementarities and contradictions with the congruency and dissonance concepts. The analysis of the combined representations resulted into six profiles that consumers can adopt depending on the moment, the information received, their lifestyle, the nature of the products. Our typology is inspired by Ruwet (2007), who built a typology of engaged consumers from the image they had of production and farming of these movements. Within our six consumer profiles, three of them are related to Ruwet's typology: supporters, inspired and tradi-moderns. The consumers are organised in three classes of combined representations:



**Figure 1: Description of combined representations (inspired by Ruwet (2007))**

- Consumers in the first class consumers value OA and FT products. Supporter (type 1 in Figure 1) distinguishes himself by his sense of altruism and the perception of a synergy between the two attributes. The OA and FT movements are a credible alternative for conventional market and production. The fashion consumer (type 2) is more self oriented and purchases these products to keep up with a trend, to value himself or to belong to a social group of responsible consumers. He perceives an imperfect congruency between the two labels: he considers organic agriculture for the health aspects and fair trade for the “support of small producers” and for a better taste of these products. He purchases these products with an idea of double profit: «I have pleasure to taste this product and in the same time, I help the producers ».

- In the second class consumers do not value one of these two attributes and who have a negative image of the product with the two labels: The health concerned (type 3) and the tradi-modern (type 4) consumer. It is a self-dissonance phenomenon related to the image they have of the consumer profile of this kind of product. It means a gap between the image they have of themselves and the image they have of the label or of consumers who choose these products. Thus, the health concerned consumer who buys organic products for selfish motivations is in opposition to fair trade “engaged” consumers altruistic values he imagines. However, he can be reassured on sanitary security of FT product if it is also OA labelled.

- In the third class consumers fundamentally agree with these movements principles but are opposed to the shape they are getting. They associate the label to a brand and criticize this growing business. They do not buy OA and FT products. It is a functional dissonance phenomenon; it means a gap between ethical consumer concerns and the label perceived reality. For these consumers there is a strong incoherency between their label representation and the ideal representation of the altruistic movements.

The fact that no respondent declared that he just not cared about OA or FT may seem surprising. However, we can explain it by the social desirability bias induced by ethical issues.

## Discussion

Our results show the nature of the interactions shown up in Tagbata (2006) and De Ferran (2007) works. Congruency and dissonance theories allowed to understand

bringing to light some interaction mechanisms: congruency and self dissonance in relation to beliefs, to attribute aims, to labels and to ideal representations.

This distinction between the movement and its shape, the label, is recurrent in consumer speech and seems to be very important to take into account in this kind of study. We distinguished these different interaction mechanisms, but they are not exclusive the ones and the others and can be combined by one person. For example, a person « health minded » will consider that the « fair trade » label is incoherent with the image he has of himself (self dissonance), but the certification « organic agriculture » will reassure him on sanitary conditions of production (imperfect congruity between attributes).

## Conclusion

This qualitative survey, combining interviews and focus groups, showed the high diversity of representations and the interactions linked to OA and FT concepts and their combinations for the consumers. If those two labels are used by food chain stakeholders as complementary, they have been differently perceived by consumers: more, some consumers perceived some contradictions between them. We have distinguished six different profiles on the basis of perceived specific interactions: from the total synergy to the contradiction between "organic agriculture" and "fair trade".

From a methodological point of view, this survey focused on an exploratory work and qualitative objectives. A quantitative survey will allow collecting more data to evaluate the weight of the profiles that we described.

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# Are Organic Consumers Healthier than Others?

Krarpup, S.<sup>1</sup>, Christensen, T.<sup>2</sup> & Denver, S.<sup>2</sup>

Key words: Organic consumers, health, diets, consumer values.

## Abstract

*Recent research results indicate that organic consumers have a healthier diet than other consumers. This suggests that there might be a positive relationship between organic consumption and a healthy lifestyle. One aim of an ongoing research project is to analyse whether consumers with a high organic consumption have a higher interest in nutrition and a healthy living than other consumers. In order to test whether such a causal relationship exists, purchase data from Danish households are combined with information on these households' perception of organic food and their health concerns.*

## Introduction

Denmark has experienced a boost in the consumption of organic foods in recent years. In order to maintain the growing demand for organic food it is of importance to understand the reasons for this increased demand. Some might be explained by the general income increase, but recent research indicates that consumers buy organic foods due to a concern for animal welfare, a clean environment, trust in the organic production and taste. Also health concerns are drivers of organic consumption.

In this paper we will analyse whether there is a relationship between a high consumption of organic food and health concerns. Moreover, we will analyse whether consumers with a high organic consumption perceive organic food to be healthier than conventional food and in general have a higher interest in nutrition and a healthier living than other consumers. This description will be followed by a socio-demographic description of the different types of consumer groups.

## Materials and methods

In order to analyse the relationship between actual purchasing behaviour and consumer values, two types of data are used, namely a postal questionnaire and a household panel data set, which includes more than 2000 Danish households (GfK ConsumerScan household panel). The panel data include information on daily purchases of a large variety of organic and conventional foods, as from 1997 and thereafter. The information includes prices, quantities, labelling, brand, store choice etc. In addition, background variables such as socio-demographic characteristics and media habits are registered for each household member. A questionnaire was sent to all 2376 households in the GfK panel and completed by 2022 households in the period from 24 April to 15 May 2007 implying a response rate of 85%. The questionnaire aims at revealing concepts, values and attitudes that can be subsequently analysed in

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relation to data regarding behaviour. By merging the GfK panel data set with the data from the questionnaire it is possible to classify and group panel members according to purchasing behaviour, perceptions of the organic products, interest in a healthy living and consumer characteristics.

## Results

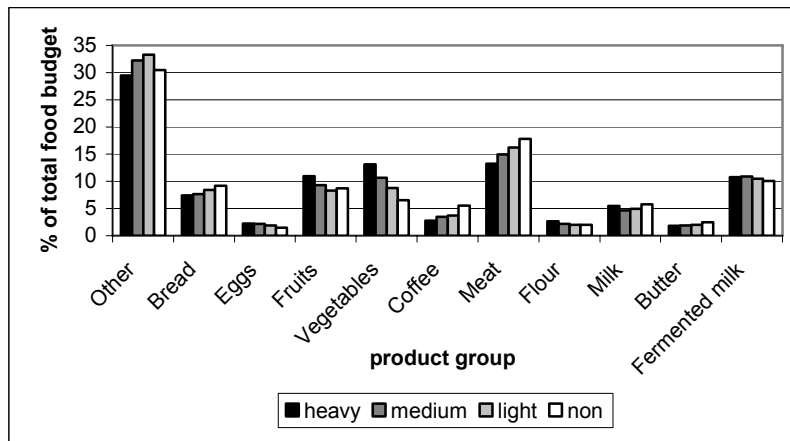
### *Consumption patterns of different user groups*

We analyse the purchasing pattern of organic as well as non-organic food in the GfK panel of the four different consumer groups. To construct these groups we take advantage of the household-specific character of the data which allows us to divide households into groups according to organic budget shares (defined as the shares of the expenditures on 32 products with organic varieties). Households with no organic consumption are categorised as non-users, households with an organic budget share less than 2.5% are light users, households spending between 2.5-10% are medium users and households spending more than 10% of their food budgets on organic varieties are denoted heavy users. Around 9% of the households did not buy any organic products in 2006 and could thereby be categorised as non-users. In 2006, approximately half of the panel was light users and one out of four was medium user. 15% of the households spent more than 10% of the food expenditures on organic varieties.

Next, we look at the product-specific organic consumption by the four consumer groups in 2006 by dividing the 32 products into 11 categories (bread, eggs, fruits, vegetables, coffee, meat, flour, milk, butter, fermented milk + a rest-category denoted 'others'). Heavy users hold the highest organic budget share for all product categories whereas medium and light users can be heavy, medium or light users of the different product groups. Heavy and medium users have a remarkably high demand for organic milk and eggs – 80% of the milk purchased by heavy users is organic and 40% of the milk bought by medium users is organic. Similar, 65% of the eggs demanded by heavy users is organically produced against 30% for the medium users. The organic share for the product group *other* is below 5% indicating that the most frequently purchased organic products are captured by the ten product categories included. In particular, it is worth noticing that medium and light users have much higher organic budget shares in vegetables than in fruits despite the fact that those categories often are recommended jointly in public health campaigns etc. An analysis of the price premiums indicates that the price premiums for fruits are 35-70% while for vegetables 20-45% (Denver et al. 2007) which might indicate that medium and light users are more sensitive to price premiums than heavy users are, but further research is necessary to validate this interpretation.

Knowing that organic food varieties are more expensive, it was surprising to see that while differences in organic expenditures exist across user groups the overall food budget is approximately the same for all consumers. This raises the question of whether the four user groups differ with respect to their general diet. Figure 1 reveals to some extent differences in diets across consumer groups.





**Figure 1: Distribution of the total food budget.**

Source: GfK ConsumerScan, Denmark.

It seems from figure 1 that there is a positive relationship between the organic budget share and the consumption of fruits and vegetables. This indicates that heavy users consume more fruit and vegetables than other types of consumers. In addition, a negative relationship between the organic budget share and the consumption of meat, coffee and butter can be seen. The data therefore indicate that heavy users have a healthier diet than other consumers.

As a supplement to this healthier allocation of the budget by heavy users, we apply a healthy eating index (HEI) (Smed 2007). The HEI links nutrition data to the products and volumes purchased by the panel members. This initiative makes it possible to evaluate the state of nutrition across households. When linking the HEI to user group affiliation, we found a clear and positive relation between organic budget shares and a good state of nutrition.

#### *Organic consumers' health perceptions*

The aim of the second part of our analysis is to test whether heavy users perceive organic food as healthier than other consumer groups and whether heavy users in general have a more healthy living than others. The results from the questionnaire show many signs of heavy users being more concerned and aware of a healthy life style. Firstly, we found that own and children's health is a major argument for heavy users for buying organic food and it is perceived much more important than for other organic buyers. Secondly, for two thirds of the heavy users as opposed to only one third of non-users, it is vital that their diet is healthy. Besides, more than half of the heavy users answered that they do not prefer tasty food to healthy food (if they had to trade off). Thirdly, it is significant that heavy users know what to eat to have a healthy diet as opposed to only one third of non-users. This shows, that many consumers think that healthy eating is important – and in particular heavy users. More than 80% of heavy users relate healthy eating to organic food as opposed to only 20% of non-users.

## Discussion & Conclusion

To our knowledge no other studies exist that analyse the relationship between actual (organic) consumption and consumers' concern for a healthy living. However, some studies exist that find organic consumers to be more concerned with health and perceive organic foods as healthier than conventional food, cf. Williams & Hammit (2000), Torjusen et al. (2004) and Wier & Calverley (2002). Also Magnusson et al. (2003) find that health concern is the best predictor of attitudes towards organic foods and actual purchase of some organic products. Shepherd et al. (2005) find that perceived health benefits from consuming organic food are strongly correlated with attitudes towards organic food and buying intentions. This is supported by Huang (1996) who finds that organic consumers are more nutritionally conscious than others. It therefore seems as if it is generally agreed that consumers buy organic foods at least to some extent because it is perceived to be healthier.

Another angle, which we have merely touched upon in the present paper, is why organic consumers have a healthier diet – is it because of their attitudes towards healthier eating or is it for budgetary reasons? With our future analyses we hope to shed some light upon these potential relationships.

## Acknowledgments

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# Consumers Values and Motives regarding Organic Food Products in Poland

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Key words: consumer, organic food, motives, values

## Abstract

*Poland, like all new European Union member states has experienced significant growth in organically managed land and the number of organic farms in the last few years. However, there are still many barriers to overcome to stimulate the consumption of organic foods. There is a need to learn more about the emotions, cognition and behaviour of Polish organic consumers in order to develop effective marketing strategies. Polish consumers are motivated to buy organic food because of its perceived health and safety attributes. The highest interest in organic food is observed among consumers who value animal welfare, environment protection and self-fulfilment.*

## Introduction

The organic foods market has become one of the most rapidly growing sectors in the European Union. Poland, like all the other countries that joined the EU in 2004 has experienced high growth in the number of organic farms and the total area under organic production due to financial support in the form of area payments. The supply of organic foods is increasing but demand is stagnating. The question that arises is what is driving consumers' decisions to buy organic food, what values are shaping Polish consumer choices? The existing studies on consumer motives to buy organic products show that organic food is mainly bought due to non-altruistic motives such as care for one's own health or taste. However, there are cross-cultural differences in the hierarchy of motives to buy organic food and Northern and Central European consumers more frequently cite environmental concerns as being their main buying motives (Zanoli et al, 2004). Consumers are increasingly expressing concern about how their food products are produced, processed, and regulated. Food scandals and uncertainty about food safety, experienced by European consumers in the last decade, have increased interest in safety aspects. One can argue that organic food produced according to strictly defined standards is a product that meets the expectations of contemporary consumers concerned with various aspects of food safety and buying organic food could be a strategy to reduce risk. Despite the fact that there is no unambiguous evidence that organic foods are healthier than conventional foods, organic foods contain less harmful residues than conventional foods. On the basis of the precautionary principle alone, choosing organic foods appears to be an entirely rational decision (Chen, 2007). Ethical concerns expressed by contemporary consumers that belong to credence attributes meaning that they cannot be experienced directly through consumption (Oude Ophuis, Van Trijp, 1995) are also playing an increasingly important role in the hierarchy of motives to purchase organic food. The main objective of the study was to gain an insight into the motives

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underlying Polish consumers' decisions to buy organic food in the context of the values that drive their choices

### Materials and methods

The research was conducted in December 2005 on a representative sample of Polish consumers. The total sample consisted of 995 respondents, 519 women and 476 men. The majority of respondents were recruited from urban areas, while more than 1/3 could be considered as residing in rural areas. The most frequently represented group in terms of educational background were respondents with a secondary education; the least represented group were those with higher education. Face-to-face interviewing technique was used to collect data for the study. Questions concerning consumers' motives to buy organic food were worded in the form of a sequence of statements, towards which the respondents, on a five-degree scale, expressed a set degree of conformance. A ten-degree scale was applied to the question concerning values, in which respondents had the ability to rate on a scale from 1 to 10, where "1" meant – totally disagree, and "10" totally agree. Respondents were confronted with a set of values representing domains such as: health, love, family life, independence, living according to norms, self-fulfilment, travelling, meeting new people and cultures, prestige, welfare, environment protection, animal welfare and living in an independent country. Data analysis was carried out using SPSS 12 for Windows and responses were, in the first stage of the analysis, evaluated using descriptive statistics followed by a segmentation of the sample population. The variables representing values were used in the factor analysis to reduce the data into four dimensions: absolute values, self-fulfilment, materialism and care for the environment. Principal Component Analysis with varimax rotation revealed four segments of consumers: "traditional" (19%), "active" (45%), "convenience seekers" (25%) and "indifferent" (11%).

### Results

In the hierarchy of motives to buy organic food, health concern is the primary motive regardless of the cross-cultural differences. Polish consumers tend to choose organic food because they are convinced that organic food is safe and 49% strongly agree with this statement (Figure 1).

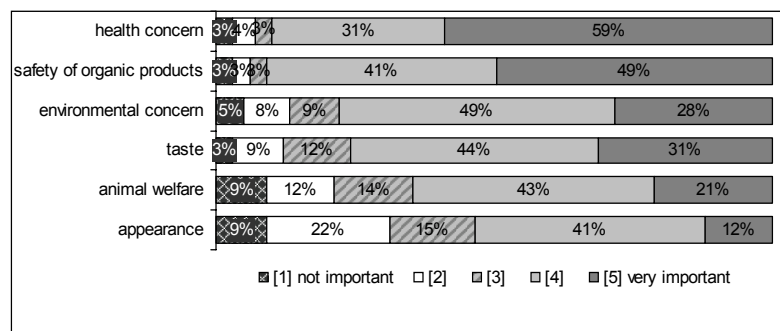


Figure 1: Motives to buy organic food among Polish consumers, N=995

Source: own research

Environmental concerns and taste play an important role in consumers' decisions to buy organic food with an average score of 3.91 on the 5-point scale. Issues related to animal welfare are considered as very important by 21% of respondents. Attributes related to the appearance of organic food are not highly scored as a factor affecting consumers' decisions to buy organic food and more than 30% of respondents admitted that appearance "is not important" or "rather not important" when purchasing organic food.

The consumers belonging to the segment of "active consumers" more frequently declare a motivation to buy organic food. They are younger, better educated, most of them live in urban areas (up to 200 000 inhabitants) and they have incomes above the average in the sample. The segment of "active" consumers is more concerned with animal welfare and environment protection. However, traditional consumers ranked environment protection the highest. Active consumers more frequently claim to be open to new cultures, willing to travel, gain knowledge and place less importance on the values of religion and living according to certain norms and rules. The traditional and convenience seekers segments do not differ significantly in terms of buying organic food but their value system and socio-demographic profile varies. Traditional consumers are particularly concerned with values related to family, religion and health and they do not regard self-fulfilment as an important aspect of their lives. The convenience seekers are the least concerned with environment protection and animal welfare. There is a relationship between the consumer values to protect the environment, animal welfare and the interest in organic food.

## **Discussion**

The most important motives to buy organic food are in the opinion of Polish consumers health and safety. However, these credence attributes of organic foods are interrelated. The research on Polish consumers' food risk perception shows that they believe organic food consumption can minimize such risks and they associate organic food with safety (Ozimek et al., 2005). However, health related attributes cannot be used in any promotional activities. Moreover, there is still not enough scientific evidence that organic food contributes positively to human health and food safety. Magnusson et al (2003) point out that health and environmental motives differ in the sense that concern about health can be regarded as egoistic (benefits the individual or his/her family) while consideration for the environment and animal welfare are more altruistic (benefits for society rather than the individual). Thøgersen (2006), based on the results of cross-cultural research, express the opinion that beliefs about health, taste and environmental consequences apparently have the strongest influence on attitudes towards buying organic whereas beliefs about costs have relatively little influence on attitudes. In the case of countries like Poland and other Central and Eastern European new EU member states, where the share of food expenditure is high, price remains an important determinant of consumer decisions when buying food. The association between organic products and higher prices, but not higher quality, as compared with conventional products (Magnusson et al., 2001), is a negative factor for the image of organic products. Polish consumers perceive availability and high prices as the main barriers to buy organic food (Żakowska-Biemans, 2006). Thus, it is necessary to communicate various aspects that affect the prices of organic products, particularly those related to organic standards, to show the benefits of organic food consumption in terms of environmental protection and animal welfare because these factors are influencing Polish consumer choices. Moreover, to

attract consumers, food attributes such as appearance and convenience cannot be neglected.

### **Conclusions**

The primary motives of Polish consumers to buy organic food cannot be considered as altruistic. Health and safety aspects are the main factors affecting the decision to buy organic food. The values underlying organic consumer choices are related to environmental protection and animal welfare and these attributes should be used more effectively in communicating organic farming and organic food to overcome the demand related barriers to its consumption.

### **Acknowledgments**

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## Exploring close consumer-producer links to maintain and enhance on-farm biodiversity

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Keywords: local selling, on-farm biodiversity, producer – consumer links, diversification

### Abstract

*This paper deals with the question of whether local selling of farm products improves on-farm biodiversity. In contrast to the main agricultural trend of farms specialising and increasing in size in response to the national and global markets, increasing numbers of Swedish farmers are instead diverting their efforts towards selling at local markets. Based on a study of six farms, the paper explores the nature of diversity on these farms and identifies factors supporting diversity. The study shows that farmers who interact with consumers are encouraged to diversify their production. The actual crops and varieties grown are determined by a combination of the natural conditions prevailing on the farm and the conditions created by the farmer in terms of marketing strategy for the products.*

### Introduction

Although the relationships between landscape heterogeneity, biodiversity and the provision of ecosystem services are not fully understood, a number of studies strongly support the idea that reduced heterogeneity in the agricultural landscape reduces the biodiversity and affects the generation of ecosystem services negatively (Altieri, 1999; Benton et al., 2003; Tscharntke et al., 2005). Thus agricultural heterogeneity – in the sense of e.g. habitat diversity of natural pastures, varieties in crop sequences and fields with extensively cultivated border strips – is of crucial importance for the maintenance of biodiversity, as it provides food, shelter and nursery areas for wild flora and fauna (Benton et al., 2003). The species making up the diversity, including their complex and still largely unknown interactions, are in turn crucial for the generation of ecosystem services (Daily, 1997), such as the maintenance of soil structure and fertility, local hydrological cycles and recirculation of nutrients. As these services support agricultural productivity, they are important for the development of more sustainable agriculture. They are decisive for the adaptability of agriculture to the demands for food and raw material under changing environment and climatic conditions, as well as for the prospect of reducing the use of non-renewable resources (Tilman et al., 2002). Despite EU subsidies aimed at inspiring and supporting farmers to adopt practices that maintain biodiversity, the heterogeneity and diversity of the agricultural landscape of Europe is threatened today (Donald et al., 2006). In contrast to this mainstream trend in agriculture, a group of farmers seem to base their

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enterprises on continuous diversification, not only in terms of crop species, but also when it comes to methods for product processing and spreading of socio-economic risks. These farmers depend on local markets, which enable frequent face-to-face communication with customers and/or end-consumers. In this paper, we explore the nature of these aspects of diversity and discuss some effects and potential underlying driving forces. Some types of farms are more suited for selling locally than others (Tscharntke et al., 2005). Studies in the United States show that farms with fruit and vegetables are by far the most represented at local markets. Farms that sell locally are also to a large extent certified organic or in practice producing organically though not certified (Tscharntke et al., 2005). Welsh and Lyson (1997) showed that farms that sold on local markets had smaller average herd size, were less likely to use chemical pesticides and fertilisers and also adopted an intensive rotational grazing system that reduced purchased inputs rather than maximised production, in comparison with farmers selling to conventional milk buyers. Furthermore, engagement with customers and other farmers at local markets contributes to social learning, enhancing innovation in marketing and vending and increasing the likelihood of producers diversifying to sell on additional markets.

### **Material and methods**

Both quantitative and qualitative methods were used in this research. Quantitative methods such as transect walks and data from geographical information system (GIS) were used to assess physical features of the farms, e.g. the numbers of crops grown and the mosaic of the farmland and the landscape surrounding the farm. Qualitative methods, mainly interviews and observations, were used to collect physical data and to explore any relationship between the feature of the farms, the perception of the farmers and the characteristics of their selling. The study material comprised six Swedish organic farms, of which three specialise in horticulture; two mainly rear animals (sheep or cows); and one mainly produces cereals and sells mill products. The farms sell locally from the farm gate, at farmers' markets, directly to local grocery stores, schools and restaurants and/or direct to consumers through the Internet. One of the farms is run as a type of Community Supported Agriculture (CSA). The word 'local' was not defined in terms of geographical distance between producers and consumers. We assumed that food systems that enable personal meetings between the actors involved were sufficiently 'local' for the purposes of the study. The assessments of cultivated and habitat diversity on the farms were used in order to decide the degree of planned and associated diversity respectively (Altieri, 1999). Planned biodiversity is the result of the crops and varieties that are grown on the farm, while associated biodiversity describes wild flora and fauna present as a result of the farming practices.

### **Results and discussion**

Local selling was of considerable importance for the economy of the six farms, as it comprised between 40% and 100% of farm income. For all farms, selling on local markets was a way to cut out the middlemen, thereby increasing the possibility to get higher prices for the products. The main factors characterising these study farms, in comparison with average Swedish farms on fertile plains selling the production to middlemen, are that they are relatively small and work-intensive and have a low monetary turnover and generally few purchased inputs. Saying this, one has to bear in mind the large variety of farm size and production methods in Sweden.



The number of different vegetables and the varieties of these grown on the vegetable farms were remarkable. The farmers on one farm grew 169 vegetable species/varieties while another grew 115. For example, one farm had nine different varieties of tomatoes and seven of white cabbage. The planned diversity also affected the size of the fields. The vegetable farmers often chose to separate cropping sequences into two separate sequences managed on separate parts of the farm, in order to secure appropriate growing conditions for all crops in respect to pest regulation and soil demands for different crops. In practice, this meant that larger fields were divided into smaller parts in a permanent mode. In essence, the field area on the vegetable farms was composed of a mosaic of different crops with broad field edges covered with grass. Different vegetables were grown in rows of a couple of metres, providing corridors of crops with different genetic composition and structural diversity. Such corridors are, depending on their character, known to be habitats for certain wild species, conduits for movement, barriers or filters separating areas or sources of environmental effect on the surrounding areas. This mosaic created heterogeneity at field level, making up a diversity of habitats supporting wild flora and fauna.

According to the interviews, the vegetable farmers had a strong interest in diversifying their vegetable production, and the local market made this possible. The farmers gave several reasons for the actual vegetables grown on their farms and the sequence in which they were grown on the fields. This proved to be a combination of the demands that the farmers perceived from the market and their interests and proficiency in optimising the conditions of their farm and enterprises. The actual crops and varieties grown were the result of a combination of the nature-given conditions on the farms and the conditions created by the farmer's marketing strategy for products. The animal-producing farmers proved to have a different diversification strategy, driven by the opportunity to market meat locally and obtain a higher price for added value. These farms did not present any remarkable diversity in crops grown. The average field size was similar to that on other farms in the region (3-5 ha). The contribution to diversity from these farms was instead that by keeping grazing animals, they maintained the semi-natural pastures that are characteristic of the landscape in which the farms are located. In essence they did not produce diversity by what they were growing, but they maintained important diversity associated with their extensive way of rearing animals.

The semi-natural pastures that are maintained by interested farmers and their grazing animals are among the most diverse areas in the Swedish agricultural landscape. Half the threatened plant species on the Swedish Red List (Gärdenfors, 2005) are connected with the agricultural landscape and of these, a large proportion are connected with semi-natural pasture. One reason for rearing animals in this way was that the access to local markets and other alternative ways of sale involved options of communicating added value to consumers and thereby getting a higher price for produce. Therefore it is reasonable to argue that the option of getting paid for the added environmental value of this kind of production at a local market was an important factor for the sustainable management of these semi-natural pastures on the study farms. Without this option farmers would have been forced to choose more intensive or extensive production methods in order to survive. The farmers expressed a complex set of reasons why they chose to grow and sell so many different products. Our interviews with farmers and their customers indicated that consumer feedback was of utmost importance for farmer satisfaction, and one strong reason why they continued, even though it required a lot of work.

## Conclusion

The vegetable farms selling locally in our study introduce small-scale diversity due to the increased motivation to grow a variety of different crops. They contribute to planned diversity at field and farm level, which furthermore adds to wild flora and fauna in the landscape. The farms concentrated on animal husbandry maintain associated diversity due to their production being well adapted to species-rich semi-natural pastures. These pastures run a high risk of being abandoned according to the overall trend of extensification in such areas in Sweden. The farmers were better paid and received a great deal of positive feedback from consumers. Moreover, the farms, situated in a small-scale landscape, suited such kinds of production. The local selling made it possible to stay in business, without increasing in scale, which might be impossible according to the landscape or not commensurate with farmers' preferences. Consequently, selling locally forces them to diversify in order to perform better, as more products to sell:

- Spreads the financial risk, which is essential for the small producer
- Gives more income per customer visiting the market, due to the possibilities of offering more different kinds of products, leading to better income from participating
- Attracts greater numbers of customers, giving better income from participating
- Leads to more positive feedback from customers appreciating the abundance of variety

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# Consumer Appreciation of Carcass Quality of Organic vs Conventional Suckling Lamb Production

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Key words: suckling lamb, carcass quality, meat colour, consumer acceptance.

## Abstract

*Carcass characteristics of suckling lambs (n= 40) of two breeds reared under conventional and organic conditions were analysed including objective and subjective parameters for fatness and conformation, meat and fat colour. Consumer acceptance was also studied using the home-use test. Results showed that the characteristics of the carcass of suckling lamb were similar for both types of production systems pointing out that organic production system did not affect fatness or muscle development. However, organic meat was darker (higher L\* and a\* values) probably related with the higher amount of exercise, although fat was not more yellow. In contrast consumers did not consider organic meat darker and there were not significant differences in appearance related with the similar conformation. These results reflect that consumer perceive organic meat as at least as good as conventional production not only regarding environmental quality but also regarding carcass quality.*

## Introduction

Organic meat production is supposed to use ecological resources, such as natural grass-lands and by-products with low alternative value. For organic meat production to expand in a sustainable way, consumers must perceive it as at least as good as conventional production regarding environmental quality and price.

Grazing and exercise which are part of the organic farming management system may produce darker meat and yellow fat (Nielsen et al., 2005) and also affect muscle conformation and carcass fatness. Suckling lamb carcass quality has traditionally been mainly based on weight, fatness, meat and fat colour. The visual aspect of a carcass, described as previously mentioned, is one of the most important attributes. This is the first characteristic seen by the consumer, and it has a direct influence on the acceptance of the product. Information has been obtained on the effects of breed, sex or carcass weight but to our knowledge, no scientific work has dealt with any suckling lamb organic carcass characteristics, despite the advantages of having well characterized quality label meats. Indeed, there are not studies that correlate objective

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determination of carcass quality and the consumer acceptance. Taking it into account, the aim of this work was to compare both types of production systems for suckling lambs in terms of carcass quality, including colour, to study the correlation of this parameters with the consumer appreciation and to determine consumer preferences between organic and conventional suckling lambs.

## Materials and methods

The material included 40 suckling lambs, ten animals per production system (organic or conventional) and breed, of two Spanish sheep breeds (Churra and Castellana) all of them from the same production area (Fariza, Zamora, Spain). Suckling lambs did not receive any kind of feed and were raised exclusively on maternal milk from birth to slaughter. The suckling lambs reared under organic conditions spent the day at pasture with their dams; however lambs reared under conventional conditions remained in a dry lot where their dams were fed with commercial concentrate. The animals were slaughtered according to current legislation, in abattoirs licensed, inspected and certified by the Castilla y León Organic Agriculture Conceal (CAECYL). Carcasses were chilled under commercial conditions at 4°C and 80% HR for 24 hours.

After chilling, the carcasses were weighed (CCW, cold carcass weight). Fatness were subjectively assessed (FS) using a scoring system that took into account the carcass as a whole (1-4 points) (EEC Regulation n° 461/93). Conformations were also subjectively evaluated (CS) using the scoring system suggested by Colomer-Rocher et al., (1988) (1-5 points) according to photographic patterns. To determine objective carcass conformation, the following measurements were taken on the whole and half carcass: carcass external length (K), carcass internal length (L), pelvic limb length (F), buttock length (G), buttock perimeter (BG), chest width (Th) and chest circumference (U). Meat and fat colour were measured on 72 h aged carcasses with a MiniScan XEPlus (Hunter Lab) with a 25 mm measuring head and diffuse/8° optical geometry. L\* a\* and b\* were recorded with a D65 illuminant at a 10° standard observer in the CIELab space (CIE, 1976). Meat colour was measured on fat free surface of the m. *L. thoracis* (between 8<sup>th</sup> and 9<sup>th</sup> ribs) after 1 h blooming at 4°C and fat colour was determined on fat-cover of the left loin.

The affective analysis was carried out using a home-use test (Lawless & Haymann, 1998) involving 35 families (4 to 5 members) coming from the province of Zamora. Three-day aged half carcasses were delivered to each family with a questionnaire from where assessment characteristics of meat were collected. A 9-point hedonic scale, in which 1 corresponded to "I don't like it at all" and 9 corresponded to "I like it a lot" was used to measure the global relative preferences for the samples. The attributes assessed by consumers in fresh meat were general appearance, meat colour, colour and appearance of fat and inviting to eat.

Data of each variable were analysed by one-way analysis of variance (ANOVA). The statistical significance of factor considered (sample) was calculated at  $\alpha=0.05$  level using the *F*-test. In tables and figures, different letter (<sup>a,b</sup>) means statistically significant differences at  $\alpha=0.05$ .

## Results and Discussion

Table 1 contains the objective conformation values that fall within the range of those reported for several Spanish breeds (Miguélez et al., 2007). Production system, in general, did not significantly affect these parameters except for chest width (Th) that

were significantly higher for organic suckling lambs, however chest circumference (U) did not show significant differences. Regarding subjective conformation parameters, fatness scores (FS) and conformation scores (CS) were higher than those reported for suckling lambs (Díaz et al., 2003) and were not affected by production system. These results revealed that organic production system, characterized by higher amount of exercise, produced similar muscle conformation and did not implies less fat as milk diet is associated with greater animal fatness.

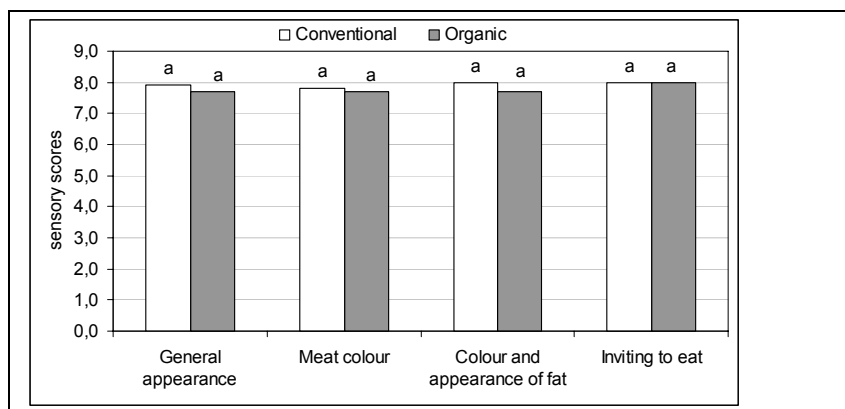
**Tab. 1: Means for subjective and objective carcass measurements, fat and meat instrumental colour of conventional and organic suckling lambs**

Carcass parameter	Conventional	Organic	Colour	Conventional	Organic
CCW	6.0 <sup>a</sup> (0.7)	6.1 <sup>a</sup> (0.5)	L* (fat)	75.6 <sup>a</sup> (5.9)	73.8 <sup>a</sup> (6.2)
K	49.1 <sup>a</sup> (2.0)	48.3 <sup>a</sup> (1.6)	a* (fat)	2.2 <sup>a</sup> (1.2)	1.9 <sup>a</sup> (0.9)
L	43.1 <sup>a</sup> (1.8)	40.9 <sup>a</sup> (6.8)	b* (fat)	11.0 <sup>a</sup> (2.6)	10.1 <sup>a</sup> (2.5)
Th	19.0 <sup>a</sup> (1.2)	19.9 <sup>b</sup> (1.0)	L* (meat)	53.3 <sup>b</sup> (5.0)	51.1 <sup>a</sup> (3.1)
U	46.7 <sup>a</sup> (2.9)	46.2 <sup>a</sup> (1.6)	a* (meat)	11.2 <sup>a</sup> (2.6)	12.8 <sup>b</sup> (2.3)
BG	38.9 <sup>a</sup> (2.1)	39.0 <sup>a</sup> (2.0)	b* (meat)	16.8 <sup>a</sup> (1.2)	16.5 <sup>a</sup> (2.0)
G	12.0 <sup>a</sup> (0.9)	11.9 <sup>a</sup> (0.8)			
F	29.0 <sup>a</sup> (1.4)	28.2 <sup>a</sup> (6.1)			
FS	2.3 <sup>a</sup> (0.8)	2.3 <sup>a</sup> (0.7)			
CS	1.95 <sup>a</sup> (0.68)	2.0 <sup>a</sup> (0.64)			

<sup>a,b</sup> Different letter means statistically significant differences at  $\alpha=0.05$ .

In contrast, significant differences were observed for instrumental colour parameters of meat. Organic meat showed significantly lower values for L\* (Luminosity) and higher values for a\* (redness), pointing out that this meat was darker than meat produced in conventional systems. As above mentioned, the exercise is part of the organic farming management system and it may produce darker meat and yellow fat but in this case no significant differences were observed for fat colour parameters.

Regarding consumer appreciation of raw meat, Figure 1 shows the results of the affective test carried out. Organic meat had lower values for some of the parameters but the differences were not statistically significant for any of them, agreeing with the lack of differences observed for the carcass fatness and conformation. Spanish consumers prefer very pale meat that is related with milk feeding and although organic meat was darker, consumers considered it as good as conventional because both were very pale.



**Figure 1: Sensory scores for the parameters evaluated by consumers in raw meat. <sup>a,b</sup> Different letter means statistically significant differences at  $\alpha=0.05$ .**

### Conclusions

The characteristics of the carcass of suckling lamb determined in this work were similar for both types of production systems pointing out that organic production system did not affect fatness or muscle development. However, organic meat was darker probably related with the higher amount of exercise, although fat was not more yellow. In contrast consumers did not consider organic meat darker and there were not significant differences in appearance related with the similar. These results reflects that consumer perceive organic meat as at least as good as conventional production not only regarding environmental quality but also regarding carcass quality.

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# Producers and Consumers Relationship Strategies in the Organic Market in Brazil

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Key words: Organic consumers, network organic farmer, consumers organization

## Abstract

*The paper deals with marketing strategies in different sales channels and organic producers and consumers relationship. The empirical study was conducted on 41 organic horticultural farms in 16 municipalities within the Curitiba Metropolitan Area, Paraná, Brazil. Two types of farmers were identified: 1-Rural, with origins and life trajectories in the rural area and 2-Neorural, with urban area background having migrated to the rural milieu. Farmers who sell directly to consumers use more than 3 marketing channels, their production systems are diversified (+ than 20 products), management is complex and the farm is versatile (inn, restaurant, pick-and-pay, rural tourism) and producer/consumer relationship is bigger. Integrated farmers (indirect sales) have only one sales channel. Farmers follow production plans from the buying companies and the output is marketed through supermarket chains. Farming systems are simple (- than 5 products) and relationship with consumers is insignificant. Events such as visit to organic farms, advanced buying, producer/consumer direct credit and organic farming courses or field days, have strengthened producer/consumer relationship and provided consumer support to an organic farms network.*

## Introduction

Most of the Metropolitan Area of Curitiba (RMC) (56%) is destined to environmental preservation, especially water supply source areas, therefore it is particularly suitable for sustainable agriculture undertaking. Since 2000 the number of organic farmers has risen (50%) and demand for organic products increased (35%). Besides, marketing channels and spots have also increased (Darolt, 2002). In this context, the study of strategies to approach rural and urban communities can encourage direct organic production marketing and redirect farms toward more sustainable and diverse agricultural activities. Also, there is a need to stimulate conscious consumption, to provide the perspective of fairer markets and to create new marketing channels.

This study also intends to appraise initiatives including organic consumers support to organic farms networks and to propose public policies directed towards agroecological farming.

## Material and methods

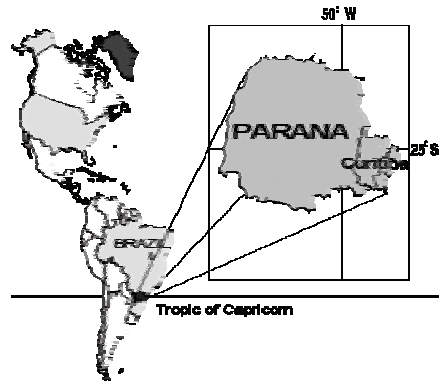
The study was based on the farming systems approach mixing quantitative and qualitative research using structured questionnaires for farmers and consumers and

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interviews with key informers. An overall study of the area concerning its organic farms and marketing places was made first (Fig. 1).



**Figure 1: Study area with counties in the Metropolitan Area of Curitiba, Paraná, Brazil**

Forty one organic farms were first selected from a total of 300 according to the following criteria: 1. direct sales to consumers; 2. certified organic farms (group or individual); 3. farms visited by the local organic consumers association in recent years; 4. farms participating in local rural development circuits or associated to formally organized groups (association, cooperative); and, 5. farms that were representative of the regional organic farming practice. Each farm had to comply with at least three of the criteria. Finally, thirty farms, those with the more complete set of data, were selected to be closely studied.

Farms were diagnosed using data collected through the questionnaires concerning their technological, social, ecological and economic historical path. Then farmers were typified according to their origins and life trajectories and marketing strategies they employed.

Evaluation of the strategies used by the Organic Consumers Association of Paraná (ACOPA) in its relationship with regional organic farms was done at the same time. This was accomplished through organic consumers visits, when they were able to get familiar with the production systems and even to suggest improvements. The exercise proved useful to establish farms networks and to improve consumer/producer relationship.

## **Results**

Farmers typology in Paraná, Brazil are shown in the following table 1.



**Tab. 1: Category of organic farmers from Parana, Brazil**

Attribute	Rural	Neorural
Origin	Life trajectory in the rural environment. Former conventional farmer who migrated to organic farming due to personal and economic reasons	Life trajectory in the urban environment. Migration to the rural area searching for a sustainable way of life based on organic farming

Source: Based in Karan (2001)

Collected data show basically two channels of consumer/producer relationship when it comes to market strategies (tab. 2).

**Tab. 2: Organic market strategies compared**

Characteristics / Channels	Direct Sale	Indirect Sale
Sales	Emphasis on local production and consumption (fairs, delivery, on farm sales, small shops, restaurants, lodges, farmer markets) (more than 3 channels)	Emphasis on supermarkets
Number of products (farming system)	20-40	3-5
Consumer relationship	Close	Distant
Form of payment	In cash or short time	Long time (30-60 days)
Family labor	High	Low

#### **Consumers attitudes to get closer to the organic farmers**

Some consumer attitudes help to improve their relationship with organic farmers:

- Farm visits to get acquainted to the production system
- Organic horticulture courses to consumers
- Festive and/or field days at organic farms
- Farmers credit support
- Advanced buying Pick-and-pay

Increasingly, urban dwellers are coming back to the countryside for leisure and re-discovery of regionality and traditional food cultures. Furthermore, organic farms within or near protected areas offer ecotourism and rural hospitality activities. More and more organic farmers are becoming involved in agritourism or local catering of specialty food (Scialabba, 2007).

#### **Discussion**

Organic farmers who sell directly to consumers employ diversified production systems growing diverse products (an average of more than 20 food crops) and have a

complex and autonomous system of farm management. They undertake several activities beyond farming (rural tours, sightseeing tours, lodge and restaurants) as additional cash sources. It seems that research and extension agencies have to think about urban consumers when dealing with options to small farmers.

Direct sales imply more diversified farming systems sometimes including non-agricultural activities. It also may mean stable incomes but a more complex production system. Farmers who work associated with companies (indirect sales) have smaller autonomy. Companies dictate production systems selling the output to supermarkets chains. Farmers must achieve production scores. Production systems are simpler (-5 products). Farming systems logic is very similar to conventional agriculture valuing more the economics aspects than social and ecological ones. As a result these farms are less attractive to consumers. These findings show the lack of public policies encouraging consumer/producer relationship as well as the absence of educational strategies valuing organic farming. Reference indicators provided by consumers related to these aspects also do not exist. According Farnworth (2004) an interactive learning process between producers and consumers is key.

## **Conclusions**

The research has shown that organic farmers interested in strengthening direct relationship with consumers have to consider other possible functions for the farm (landscape, tourism, gastronomy, amusement and sport), beyond agriculture. Another finding is that urban consumers have to be considered in the rural development process.

Direct sales are related to diversified farming systems as well as with farms with different economic activities beyond agriculture. Farms are ecologically and socially stabler and more attractive to consumers and their visits. On the other hand farming systems are more complex and laborwise costlier. They are also technically and economically less efficient.

Integrated farmers who choose indirect sales need less labor and are more specialized growing fewer products. Thus, farming systems are simpler and similar to conventional ones, being more efficient both technically and economically. It is believed that these characteristics make them less attractive to consumers visiting.

Public policies should create programs to train farmers in public relations so that they could better host and sell directly their products to organic consumers. These farmers should also be prepared to undertake other economic activities beyond agriculture thus diversifying their sources of income. Finally, organic farmers should be able to explain their farming systems to consumers who want to be more familiar with them.

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# Food for Thought about Environmental Values and Food Demand

Henseleit, M.<sup>1</sup>

Key words: Environmental Preferences, Consumer, Labelling.

## Abstract

*It is a controversial discussion whether consumers are taking care of environmental issues when buying food. This question seems to be of significance to understand the demand for organic products, and thus many investigations have been made in this field. However, no strong relationship between attitudes and knowledge about environmental issues on the one hand and consumption behaviour on the other hand could be confirmed yet, and still there is a gap in thorough understanding of the demand for eco-friendly produced food. In this text it is discussed to what extent people are both willing and enabled to consider environmental footprints in their food choice by applying recent surveys of environmental preferences and food labels.*

## Introduction

Research into attitudes towards environmental concerns as well as investigations of the willingness to pay for environmental goods and services usually show a high level of awareness of environmental issues. In contrast to that, many investigations conclude that most consumers are taking environmental issues rarely into consideration when shopping for food, whereas only a minority<sup>2</sup> consider ethical factors regularly (Thøgersen 1999; Birner et al. 2001; Halkier 2001; Verbeke and Vermeir 2006; Codron et al. 2006 and many more). The majority of investigations on this subject are based on the demand for organic products. Usually social and psychological factors, and in particular peoples' attitudes and concerns, are focussed because they are deemed important, if not even the main factors for the choice of organic products (Lintott 1998; Weber 1999; Belz 2001; Rubik and Frankl 2005; Honkanen et al. 2006). In some studies environmental concern has been found to be a major determinant of buying organic food (for example, Brombacher and Hamm 1990; Van Dam 1991; Grunert 1993; Honkanen et al. 2006). Indeed, many studies, and in particular the more recent, come to the result that health concerns are more important than environmental values (e.g. Sirieix and Schaer 1999; Halkier 2001; Bruhn 2001; Codron et al. 2006; European Commission 2007; Nocella et al. 2007). Accordingly, the critical question remains, whether consumers are both willing and enabled to turn their expressed interest in environmental problems into actual purchasing habits (Martin and Simintiras 1995; Weber 1999; Torjusen et al. 2004; Vermeir and Verbeke 2006).

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<sup>2</sup> However, the categorisation of consumers depending of stated or revealed environmental consciousness has to be regarded carefully as it is often based on the attachment of meanings on some variables. Thus it may be the same as the basis for the segmentation, so that the results become merely tautological (Torjusen et al. 2004, 32). Therefore, the categorisation is itself an interpretation and may be a useful basis for strategic marketing decisions, but it is not suitable for the explaining or understanding of the changing patterns of consumption in the longer term.

## Materials and methods

Food production usually goes along with multiple impacts on the environment. In order to discuss the question, whether ecological side-effects could change the value of products in the view of consumers, preferences in the form of stated willingness to pay values for environmental goods are considered. It is also discussed how far consumers are enabled to regard environmental preferences easily when buying food.

The environmental impact of food production, processing and consumption can be described as a summation of influences on environmental goods and values like water, soil, air, climate, structure of landscape, genetic resources and non-renewable resources. In the following table willingness to pay values from selected representative environmental valuation studies are given. In order to ease the comparison, monetary values are converted into US \$ per household per year by applying the consumer price index (CPI) of 2000. Only the data for farm animal welfare is weekly.

**Tab. 1: WTP for environmental values**

Landscape	Species	Water, Soil, Air, Climate	Animal Welfare
Agricultural landscape: \$ 340 (Drake 1992, SE) \$ 100 (Tronstad 1993, NO) \$ 256 (Roschewitz 1999, CH) \$ 68 (Brink et al. 2000, various) \$ 46 (Moran et al. 2004, UK) \$ 46 (Bonnieux, Le Goffe 1997, FR) Open landscape: \$ 15 (Sirex 2004, FR) \$ 112 (Ollikainen et al. 2004, FI)	Preservation of endangered species: \$ 144 (Holm-Müller 1992, DE) \$ 106–209 (Hampicke 1991, DE) \$ 130 (Brink et al. 2000, various) Single species: \$ 5–126; Multiple species: \$ 18–194; Ecosystems: \$ 27–101 (Nunes et al. 2001, various). Enhanced biodiversity: \$ 14 (Travisi et al. 2004, various)	Groundwater Quality: \$ 65-1,341 (Boyle et al. 1994, US) \$ 209 (Brouwer et al. 1997) Nitrate free drinking water: Reduction of 50%: \$ 58-77; Additional complete reduction: \$ 0.1–10 (Crutchfield et al. 1997, US) Fresh water quality: \$ 97; Riverine quality: \$ 113 (Brouwer et al. 1997, various) Small improvement: \$ 13; Medium improvement: \$ 32; Large improvement: 48 US \$ (Bateman et al. 2006, UK) Soil conservation programme: \$ 18.5–34.5 (Colombo et al. 2006, ES) Air quality: Reduced - harmful substances: \$ 360 (Diener 1999, CA) - toxicity of vehicle emissions: \$ 112 (Bateman et al. 2002, UK) Address problems of climate change: \$ 252 (Curry et al. 2007, US)	Raising welfare standards of veal and hens: \$ 13.42 Ban on egg cages: \$ 1.60 Slaughtering pigs more humane: \$ 4.68 (Bennett et al. 2002, UK) Improvements for - laying hens: \$ 4.24; - dairy cows: \$ 4.15; - chickens: \$ 3.78; - pigs: \$ 3.02 (Burgess et al. 2003, UK) Price premium for animal friendly products: \$ 12.73 (Nocella et al. 2007, various)

Source: Own Compilation

Stated willingness to pay (WTP) often diverges highly within the same environmental amenities. Monetary values for the prohibition of negative environmental externalities and, respectively, for the supply of positive ones can be biased due to several reasons, like, for example, embedding and prior information. Differences in WTP values can be caused by survey methods and in particular by the payment vehicle, but also by the question format or by the way of sample selection. Accordingly, WTP answers can hardly be treated as absolute values in economic calculations. However, stated preferences can be intended to some extent for comparison purposes as well as an indication that people do hold significant values for such environmental goods (Bateman et al. 2002, 39).

## **Results**

Not surprisingly, people seem to be first of all willing to pay for the prevention of threats to vital resources like climate, water and air. Also farm animal welfare and the omission of chemicals in general are valued highly, as they may affect the quality and safety of food directly. However, issues which mainly provide non-use values in the view of consumers are of importance as well, likewise due to a desire to prevent rare goods from deletion. This motivation may be driven on the one hand by moral values (like, for example, the right to live for every creature) and on the other hand by risk aversion, which means that people are afraid about losing something forever.

Regarding WTP values for environmental goods and the basis of information on which consumers are choosing food products, there seems to be potential to affect the food market by applying sustainable production techniques combined with reliable product information. An alternative to do so would be to introduce more informative eco-labels in order to gain consumers' trust and to assure demand in the long run. Currently consumers buy organic food mainly because they think it is healthier. As long as there is no evidence, that organically produced food significantly provides higher health benefits, there remains the risk that simply the criterion 'organic' will lose its power as a sales argument. Therefore, it could be useful for certified organic products to provide more information about environmental impacts. This could provide an opportunity for suppliers to differentiate from competitors by applying technologies which are less harmful to climate, water and other environmental goods and which imply improved farm animal welfare.

## **Discussion**

An obvious way to emphasise comparatively low negative impacts of food products for the environment is product labelling. However, several important questions need to be considered in terms of eco-labelling. First of all, a necessary condition for the spread of moral environmental reasoning to buying decisions is that characteristics, which connect the purchase to environmental problems, become salient in the buying situation. This means, other characteristics of the purchase should not be too highly involving and thus not 'monopolize' the attention of the consumer as it is usually done by the price. Additionally, the individual should feel a high degree of concern for an environmental issue that is associated with the particular buying decision (see also Thøgersen 1999, 441). It is also important to consider the amount of information people can take into account when purchasing food. Usually consumers don't spend much time for daily shopping, because food is a low-involvement good. Thus, only a limited number of product characteristics are crucial for the buying decision. Also the level of knowledge about environmental risks and issues is very different across

people. Therefore, the kind of information given about environmental impacts and its way of presentation has to be elaborated carefully in order to convey benefits of sustainable food production and processing methods.

Finally, it appears to be important to anticipate the abuse of 'green' claims and misleading advertising, because consumers' confidence in environmental certificates still needs to be consolidated (Martin and Simintiras 1995, 17; Karstens and Belz 2006, 189). Hence, consumers often are distrustful if products labelled as 'organic' indeed are produced according to the rules of organic farming. Also the use of pictures and images on products and for promotion is quite often misleading. For example, many dairy products have lucky cows, green meadows and flowers on the package although the milk comes from industrialised farming systems without free range. Since these symbols stand for animal welfare, healthy nature and nice scenery, consumers don't get the right impression about the conditions of production.

## **Conclusions**

Labelling concerning ecologically sound production and processing methods is probably most effective when these characteristics are seen as an indicator of product quality. On the one hand, this can stimulate the demand, but on the other hand, intangible characteristics like a reduced application of pesticides and fertilisers can become experience attributes in this way, which means that expectations can be confirmed after purchase. Such an association can possibly raise potential barriers for increasing demand because consumers could reject their perhaps unrealistic expectations regarding, for example, better flavour or positive health effects of eco-friendly products after consumption. Thus, marketing experts should communicate eco-friendly characteristics with a maximum of transparency, but without creating unrealistic expectations.

Indeed it remains to be seen if the labelling of environmental impacts will have an influence not only on the product choice of ethical consumers, but also on the consumption behaviour of the mass market. Further research is necessary to understand consumers' conception of environmental sustainability, quality and healthiness. The effects of more transparency in terms of externalities of food production, as well as labelling strategies, have not been studied very well so far and thus more investigations are required

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## **Marketing from multiple perspectives**



## Local food networks and the change of the agrofood system

Lamine, C.<sup>1</sup>

Key words: food systems, consumers, food democracy, system redesign, trajectories

### Abstract

*Can alternative local food networks, through the relocalization of production and consumption and the higher proportion of organic practices, bring significant changes in the agrofood system? Drawing on the case of French Amaps, the distinction between an “input substitution paradigm” and a “system redesign” paradigm, which is at the crossroads of agricultural and social sciences, will help to assess the changes which occur in consumers and producers practices and in their interactions.*

### Introduction

AMAPs are CSA-type box schemes which emerged in south-eastern France in 2001 and gather in mid-2007 about 500 different groups all over France. They take the material form of weekly boxes composed of diverse agricultural products (most often, fruits and vegetables) grown “without using pesticides and chemical fertilizers” (the organic certification is not compulsory even though farmers should obey organic rules). Basic principles are the long-term subscription and the variability of the assortment, with consumers being unable to select their products. A stable price is set in advance, in principle based on farm costs and incomes, and the boxes are paid for before the beginning of the season. Behind these common principles, the systems are quite diverse: they include one or several producers, only fruits and vegetables or also meat, eggs, honey, cheese or other transformed products. Each AMAP is generally a specific organisation created by the consumers to run the system and take in charge part of the distribution tasks.

AMAPs belong to local alternative agro-food networks (AFNs), which also include farmers' markets or shops and many cooperative forms and can be defined through what they contest, i.e., deregulation, globalisation, and/or degradation of agroecosystems; and what they defend, i.e., a construction of trust based on direct relationships and the relocalization of production and consumption.

In the social sciences, many studies have analysed these AFNs ambition and potential to create meaningful change in the food system. Some consider they are more oriented toward developing new alternatives for consumers in a more diverse food system, than toward changing the dominant food system (Allen et al., 2003). Others analyse the relocalization of food systems as rather defensive and being possibly part of what may be called a neoliberal governmentality (DuPuis et Goodman, 2005). Finally, more “optimistic” analysts try to overpass the tension between the alternative potential of these AFNs, which relies on a pragmatic and incremental way of acting, and their oppositional potential, which supposes more classical political action, by suggesting the notion of food democracy (Hassanein, 2003).

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On their side, biological and agricultural sciences have suggested a distinction between an "input substitution paradigm" and a "system redesign" paradigm (Altieri et Rosset, 1996). The first paradigm defines organic farming as the ban of certain inputs and/or the recommendation of others (list of non chemical methods to "fight against" pests and diseases). The second one defines organic farming in a more qualitative way and refers to the construction of diversified production systems following the ecological model considered as the "natural" one, where interactions between components guarantee fertility, productivity and resilience properties. These paradigms could help us assessing the changes occurring at different levels of the food chain in the case of AMAPs.

## **Methods**

The empirical data was collected through a hundred in depth interviews of horticultural producers and consumers lead between 2002 and 2007 and through an ethnographic analysis of these initiatives based on observations (e.g. distribution of the boxes, interactions between farmers and consumers, farm visits) and participation to various meetings of their network at regional level between 2004 and 2007. The interviews combine a life-story approach and a more systematic review of the different changes occurring in the food and production practices. The notion of trajectory is used in order to describe the changes in patterns at three levels: consumers, producers, and the systems and organisation that link them through these box schemes.

## **Changes along consumer and producer trajectories**

For consumers, belonging to such a scheme might involve minor changes in the food practices. One could perfectly eat the same kind of products, cook them the same way, and not change much to his provisioning patterns beyond the box itself. We could then talk of a mere substitution in provisioning patterns and in products, with the replacement of non organic products by organic ones. However, nearly all consumers talk of profound changes in their practices and in their diet, much more than in other short circuit schemes like farmers market or producers shops. One of the reasons might be that in these networks, there is a large diffusion of some strong arguments regarding the alternativeness of the scheme. Indeed, as the content of the box is imposed and variable, consumers have to cook according to what they get each week. Most consumers also consider they eat more vegetables since they entered an AMAP. Moreover, once there, they often get interested in other alternative food systems such as fair trade. This would suggest a possible redefinition of food practices which takes place over time and is favoured and facilitated by the diffusion of values, arguments and information across the networks as well as the access to new circuits.

On producers side, trajectories were depicted as temporal organizations with successive phases whose boundaries are specific events, decisions or changes. The trajectories were formalized through a comprehensive sketch combining the main changes regarding technical and managerial dimensions, marketing, learning processes, and interactions with consumers. This allowed the comparison of the different cases and their analysis from a combined agronomical and sociological point of view. The analysis of these trajectories showed that conversions to OF can be more direct (for example following a health incident or economical difficulties) or more progressive (when a former rupture with conventional agriculture was to be identified long before conversion to OF was considered) and that a decisive aspect of these trajectories, and especially of their progressiveness, was the issue of plant protection.

In this regard, the two paradigms of substitution and redesign can describe different trajectories or different moments in the farmers trajectories. Some farmers replace forbidden inputs by eligible ones but remain in the aim to “fight against” pests and diseases: “*We do not use the same products, but we do the same treatments*”. Others would redefine things more globally and consider “*that a new ecosystem can rapidly appear as there is no chemical intervention*”, aiming more at doing “with” pests than at fighting against them. In this paradigm of system redesign, interactions between techniques and the components of the “agro-eco-system” have to be built so as to enhance natural regulation processes and partial or indirect effects. A third intermediary paradigm is also observed, in which substitution (of conventional chemical by organic inputs) was followed by a reduction of these organic inputs themselves. All the dimensions of the trajectories are linked in such evolutions: the adoption of such a box scheme gives the farmer a guarantee of income which allows him to take certain technical risks, especially regarding plant protection, and in some cases, to turn to organic. Indeed, the changes do not only concern agricultural practices, but also marketing choices (table).

Agric. Practices ->	Already certified	Turned to OF	Non certified
	46%	19%	35% (half are considering conversion to OF)
Marketing choices->	Already in short circuits before	Gave up long circuits	Combine short and long circuits
	47%	36%	17%

Source: survey among 54 Amap vegetable growers in Provence, 2006

### Redefining the agro-food system?

Beyond these changes along consumers and producers trajectories, how can these schemes contribute to larger changes in the agro-food systems? This question is hardly tackled in these networks, even though it is very central as a claimed aim. Several possible types of changes can be identified and are partially experimented: 1/ enlarging the number of involved consumers (and producers); 2/ enlarging the number of different products in each scheme and box; 3/influencing the dominant system through the creation of hybrid schemes or approaches; 4/ influencing the definition of public policies at different levels.

The two first possibilities aim at going beyond the current “niche effect” and relate to the substitution paradigm. The third one might be closer to the redefinition paradigm but for the time being, it emerges rather from outside these alternative systems. For example, many similar box schemes are now proposed by more “conventional” food chain actors such as organic wholesalers and do not include any direct commitment and links between producers and consumers. In France, the fact that many extension structures have recently acquired competences in short circuits might also be considered as an effect of such initiatives on the dominant agrofood system, even though it is often perceived in terms of “recuperation” in the alternative circles. Finally, the fourth mode of change combines substitution and redesign. For example, some AMAPs try to have local schools or hospital establishing contracts with their local producers, which means a substitution in their sourcing practices but also a potential redefinition of local policies. Another possible effect, which goes beyond the question of food production and consumption and towards potential redesigning effects, is the participation of such local networks to local or larger environmental and land use issues. The necessity to fight for a common (threatened) environment through civic

engagement and “civic agriculture” might indeed be more involving than the mere acquisition of a weekly box of vegetables.

### **Changes at the interface between production and consumption**

Even though AFNs often appear very ambitious regarding their possible effect on the agrofood system, it might be more modestly at the interface between producers and consumers in local groups that some effective change can occur. In the AMAPs, the principle is that consumers negotiate collectively the process of production (e.g., the content of the box over the growing season, the choice of crop varieties, etc.) with the farmer(s) as well as the system of distribution, which allows them to take part in decisions which they are ordinarily excluded from. Such negotiations are made possible through learning processes of both farmers about consumers' taste and culinary uses, and of consumers about farmers' production and distribution constraints. This allows for a re-skilling of consumers which is a reaction to the consumer deskilling achieved by the corporate system (Jaffe et Gertler, 2006). The decision to ask for organic certification might be discussed in the case of non organic farmers and the consumers might propose to pay for the costs or might decide, together with “their” farmer, that trust rely on proximity and direct relations more than on any label. Such an issue rarely leads to a conflict at local scale but has been a major source of conflict at regional scale. In Provence, the AMAP network is currently elaborating a participatory certification scheme so as to solve this (Lamine, 2008).

### **Conclusion**

By establishing strong commitments between consumers and producers, AMAPs intend to redefine both the consumption system and the production system. The study of their networks over a 5 years period of time shows that not only substitution but also redefinition processes can be observed along time both in farmers and in consumers practices as well as in their interactions. However, such changes are mainly visible at the scale of local groups and the conditions of an “upscaling process” are still unclear. It will be necessary in the future to follow the trajectories of such initiatives....

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# Direct marketing of beef in organic suckler cattle farms: economic results and impact on breeding system management

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Key words: beef, suckler cattle, direct marketing, organic farming

## Abstract

*In response to the bovine crises of 1996 and 2000, and also to the poorly structured organic beef market chain, direct marketing of beef to consumers by the farmer has developed. We studied the impact of this marketing system on economic performance and farming practices. The results show that direct marketing can generate added value, despite the extra costs. Farmers have made the necessary changes to their practices, and have adapted their herd management. Through strengthening the link between the farm and the outside world, direct marketing offers an alternative to the expansion of farms, making it possible to support a greater workforce with the same structure.*

## Introduction

In the last ten years several crises have occurred in the beef market chain (BSE). These crises caused a temporary drop in French consumers' confidence and a collapse of meat prices paid to the producers. To try and control the risk of price fluctuations, and also to make better use of extensive animal production from grasslands, which enjoyed a good image, some farmers chose direct marketing of meat (Lozier et al., 2005). Direct marketing (DM) of beef is still marginal in France, concerning only 0.8% of the national market. Beef from organic farming (OF) -certified farms represents only 1% of the domestic market, while only 1.6% of suckler cows are OF-certified. More than half the animals produced from OF suckler cattle are not sold on the organic market, owing in part to the poorly structured OF beef marketing chain (Veysset et al., 2006). OF beef producers turned massively to direct marketing to find an outlet for their production with a remunerative price. Direct marketing now represents 22% of the organic beef market (Agence Bio, 2007). The objective of this study was to assess the impact of direct marketing on economic results and farming practices for both OF and conventional suckler cattle farms.

## Materials and methods

Direct marketing is taken here to mean the sale to consumers of meat from farm animals.

Surveys were carried out in 20 private suckler cattle farms in central France. These farms were specialised in beef production, with cow-calf and finishing systems (Limon, 2006). The sample covered the full diversity of the systems: (i) organic and

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conventional (Conv.) production systems, (ii) range of animals sold (calves, steers, bulls, heifers, cows) and (iii) butchery management either internalised (carried out on-farm in a specific building) or externalised (carried out off-farm by a service provider).

Interviews were used to determine the type, number and weight of the animals sold on-farm. The selling price to customers and all the costs and investments directly related to the DM were identified. The husbandry pattern and the management of the animals to be sold on-farm were described by identifying, jointly with the farmer, the changes made by category of practices (feeding, reproduction, replacement, range of animals, calendar sales). We used multivariate analysis to assess the consistency of the change processes.

Lastly we collected data on the organization of this activity and the estimated labour time requirements from slaughter to market.

## Results

### a) Sample and range of animals sold

Twenty cattle farms were surveyed, comprising 8 farms with OF and 12 farms with Conv. system. Table 1 shows the main structural characteristics of the farms, and the range and number of animals sold on-farm.

OF farmers sold more young animals by DM; 44% of the animals sold on-farm were calves (25% for Conv.). For adult sales, OF sold as many males as females, while Conv. sold predominantly females on-farm. The males from the French suckler herd were mainly sold as stock animals for the Italian market. There is no organic market for this type of animal; the organic farmers have to fatten their males if they want to sell them on the organic meat market.

**Table 1: Size of farms, and range and number of animals sold by direct marketing**

	Area (ha)	Calving (nb.)	Animals DM (nb.)	Animals DM (%)	Animals sold DM (number/year)					kg carcass DM
					Cows	Heifers	Steers	Bulls	Calves	
OF	99	39	16	44	3	2	4	0	7	4 491
Conv.	150	94	24	25	6	9	2	2	5	7 686

### b) Economic results

The average selling price charged by the farmers was 9.8 €/kg for meat from adults and 12.9 €/kg for veal. These prices were close to those charged by the supermarkets for beef (9.9 €/kg) and below those charged by butchers (14.1 €/kg). The OF label permitted an added value on the retail sale price of about 20% for adults and 7% for calves, although according to the farmers, the customers valued the direct link with the farmer more than the OF label.

The selling prices of the animals per kilo of carcass, were 7.3 € and 9.2 € respectively for OF adults and calves (6.1 and 8.3 €/kg for Conv.).

The average specific costs linked to the DM amounted to 1.92 €/kg carcass distributed over three major items: (i) transport of animals and meat: 0.23 €/kg carcass, (ii) slaughtering, butchering, processing, depreciation of butchery unit: 1.56 €/kg carcass,

(iii) water, electricity, administrative management, advertising: 0.13 €/kg carcass. We did not differentiate between OF and Conv., because these costs were not linked to the production system but mainly to the butchery management. However, we note that the transport costs were 0.14 €/kg carcass higher for OF owing to a shortage of OF-certified slaughterhouses, resulting in longer transport distances.

The threshold for the minimum volume of meat enabling the farmers to invest in specific butchery equipment was 8 tons of carcass per year, equivalent to 20 adult animals (400 kg carcasses).

Table 2 shows the net prices (€/kg carcass), which are the differences between selling prices and direct costs. Overall, in DM, OF adult animals earned an added value of 18% compared with Conv. We did not observe this added value for OF calves, because conventional calves have high value in DM.

Comparison with the classic marketing chain was made on the basis of the 2005 conventional market prices. The OF market being poorly structured, we could not indicate average OF prices. DM generated an average added value of almost 50% for OF and of 30% for Conv. This added value was higher for the adult animals.

**Table 2: Net prices (€/kg carcass) calculated for DM and observed in conventional classic market chain (CMC)**

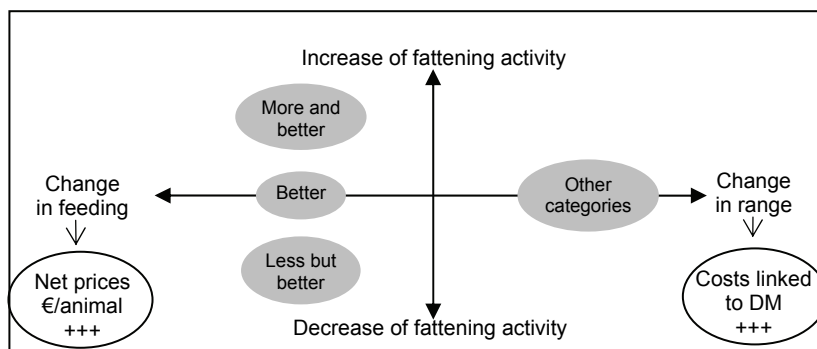
Category	OF DM	Conv. DM	CMC	OF DM /CMC (%)	Conv. DM /CMC (%)	
Adults	Cows	5.3	4.6	3.22	+65	+43
	Heifers	5.1	4.4	3.59	+42	+23
	Steers	5.3	4.3	3.43	+55	+25
Calves	Milk	7.0	10.2	7.36	-5	+39
	Older	6.3	6.4	5.6	+13	+16

For the whole herd, taking into account the percentage of animals sold by DM, the gain was 136 €/LU/year for OF (50 €/LU/ year for Conv.). The average labour time spent in DM was 29 days per year, for a total added value of 6,900 €, or 350 € per day to finance the additional workforce requirements (240 €/day for Conv.).

#### c) Farming practices

Concerning the management of the cattle, the main systematic change was an increased replacement rate (inducing a younger average age of cows in the herd) and an increased number of calving periods to produce young calves throughout the year.

The changes in farming practices associated with the animals to be sold concerned: the animal range, the ways of combining the oldest and the youngest animals throughout the year to ensure regularity of sales and the fattening schedule over the year. Two strategies were identified (figure 1). One was focused on the quality of feeding without changing the type of animals (a more "technical" strategy). The other was focused on animal categories, without changing the feeding management (a more "commercial" strategy). The link between these strategies and the economic results of the farms showed: (i) a sophisticated feeding and fattening management system with limited investments, to optimize the technical performance and the economic value of each carcass (ii) a wide range of animals sold and a specific organization requiring investments both in time and money, with a strong involvement in the marketing activity, and with a broad offer to satisfy the consumers.



**Figure 1: Changes in the management of animals to be sold**

### Discussion, conclusion

Direct sales make it possible to add value to animals when there is a market opportunity. It is also a good way to sell animals that are not "standard" (e.g., steers and heavy calves) and at the same time satisfy the customer.

Only some of the animals produced by the farm are intended for direct sales. Hence at least two marketing circuits exist side by side. This creates a need to sort the animals. There are various strategies for directing animals according to the category to which they belong and their quality.

Direct selling adds value in spite of extra costs. The farmer's degree of commitment to direct selling cannot be assessed solely in terms of the quantity sold, because the farmer also makes choices in terms of investment and additional working time.

The practice of on-farm marketing is an alternative to enlarging structures because it makes it possible to create more added value and to provide a living for more workers from the same structure.

The development of this marketing method always brings about changes in herd management. How the farmers react is also important, because they adapt quickly and direct sales strengthen the farm's links with the outside world.

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# Innovations within the organic food sector – basis for novel business relations between agricultural and processing enterprises

Gottwald, F.Th. & Boergen, I.<sup>1</sup>

Keywords: Innovative products and processes, cooperation, organic food industry, organic farming, processing industry.

## Abstract

*Innovations within the processing sector may stimulate new, and extend and stabilize existing business relations with agricultural enterprises along the market chain. Due to their regional focus, small and medium-sized businesses in organic food production are eminently dependent on collaboration. On the basis of the evaluation of 140 applications for the Innovation Contest, this paper demonstrates how new and sustainable revenues can be built up by entering economic collaborations with innovative businesses of the processing sector.*

## Introduction

The competitive standards within organic food processing have increasingly changed over the past years. Participation of larger businesses, store brands and international as well as national certifications have been contributing to these changes. Innovations in the processing sector can help managing the new market situation. As in other sectors, the uniqueness of an innovative business solution in organic production is of particular importance in order to be successful (Gottwald et. al., 1982). This also includes effective marketing strategies, which highlight the positive image of organic products (Reuter and Kunz, 2006). The major condition for a successful innovation is its awareness level, i.e. the identification of the innovative idea with the producer or the brand. Research has shown that innovations often are encouraged by the legal framework, for instance prescriptive limits or environmental codes of practice. The *Innovation Contest* was launched by the Schweisfurth Foundation in 2003, amongst other reasons, in order to empirically assess how the EU-certification of organic food stimulates the business relationships between agricultural and processing enterprises. The competitions took place in 2003, 2005 and 2007 and figured out innovative business solutions in different sectors of the processing industry (<http://www.innovationspreis-bio-verarbeitung.de>). Following Hauschildt (2004), the concept of the *Innovation Contest* aims at identifying innovative business solutions from their development to their marketing and highlighting their contribution to complex societal interactions. The main objective of the contest is, to gain information about innovative capacities of the processing branch and make them accessible in order to encourage more companies to break new ground. The second objective is to motivate enterprises which are already operating in the organic food industry to improve their products and performance via innovations. Thirdly, the contest enriches the pool of ideas which is necessary for the success of the organic food market and helps combating prejudices against the sector. For the competition and for this paper,

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innovation is understood as the introduction of new goods, new methods of production and/or the conquest of new sources of supply. The innovation can be original (the introduction of a completely novel product or production method) or incremental (the transfer of an already existing product or production method to a novel business area).

### Materials and methods

The present study is a qualitative analysis of 140 applications the Schweisfurth-Foundation received for the *Innovation Contest* in 2003, 2005 and 2007. The applying enterprises were classified into three categories: small enterprises (1-15 employees), medium sized businesses (16-299 employees) and large-scale enterprises (300 employees and more).

First of all, the innovations were examined with regard to their contribution to *Five Dimensions*. These dimensions are:

Technology  
 Production and raw materials  
 Nutrition and health  
 Corporate culture, marketing, cooperation and communication  
 Environmental responsibility and climate protection.

The 140 applicants have assigned each of their innovations to one or more of these five categories, depending on the subject of the innovations. These 389 innovations in the different categories were quantitatively analyzed. In a second step, the innovations were typified into four categories in order to assess the impact of the innovation on stimulating, extending and stabilizing new business relations within the organic food sector. These categories describe the impact on developing new or expanding existing:

Supplier cooperation (initial production)  
 Market relations  
 Supplier cooperation (process technologies)  
 Scientific cooperation

According to the classification within the five dimensions, the different aspects of the innovations were assigned to one or more of these criteria.

### Results

Overall, most of the 140 applicants were medium-sized businesses (53,6%), followed by small businesses (38,5%). Following, the results for small and medium-sized businesses are presented, since only 11 applicants were large-scale businesses (7,9%) within the three years. Medium-sized businesses were contributing most of the innovations:

**Tab. 1: Proportion (in percentage) of innovations for small, medium and large businesses in 2003, 2005 and 2007**

	2003	2005	2007	Overall
<i>Small</i>	44,3	26,9	49,3	41,4
<i>Medium</i>	50,3	61,5	42,6	50,6
<i>Large</i>	5,4	11,5	8,1	8,0

**Tab. 2: Number of innovations (in percentage), categorized by business size (s=small, m=medium), year and the five dimensions.**

Year	Size	Tech- nology	production & raw materials	nutrition & health	corporate culture, marketing, cooperation & communication	Environmental responsibility & climate protection
2003	s	25,8	21,2	18,2	21,2	13,6
	m	21,3	26,7	10,7	29,3	12
2005	s	28,6	32,1	3,6	32,1	3,6
	m	17,2	26,6	15,6	32,8	7,8
2007	s	17,9	19,4	29,8	19,4	13,4
	m	13,8	22,4	25,9	19,0	19,0

## Discussion

The kind of innovations not only differs by business size, but also by the year of application. For instance, the focus on the dimension *nutrition & health* has increased with the years. Innovations in this dimension are most frequent in 2007, for small (29,8%) and medium (25,9%) businesses (table 2). One explanation for this result can be the increased awareness of health, wellness and nutrition as a sales argument. Small enterprises have least innovations in the dimension *environmental responsibility & climate protection* (table 2). This effect also exists over the years and could be explained by the lower personal and financial scope of small enterprises. Hence, larger investments into environmental technologies or programs are more unlikely for small, than for medium or large enterprises. The quantitative analysis of the 140 applications shows, that innovative business solutions create new potentials with regard to new and/or existing collaborations. The results of table 3 suggest that business innovations within the organic food sector may contribute to building up new market and business relations. As expected, innovations within the technology sector mainly may lead to collaboration with suppliers of process technologies (small businesses: 64,9, medium-sized businesses: 85,7%). Innovations around raw materials have the largest impact on cooperation between processors and suppliers who deliver these materials (small businesses: 75%, medium-sized businesses: 88%). Innovations within the dimension *environmental responsibility & climate protection* are most likely to lead to new market relations and supplier cooperation with regard to new process technologies. Innovations within the dimension *nutrition & health* mainly contribute to new market relations; this result can be explained by the high number of innovations in this dimension which are subject to concrete consumer interests (e.g. special products for allergic persons or people with food incompatibilities). Communicative or marketing-innovations also can lead to new market relations (table 3). The study indicates, that innovative products and processes are appropriate to building up economic collaborations and networks within the organic food processing sector.

**Tab. 3: Percentage of innovations (small and medium enterprises) which have an impact on (1) supplier cooperation (initial production), (2) market relations, (3) supplier cooperation (process technologies) and (4) scientific cooperation, sorted by the five dimensions:**

<b>Small enterprises</b>					
	<i>technology</i>	<i>production &amp; raw materials</i>	<i>nutrition &amp; health</i>	<i>corporate culture, marketing, cooperation &amp; communication</i>	<i>Environmental responsibility &amp; climate protection</i>
(1)	48,6	75	33,3	50	42,1
(2)	45,9	50	87,9	83,3	68,4
(3)	64,9	27,8	27,3	19,4	68,4
(4)	13,5	5,6	6,1	2,8	5,3
<b>Medium enterprises</b>					
	<i>technology</i>	<i>production &amp; raw materials</i>	<i>nutrition &amp; health</i>	<i>corporate culture, marketing, cooperation &amp; communication</i>	<i>Environmental responsibility &amp; climate protection</i>
(1)	31,4	88	48,5	55,6	44
(2)	54,3	68	100	90,7	72
(3)	85,7	38	39,4	29,6	84
(4)	8,6	4	12,1	9,3	16

Innovative business solutions on the basis of reliable contractual relationships, fair producer's prices and high quality standards may stimulate and -at the same time- require stable business relations between producers and processors.

### **Conclusions**

On the basis of innovations within the processing sector, reliable and promising cooperation between processors and producers can be built up. However, this thesis needs further research.

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# Development of organic farming in Central and Eastern European countries

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Key words: Central and Eastern European countries, Land use structure, Organic farming, Organic livestock

## Abstract

*The total organic area in the eight examined Central and Eastern European countries (CEECs) increased to 907,900 ha and represented 2.73% of the utilised agricultural area (UAA) in 2005. This corresponds to an annual growth rate of 23.13%. However, the area of fodder crops represented over 65% of this increase. Estonia and the Czech Republic have the highest share (over 7%) in total organic area of UAA. At the same time these countries have seen a steady decrease of in-conversion area, which limits the potential for further growth. In the organic production structure, grassland and the production of fodder have become the main organic crop areas, mainly in Slovenia, the Czech Republic, Slovakia, Estonia and Latvia. In relation to organic livestock, beef production dominated with 67% in total CEECs organic livestock units, followed by dairy and sheep production with 14% and 8%, respectively, in 2005. Overall, sheep are the most popular species in nearly all CEECs when shares in total production are compared. Despite the rapid growth of organic farming (OF) in CEECs in recent years, the current arrangement of organic production can be noticed as one of many factors hindering the development of the organic food market and diversification of supplies.*

## Introduction

The proportion of organically managed land of total UAA is comparable to that observed in the former EU-15 countries but the supply of organic products in CEECs is limited. A well-developed market is one of the biggest problems facing the CEECs and the current land use structure does not sufficiently contribute to the enhancement and diversification of organic products and food supply. The aim of this paper is to give an overview of the current state of OF and highlight trends in the level and structure of organic production in 8 CEECs between 2000 and 2005.

## Materials and methods

Statistical analysis is hampered by the lack of data in most CEECs before 2004. Therefore, a survey based on a questionnaire sent to national experts in CEECs was carried out to collect the relevant information. Data collection was held in 8 CEE countries: Czech Republic (CZ), Estonia (EE), Hungary (HU), Poland (PL), Lithuania (LT), Latvia (LV), Slovenia (SI) and Slovakia (SK) and was carried out in 2003 and 2004. The questionnaire focused on general statistics covering data about the number of organic farms, area under organic production, organic crop composition and the

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amount of livestock during years 1997-2004. The Eurostat format was used for statistical data collection. Data for 2005 is based on Eurostat database supplemented by national sources and FAOSTAT where needed.

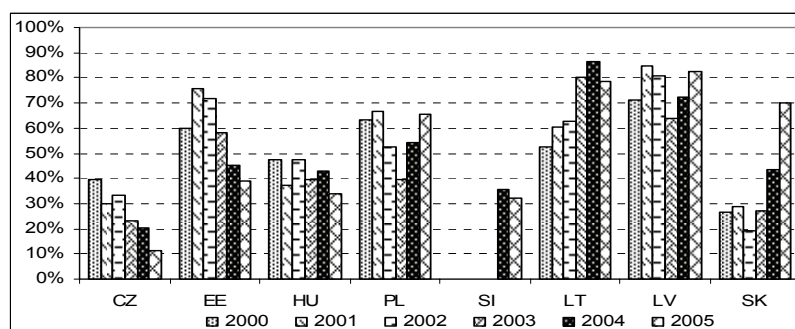
## Results

The total organic area in 8 CEE countries, both in-conversion and fully converted, increased from 71,881 ha in 1997 to 907,900 ha in 2005. This increase corresponds to an average annual growth rate of 21.02% between 2000 and 2004 or of 23.13% until 2005, and represented 2.73% of UAA in 2005. There are substantial differences between the individual CEECs regarding the importance of OF. In absolute figures, in spite of slower growth, CZ recorded the largest total organic area (more than 254,000 ha and 28% of CEECs), followed by PL, HU and LV in 2005 (see Table 1). The picture is different if the countries are arranged according to their share in total organic area of UAA. Due to quite an impressive growth in EE in recent years, this country showed the largest share equal to 7.16% in 2005, followed by CZ with 7.07% and LV with 6.84%. Among CEE countries with the highest average annual growth rate of total organic area over the period of 2000 - 2004 were LV (77.73%), LT (73.78%), EE (46.93%) and SI (43.43%). However, only the Baltic countries (LV, LT and EE) recorded higher growth of total organic area in 2005 also. In addition, PL and SK recorded significant increases in total organic area in 2005 (102.76 and 69.91%, respectively). In contrast, CZ and HU for the first time experienced decreases in organic area and SI stagnation.

**Tab. 1: Total organic area, average annual growth rate and share in 2005 UAA**

	Total organic area (ha)				Annual growth rate (%)		Share of UAA (%)	
	2000	2003	2004	2005	2000-2004	2004-2005	2000	2005
<b>CZ</b>	165,699	254,995	263,299	254,982	12.27	-3.16	4.60	7.07
<b>EE</b>	9,872	42,573	46,016	59,741	46.93	29.83	1.18	7.16
<b>HU</b>	47,221	116,535	133,009	128,576	29.54	-3.33	0.81	2.19
<b>PL</b>	25,000	49,928	82,730	167,740	34.87	102.76	0.16	1.05
<b>SI</b>	5,440	20,018	23,023	23,499	43.43	2.07	1.07	4.60
<b>LT</b>	4,709	23,289	42,955	64,544	73.78	50.26	0.17	2.28
<b>LV</b>	4,400	24,480	43,902	118,612	77.73	170.17	0.25	6.84
<b>SK</b>	58,458	54,479	53,091	90,206	-0.02	69.91	3.01	4.65
<b>ALL</b>	320,799	586,297	688,025	907,900	21.02	31.96	0.97	2.73

The actual proportion of in-conversion area of the total organic area can indicate potential growth in the organic sector in the near future. The differences in the potential increase of organic production are shown in Figure 1. CZ and EE corresponded to the overall CEECs development with the percentage of in-conversion area constantly decreasing. The potential for further growth is limited especially in CZ, where the share was less than 15% in 2005. On the other hand, these two countries have the largest share in organic area of UAA nowadays. HU, PL, LV and SK showed a balanced development, with a certain increase realized in the last two years in the case of PL, LV and in particular SK. Only in LT the proportion of in-conversion area steadily increased, except for the last year investigated (2005).



**Figure 1: Proportion of in-conversion area of total organic area by country, 2000-2005**

The total organic land use structure in 8 CEECs did not differ significantly from those observed in EU-15. In 2005, out of 907,900 ha of organic area around 22% were covered by arable crops, 71% by grassland and fodder crops, followed by 2% under permanent crops and 5% occupied by other uses. The CEECs contributing most to the total organically cultivated arable land in recent years were HU, PL and LT and these represent higher potential of organic production. Conversely, nearly 50% of organically managed grassland was located in CZ, followed by HU and SK. In the case of permanent crops, HU and PL had the largest shares over the whole period studied, supplemented by a significant increase in LT in 2005. Production of grass and fodder crops was the most important use of organic land in most CEECs and even more significant (over 75%) in SI, CZ, SK, EE and LV. In the case of the two latter countries, green fodder on arable land covered a significant share (80% and 70%, respectively). The highest share of organically managed arable land in total arable land was recorded for LV (8.31%) and EE (7.77%), mainly due to covering of fodder production. The highest share of pastures and meadows in total permanent grassland was recorded for CZ (24.62%) and the highest share of permanent crops was found in LT (9.09%) and EE (8.44%).

**Tab. 2: Organic livestock (number of heads), 2005 and % changes 2004-2005**

	Organic livestock				% changes 2004-2005			
	Cattle	Sheep	Goats	Pigs	Cattle	Sheep	Goats	Pigs
<b>CZ</b>	67,956	24,230	1,725	3,108	-32	-23	-34	129
<b>EE</b>	9,289	11,163	333	253	-8	3	-3	-36
<b>HU</b>	12,235	29,829	3,071	1,877	45	-2	-27	-27
<b>PL</b>	13,913	12,192	1,958	17,918	x	x	x	x
<b>SI</b>	14,539	21,071	3,827	1,966	11	17	10	59
<b>LT</b>	3,843	3,658	388	70	-42	-3	21	-16
<b>LV</b>	21,439	6,109	928	6,580	114	210	40	217
<b>SK</b>	20,133	57,830	1,006	206	58	114	52	565

NB: PL - data from 2004 is used.

The most important organic livestock category in CEECs was beef production (67% of total livestock units), followed by dairy production (14%) and sheep production (8%). The percentage of organic livestock category in total production shows that sheep were the most popular species in nearly all CEECs (7%). In EE, as many as 29% of

sheep are bred organically. The share of organic cattle was significant, over 5%, in CZ and LV. Certified pig and poultry production was less developed in all CEECs and the share of organic in total pig and poultry production was under 0.5% in 2004. All organic livestock categories are on the increase in SI, LV, SK and on the decrease in CZ, EE, HU and LT with the exception of always one livestock category (Table 2).

### **Discussion and conclusions**

The rapid growth of organically managed land in nearly all CEECs since 2004 can partly result in better availability of organic raw materials. Moreover, the highest growth was realized in the acreage of arable land (in 67% of CEECs). However, the area of fodder crops represented nearly 72% of this arable land growth, and meadows and permanent pastures were still dominant uses of organic land. At the same time, the lowest area payments were provided to organic grassland in all CEECs, with the exception of LV, where one general payment rate has been applied since 2004. Considering that, the current structure of organic production can be seen as one of the main factors hindering the development of the market for organic food and diversification of organic supplies. Since the OF area payments are one of the most powerful and almost the only support for the organic sector, the payments should remain in existence but under the proviso that higher payment levels for arable crops, vegetables and permanent crops in comparison with grassland was provided, and that the difference between area payments for organic and integrated production was ensured. Moreover, other supporting measures (mainly demand-pull), such as support for marketing initiatives, promotion, professional advisory services, education and R&D, are needed for the stimulation of more market-oriented production in consequence of the increased demand for organic produce and contribution to sustainable OF development in CEECs.

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# Construction of prices for organic products enhancing farmers' profiles diversity in the South East of France

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*Key Words:* marketing choices, agricultural techniques, values, price

## Abstract

*The Provence-Côte d'Azur region is a French leader for organic farming, both in term of bulk production and number of farmers. This study aims at identifying organic farmers' profiles diversity within the region and at creating a framework in order to understand the construction of prices for organic food. Targeting technical, economical and marketing channel choices issues, elaboration of prices for organic commodities is studied through 20 interviews, where farmers' values were also considered. As results, first enhancement of the organic products is highly correlated to the natural and logistic resources. Moreover, most organic farmers have elaborated innovative marketing channels in order to cope with the local supply and demand. Indeed, a large number of farmers are involved in direct selling, even in combination with other marketing channels, in order to enhance their production through prices. Finally, farmers' values have an important influence on final prices. Indeed several organic farmers pay a great attention to social, ethical, environmental issues, beyond a basic compliance with the organic standards. As a result, fairness, environmental issues, or rural development lead farmers to implement innovative techniques and marketing strategies with a final incidence on price construction.*

## Introduction

Organic food and farming are taking an increasing importance in the global food sector over the last years. In European Union, since 1991 and the implementation of the regulation on organic crop productions (regulation EEC N°2092/91), organic farming has developed constantly, until reaching nowadays in France two percent of the agricultural production (Agence Bio, 2007).

The French organic sector is faced today with a challenging issue, which stands in the increasing share of the total food production and consumption. Moreover, society is paying more and more attention to environmental aspects of food and the sustainability of agriculture. Likewise, political frame is willing to support ecological and high quality agriculture.

With more than 900 organic farmers, the Provence-Côte d'Azur is one of the leading regions in France for organic farming. The present study aims at pointing out the farmers' profiles diversity and at understanding the elaboration of prices for the organic food, through farmers' interviews.

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First, highlighting general trends of farmers' initiatives, both in terms of technical and marketing practices, the study then describes in depth examples of individual or collective trends with their consequences on price elaboration. Finally, confronting the literature review, the study shows the dynamic dimension of farmers' approaches.

## **Methods**

Twenty interviews were conducted. Case studies were chosen according to a framework which classifies organic farmers in "ideotypes" according to their involvement into the organic standards and the choice of marketing channels (Sylvander *et al.*, 2006). This frame allows dividing organic farming into four models. Sheep husbandry is particularly targeted in animal husbandry, fruits and vegetables for crop productions, as well as wheat production.

Interviews, conducted through a questionnaire dealing with both semi and fully opened questions, were registered. Interviews were planned to last less than an hour; however semi opened questions often needed more time. Interviews were divided in three main parts: technical aspects (mechanisation, production costs, labour force, and soil fertility management), marketing aspects (marketing channels, relationship with customers and price) and values (involvement into the organic movement and standards, social and societal considerations, evolution and enhancement of both systems of production and marketing).

## **Results**

For all farmers, enhancement of the organic products is highly correlated to the natural and logistic resources. Indeed the presence of an organic chain at the slaughterhouse (for sheep production), water resource through artificial channels (for vegetable production), or the distance between the farm and potential markets are serious limiting factors. Due to the small number of farmers and the limited amount of sheep produced, slaughterhouses in the studied region do not implement specific organic chains. As a result, farmers can not enhance their production as organic which entails a clear incidence on selling price and financial viability of the farm. Conversely, two of the most important French wholesalers for organic food are located in the region. It clearly allows farmers in the surroundings, especially for vegetables and fruits growers, to create financial security. However, for farmers located far away, transportation costs do not lead farmers to deal with these wholesalers.

In details, three trends can be highlighted.

In a first group, farmers have elaborated innovative marketing channels in order to cope with the local demand. Through direct selling, these farmers offer a large diversity of products, especially corresponding to specific consumers' demands for fresh, organic and locally produced food. Among them, one organic livestock farmer producing goat cheese with a Protected Denomination of Origin (PDO) prefers not to sell the cheese as organic. He noticed that the combination of PDO and organic does not correspond to his customers expectations. Thus, organic farmers involved in direct marketing develop strategies to combine, as much as they can, organic and local attributes.

In a second group, interesting cases can be identified through diverse experiences of organic farmers' organisations within the region. A first example corresponds to a wheat producer, growing traditional varieties of wheat which have found marketing

and technical development, associating the Regional Park of Luberon, in order to create a brand linking his wheat variety with the park. In this way, he has developed partnerships with other farmers, mills, bakers and consumers within the region, enhancing his production. On the other hand, organic sheep farmers expect the slaughterhouse to implement an organic chain, but no collective action is engaged. Thus the incidence of individual requests on the slaughterhouse remains insufficient.

Finally, as long as the construction of price stands mainly on a tricky combination between demand and supply, a third group of farmers is targeting the national market. They are producing a large amount of quality food and specialising in a few products. A close relationship with wholesalers enables such farmers to sell the bulk of the production, certainly at a lower price, but with the guarantee to dispose of the merchandise.

In all cases, elaboration of prices is first a result of a sum of technical and economical issues. Moreover, farmers' values have an influence on final prices. Generally, organic farmers are often not only dealing with issues related to organic farming, but also with environmental issues, the place of farmers within the society, high quality food, fairness and rural development. Through the following examples, new trends can be highlighted, especially in the scope of the evolution of the compliance of farmers with the organic standards.

Six farmers prioritize the employment of farm workers rather than maximize their incomes. The value behind is the willingness to keep workers in rural areas. All farmers involved in direct selling express the willingness to produce and sell locally. Producing locally is not typical of organic farming, but makes sense when organic farming aims at preserving environment and enhancing local resources. Indeed, those farmers find absurd to grow organically on the farm and sell hundreds miles away (in terms of environmental costs). Other farmers, especially in vegetable production, are willing to sell their products at a fair price (just covering the production costs), even in direct selling, in order to allow financially consumers to reach a healthy food (free of pesticide).

## Discussion

The first component of price states in the availability of the market, of the resources, infrastructures and services. Indeed, as for the sheep farmers interviewed in this study, the lack of organisation between farmers to engage a collective request for an organic chain at the slaughterhouse got a clear incidence on final price, with a meat not sold with the organic label.

Research on organic marketing initiatives has already shown the interest of farmers for direct marketing, especially in order to reduce price due to the several middlemen (Weier and Caverley, 2002). However, some of the farmers interviewed in this study aim at selling their products even more expensive than the production costs, arguing that the final product presents more than the basic qualities of an organic product, e.g. locally grown, contributing to rural development (Schmid *et al*, 2004), until reaching the limit of the consumer' willingness to pay (Michelsen *et al*, 1999).

Farmers dealing with wholesalers clearly assume that it implies clear constraints, such as tricky relationship with customers, lower added value on final price, but this market channel choice allows farmers to focus on their job, *i.e.* organically growing (Schmid *et al*, 2004).

It is relevant to mention the dynamic approaches of farmers within the region, lying in the evolution of practices and marketing channels choices in time, already described in other European regions, especially in the frame of the Omiard (Organic Marketing initiatives and Rural Development) project (Schmid et al., *op. cit.*).

### **Conclusion**

The present study aims at describing the construction of prices, for organic commodities, through farmers' interviews. Different components, such as production cost recovery, incidence of redesigning the practices management or the added value due to marketing strategy are first studied. Then, a large part of this study deals with the enhancement of the organic products through organic farmers' values. Indeed, in most cases, issues such as rural development, ecological impacts of farming, fairness with consumers, lead to have a significant incidence on final prices.

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## Carbon storage and energy use

# Carbon sequestration in organic and conventional managed soils in the Netherlands

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Key words: organic matter, carbon sequestration, farm management, organic agriculture

## Abstract

*Next to other important agronomic and ecological aspects, the organic matter sequestration in the soil plays an important role in the CO<sub>2</sub> balance. Based on detailed farm registrations, the input of effective organic matter and the changes in carbon sequestration in the soil was calculated for a large number of organic and conventional farms in the Netherlands. Results show that both organic and conventional management resulted in a decrease of the pool of organic carbon in the soil. The average decrease for the conventional management was 401 kg ha<sup>-1</sup> year<sup>-1</sup> and for the organic management 261 kg ha<sup>-1</sup> year<sup>-1</sup>. The input of effective organic matter in the soil was significantly higher in organic than in conventional farms. Animal manure was the main contributor to this difference.*

## Introduction

Changes in the organic matter in the soil are crucial for agronomic aspects like nutrient dynamics, structure and water storage capacity as well as for the environmental performance of a farming system like biodiversity, nitrate leaching and recently in focus, carbon storage in the soil. Organic matter in soils acts as a large carbon sink and plays an important role in the CO<sub>2</sub> balance. This paper will deal with the changes of the organic matter in the soil under current organic and conventional management practices in the Netherlands.

## Materials and methods

Data for the calculation of the changes in soil organic matter were obtained from detailed farm registrations of 101 organic and 85 conventional farms in the Netherlands divided in three regions: Central clay, South-west clay and South-east sand. Each region represents a group of farms on a similar soil type and under similar climate conditions. Data were registered in the period 1998 to 2006. From every farm there were 1 to 4 years of registered data available. Both the amount and type of organic matter input were registered including crop residues and green manures.

From the data an average organic matter input and the so called effective organic matter input were calculated for organic and conventional farms in a certain region. The effective organic matter is defined as the organic matter that is still available one year after incorporation in the soil. For every type of organic matter, standard data are used for the remaining percentage of organic matter after one year of incorporation in the soil.

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To predict the effect of different organic matter management strategies on organic and conventional farms, the decomposition model of Janssen (1996) was used. This model describes the decomposition of organic matter or carbon (C) in the soil as:

$$Y_t = Y_0 \cdot \text{EXP} ( 4.7 ((a + t \cdot f_{temp})^{-0.6} - a^{-0.6} ) )$$

Where  $Y_t$  = remaining amount of OM after  $t$  years;  $Y_0$  = initial amount of fresh organic matter added to the soil;  $t$  = number of years after application;  $f_{temp}$  = correction factor for temperature ( $f_{temp} = 1$  when average temperature is 9 °C);  $a$  = initial age of the organic material.

The increase of organic matter in the soil caused by the yearly input on the one hand and the loss of the present soil organic matter (SOM) on the other hand, were calculated separately. The  $a$ -value is based on the type of organic matter that is incorporated in the soil and can be derived from the humification rate of the incorporated organic matter in the first year. For this study an average  $a$ -value was calculated per region and farm type, based on the average organic and effective organic matter input per region and farm type and this value was used in the model. The decomposition rate of the present SOM of the involved farms is unknown. From results of long-term experiments in the Netherlands by Kortleven (1963) an average  $a$ -value for SOM of 16 was determined (Janssen, 2002). From a long-term pot experiment with 36 Dutch soils Wadman & De Haan (1997) found  $a$ -values ranging from 14 to 50. On two different sand locations in the south east of the Netherlands Postma & van Dijk (2004) found  $a$ -values of 16 and 19. According to Van Veen & Kuikman (1990) finer, clayey soils show on average slower decomposition rates and a higher retention of organic matter than coarse, sandy soils. To calculate the carbon loss of the involved farms for this case an  $a$ -value of 21 is used for the clay soil regions and of 16 for the south east sand region. The  $a$ -values correspond with a decomposition of the soil organic matter of 2% respectively 3% between  $t_0$  en  $t_1$ . For all calculations the average year temperature in the region is used for the calculation of the correction factor  $f_{temp}$ .

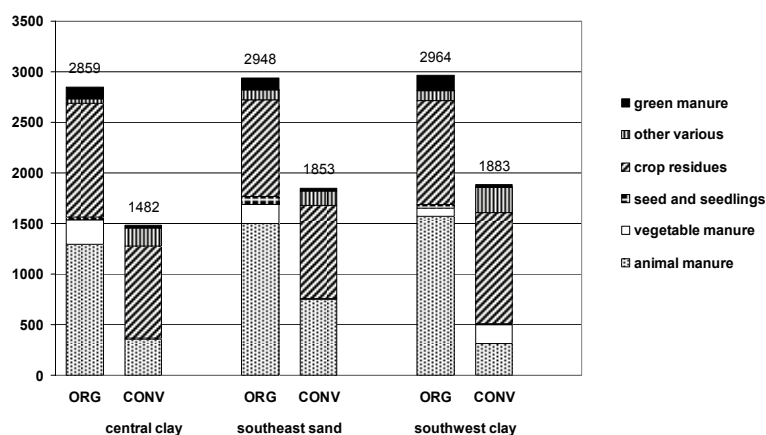
## Results and discussion

It shows in figure 1 that the main contributions to the input of effective organic matter are made by the input of crop residues (roots, stubble etc.) and by the input of animal manure. Animal manure is available in abundance in the Netherlands. The main difference between organic and conventional management is the amount of input of animal manure, vegetable manure (mainly compost) and green manure.

Table 1 depicts the results of the model calculations. It shows that both with the conventional and the organic management the amount of carbon in the soil is decreasing in the course of the coming 25 years. However the organic management loses on average 140 kg of carbon per year less than the conventional management.

A critical comment on the better performance of the organic management is that in the Netherlands the majority of the applied animal manure on organic farms is still coming from conventional farms. So it derives part of its better performance in carbon losses from the conventional sector.





**Figure 1: Input and origin of effective organic matter ( $\text{kg ha}^{-1} \text{ year}^{-1}$ ) per group of farms in a region.**

**Tab. 1: Average percentage of organic matter (o.m.) in the soil and calculated changes in sequestered carbon in the soil per group of farms.**

Region	Type	No of farms	%soil o.m.	Carbon change ( $\text{kg ha}^{-1} \text{ year}^{-1}$ )		
				increase	loss	net change
central clay	organic	22	4.0	320	670	-351
	conv.	17	3.4	138	589	-451
southeast sand	organic	38	3.0	339	659	-320
	conv.	34	2.9	174	640	-465
southwest clay	organic	41	2.4	326	437	-111
	conv.	34	2.6	176	463	-287
total	organic	101	3.1	328	589	-261
total	conv.	85	3.0	163	564	-401

The decomposition of organic matter may better be described by the model of Yang (Yang and Janssen, 2000). However this model uses two parameters for the decomposition rate and the values of these parameters for different types of organic matter are unknown yet. Furthermore the used Janssen model, does not account for soil properties affecting the decomposition rate of the organic matter such as texture.

The result of the calculated net change of soil carbon largely depends on the decomposition of the present SOM (for this case the setting of the a-value). When the a-value is changed into 18 or 30 for clay soils and 13 or 25 for sand soils, the average net change of soil carbon varies from  $-360$  to  $-71 \text{ kg ha}^{-1} \text{ year}^{-1}$  for the organic farms and from  $-496$  to  $-219 \text{ kg ha}^{-1} \text{ year}^{-1}$  for the conventional farms.

The net decrease of organic carbon in the soil on arable land is confirmed in several studies. Vleeshouwers & Verhagen (2002) come to the same conclusion for the European arable soils. Although their estimation of net carbon losses are almost double the values found in this study. In long-term comparisons of farming systems in the Netherlands on southeast sand and central clay soil organic matter content declined as well for the conventional as for the biological farming systems (Dekking, 2003; Van Geel & De Haan, 2007). The inputs of effective organic matter were comparable to the amounts mentioned in figure 1 for the two regions and farm types. Pimentel et al. (2005) however measured a net increase of organic carbon in the soil for both organic and conventional agriculture. The results concerning the additional carbon sequestration in organic soils compared to conventional soils correspond with the study of Freibauer et al (2004). Freibauer (2004) concludes that organic farm management could sequester between 0 to 500 kg of organic carbon per hectare per year more than conventional agriculture.

## Conclusions

Field experiments as well as model calculations show that with the current farm management in practice on Dutch arable farms the amount of organic carbon stored in the soil decreases, both in organic as well and in conventional managed soils. However the decrease with the organic management is lower than with conventional management.

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## Should organic farmers be rewarded for sequestering C in soil?

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Key words: organic farming, soil organic carbon, carbon sequestration, greenhouse gas emissions

### Abstract

*The question of whether farmers, and organic farmers in particular, should be rewarded for sequestering C in soils is controversial. A review of the literature on long term experiments comparing organic and conventional systems, demonstrates that soils under organic management tend to have higher soil organic carbon (SOC) contents than conventionally managed soils. But the logistics of designing a system that compensates individual farmers for this ecosystem service are challenging. Agreements would have to be reached on the baseline system used for calculation of relative gains in SOC, values for emissions of other GHGs from soils (e.g. methane and nitrous oxide), the direct and indirect CO<sub>2</sub> emissions associated with energy use and crop production inputs in the C sequestering system, and emissions associated with sources of SOC imported onto the farm. Alternatively, the evidence for generally higher SOC under organic management could justify an additional payment, for example under the UK Government's Organic Entry Level Scheme.*

### Introduction

In general terms, C sequestration is the conversion of atmospheric CO<sub>2</sub> into organic C (C fixation) that is protected or prevented from oxidizing back to the atmosphere. The storage of organic C in soils is one form of C sequestration. While it is acknowledged that the UK will need to adopt a variety of strategies to meet its commitment to the Kyoto Protocol, there is considerable potential for carbon mitigation through changes in agricultural land-use and management that increases soil C (Smith et al., 2000).

Currently, changes in soil C resulting from land use change (LULUCF sector) among four broad categories: forestland, grassland, cropland and settlement, are included within the UK's national GHG inventory (Baggott et al., 2007). Differences in soil organic carbon (SOC) among systems of agricultural production on grassland and cropland, however, are not included in the inventory.

### Do organic farming practices increase soil C?

Practices that increase soil organic carbon contents include reduced tillage, ley periods in the crop rotation (e.g. grass or grass/clover crops), the use of organic amendments like compost or farmyard manure (FYM), and increasing biomass production per unit area (in some cases through the judicious use of mineral fertilisers). Organic standards prescribe many of these practices.

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There is a high degree of variability in management practices and soil fertility outcomes, even within specific categories of organic farms (Stockdale and Watson, 2002). Nevertheless, when researchers have compared organically and conventionally managed soils, they have often found that on average SOC contents are higher under organic management. This result was found in paired comparisons of soils from organic and conventional farms in the same region (Armstrong Brown et al., 2000; Drinkwater et al., 1995), and in long-term trials that more rigorously compare organic and conventional systems (Table 1). In these trials, SOC values are frequently higher where organic fertility inputs are used. In the DOK trial at the Institute for Organic Agriculture in Switzerland (FiBL), the plots receiving biodynamically composted manure and slurry at a rate equivalent to 1.4 livestock units per ha (BIODYN 1.4), had the highest SOC relative to the mineral fertilizer treatment (here including clover leys) after 21 years (Fließbach et al., 2007). Raupp and Oltmanns (2006) had similar results comparing composted manure with (CMBD) and without (CM) biodynamic preparations, with inorganically fertilized crops, at three different application rates. After eighteen years, the two higher rates of compost had significantly greater levels of SOC than the inorganically fertilized treatment. In the Rodale Institute Farming Systems Trial (Hepperly et al., 2006) there were significantly higher SOC contents in the organic, legume-based system (LEG) compared to the conventionally fertilized system, even with similar annual returns of crop residues to the soil.

**Tab. 1: Difference in soil C relative to conventional management ( $\Delta C$ ) for organic treatments in several long-term experiments**

Experiment	Treatment <sup>z</sup>	$\Delta C \text{ t ha}^{-1}$	Duration of experiment	Reference
DOK trial	BIODYN 1.4	3.82	21 y	Fließbach et al., 2007
	BIOORG 1.4	0.6		
IBR Darmstadt, DK	CM rate 3	3.8	18 y	Raupp and Oltmanns, 2006
	CMBD rate 3	5		
Rodale trial	MAN	10	21 y	Hepperly et al., 2006
	LEG	8		

<sup>z</sup>BIODYN 1.4 = biodynamic compost and slurry at 1.4 LU ha<sup>-1</sup>; BIOORG = rotted FYM and slurry at 1.4 LU ha<sup>-1</sup>; CM rate 3 = composted manure at a total N rate of 140 kg N ha<sup>-1</sup>; CMBD rate 3 = composted manure with biodynamic preparations at a total N rate of 140 kg N ha<sup>-1</sup>; MAN = organic manure and legumes as N source; LEG = legumes only as an N source

### Calculation of total sequestered C

Carbon sequestration is not just a function of soil organic carbon levels. King et al. (2004) defined total sequestered carbon (TSC) in agricultural systems as a function of soil organic carbon (SOC), direct energy (DE) used on site i.e. to power machinery and operations, indirect energy (IE) used on site i.e. to manufacture and supply fertilizers, agrochemicals, etc., and greenhouse gases (GHGs) other than CO<sub>2</sub> emitted from soils. This relationship can be summarized as the TSC equation:

$$\text{TSC (kg ha}^{-1} \text{ yr}^{-1} \text{ CO}_2\text{-C)} = \text{SOC} - \text{DE} - \text{IE} - \text{GHG}$$

Increases in TSC can be achieved by gains in SOC, or by decreases in DE, IE and GHG, or by a combination of these. Literature values for energy usage on-farm and in

the production of inputs can be used in the calculation, as well as default values for emissions of N<sub>2</sub>O and CH<sub>4</sub> under different management scenarios (King et al., 2004).

The calculation of TSC requires an estimate of the annual rate of change in SOC. According to standard methods of modelling SOC dynamics (first order kinetics), this rate declines with time and eventually becomes insignificant as the soil approaches a new equilibrium SOC content. There is no consensus on how long it takes to achieve equilibrium SOC contents: SOC models like ROTH-C are generally run for 100 years after a perturbation in order to obtain some certainty about the equilibrium SOC contents (Webb et al., 2003), yet King et al. (2004) assumed that gains in SOC were negligible by 10 years after a change in soil management.

The source of the C used to increase SOC levels also needs to be considered. When C is imported from off-site, e.g. as livestock manure or crop residues, there are off-site emissions (OSE) associated with that C source, that need to be included in the TSC equation to get a true estimate of the sequestration benefit of increasing SOC in this way.

### **Crediting management-related changes in TSC on agricultural land**

Changes in SOC due to soil management could be incorporated into the UK Greenhouse Gas Inventory (Baggott et al., 2007). A similar approach to the method currently used to estimate changes in SOC due to changes in land use (e.g. from cropland to grassland) could be adopted to reflect changes to C sequestering practices (e.g. from conventional to organic production). This would require the estimation of rates of change in SOC for different management systems, and an inventory of land areas under improved management. The DE, IE and GHG values used to calculate TSC on a given area of land, are already accounted for in the National Inventory under the Energy, Industrial and Agriculture sectors. In order to maximise C sequestration in soils, a reward system for C sequestration by individual farmers would be desirable. This would require agreement on the baseline conditions for calculation of TSC. While the UK Greenhouse Gas Inventory uses a 1990 baseline, this may penalize farmers who are already farming in a relatively C-efficient way, as they will find it difficult to further increase their TSC. A better option may be to estimate the maximum potential SOC values for a given soil and climate (SOC<sub>max</sub>), under optimum agricultural land management, and reward farmers based on their actual SOC contents (SOC<sub>act</sub>) relative to optimum levels. Separately, emissions from DE, IE and GHG, as well as OSE from imported C sources, could be calculated. While this approach would provide clear incentives to individual farmers to maximize C sequestration, it would require detailed estimates of the maximum potential SOC values for all soil types in the UK, and separate agreements with individual farmers. The design of a system to reward individual farmers for C sequestration presents logistical challenges. Alternatively, the evidence for generally higher SOC in soils under organic management would support claims for an additional payment, for example under the UK Government's Organic Entry Level Scheme (OELS). Currently, the OELS pays organic farmers £30 per hectare in recognition of the public goods of enhanced biodiversity and reduced pollution that they deliver. Under the OELS, it would be possible to provide recognition of the higher average SOC levels achieved by organic farming, and the ecosystem services including C mitigation, that this provides.

## Conclusions

Research results have consistently shown that for similar crops and soil types, organic farming practices which include compost or FYM results in higher levels of SOC than conventional farming practices. Nationally, the C sequestration benefits of these increases could be accounted for in a similar way to the current method of calculating SOC change in the LULUCF sector. At the farm scale the ecosystem services provided by SOC could be recognized by rewarding organic farmers for maintaining high SOC through the existing UK OELS.

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# A comparison of energy use in organic and conventional agriculture in Spain

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Key words: Organic Farming, Ecological Agriculture, Agroecology, Sustainable Agriculture, Energy Efficiency.

## Abstract

*The current situation of worldwide concern over the emission of greenhouse gases and its effect on the climate demands an evaluation, from the perspective of energy efficiency and more specifically of non-renewable energy sources, of tendencies for change in the management of agricultural systems that have arisen in recent years. This article uses energy balances to evaluate the contribution of organic agriculture to the increase in the energy efficiency of Spanish agriculture. The results show the higher nonrenewable energy efficiency (NREE) and the lower use of nonrenewable energy (NRE) in organic systems compared with conventional ones. Nevertheless, agricultural systems in general could still improve their energy efficiency.*

## Introduction

In recent decades concern has grown among researchers and society as a whole over the sustainability of farming. Within the European Union this interest has mainly arisen in relation to its environmental problems and their repercussions for food safety. A sign of interest in sustainability is the growth of organic agriculture, which occupied about 31 millions hectares in the world by 2006, of which more than 925,000 ha were in Spain. Therefore, the vast surface area occupied by organic agriculture guarantees that any change in management to save on fossil energy will have a very high impact.

The environmental and socioeconomic benefits anticipated from switching to organic management are multifold: an increase in biodiversity, a reduction in pesticide residues in the environment, less erosion, an increase in edaphic organic material, higher income for farmers, etc. (Alonso *et al.* 2001, Gliessman 1997, González de Molina & Guzmán, 2006). With respect to energy, we can expect organic production to contribute significantly to saving nonrenewable energy (Pimentel *et al.* 1983, Dalgaard *et al.* 2001, Wood *et al.* 2006), although this is not always the case (Pimentel *et al.* 1983, Helander and Delin 2004).

In this article we aim to evaluate the contribution of organic agriculture to the increase in energy efficiency of Spanish agriculture, estimating its potential contribution to the reduction of nonrenewable energy consumption. We also will discuss some proposals for improving the energy efficiency of agriculture in general and of organic agriculture in particular.

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## Materials and methods

To compare the NREE (ratio of the final output and the NRE used) and the NRE consumption we analyzed 160 cases in Spain: 80 organic and 80 conventional farms (comparison by pairs). The selection of comparable cases was based on three basic criteria: history, proximity and similarity. The organic farmers were chosen at random according to how long they had been producing organically, as it takes time to establish management practices and to overcome a possible downward turn in production following the switch to organic farming. These farmers had all been operating for between 4 to 17 years. Conventional farms were chosen according to their proximity and similarity to organic ones, usually those with neighbouring plots (in order to ensure similar agro-climatic conditions) and/or with other similar characteristics (dry land or irrigated land, varieties used...). Certain aspects of management were also discussed and verified with technicians from the zones. The organic and conventional farmers were interviewed in person to obtain detailed information on management techniques, types of machinery and inputs used. The interviews were conducted from March to July 2006.

For the purposes of calculating energy efficiency, input refers to those sources of energy brought in that have an opportunity cost in an economic sense. The energy value of agricultural inputs takes into consideration both the energy used in the transformation of the products into the state in which they are used by farmers and inherent energy. Energy output refers to the energy content of the material produced from the agricultural activity. The main references used for the energy conversion are Ausdley *et al.* (1997), Fluck (1992), González de Molina & Guzmán (2006), Green (1987) and Mataix & Mañas (1998). The unit of analysis for the comparisons is the hectare.

## Results and discussion

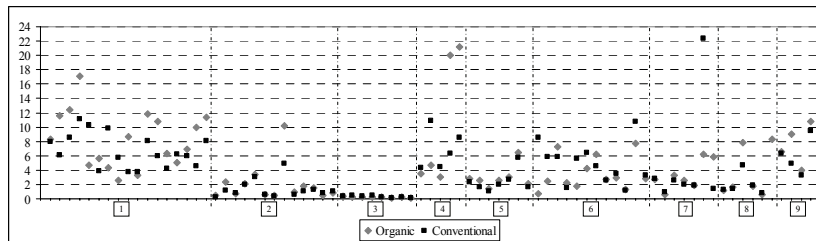
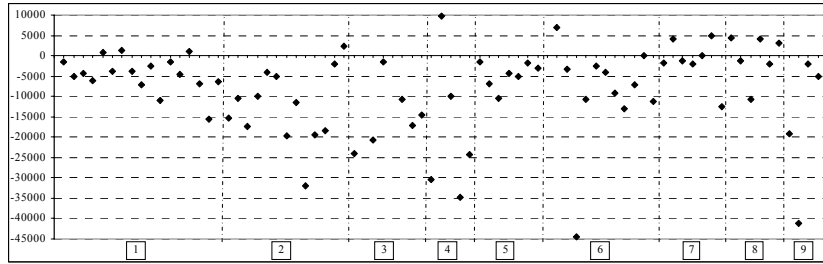


Figure 1: Non-Renewable Energy Efficiency in organic and conventional crops





**Figure 2: Differences of Non-Renewable Energy consumption: organic minus conventional crops (MJ/ha)**

Note: 1 = Cereals and legumes; 2 = Vegetables; 3 = Greenhouse vegetables; 4 = Citrus trees; 5 = Olive trees; 6 = Fruit trees; 7 = Vineyard; 8 = Nuts; 9 = Tropical fruits

Figure 1 shows the NREE in organic and conventional crops. In most of the cases this indicator is higher in organic systems. Figure 2 shows the differences in NRE consumption between organic and conventional crops. Only 11 conventional cases (of the total of 80) have a lower use of NRE.

The main causes of these results are the use of machinery and chemical inputs. In general, the practice that uses more energy in organic production than in the conventional system is mechanical weed control, which in conventional production is partially replaced by the use of herbicides. Some organic farms use more energy because greater quantities of compost are incorporated into the soil without the use of adequate machinery, or because too high amounts of industrial inputs (copper, fertilizers, etc.) are used. However, organic production saves much more energy on pesticide and herbicide treatments and on chemical fertilizers (especially nitrogen, which has a very high transformation and inherent energy).

On the other hand, there are two factors that contribute to reducing the NREE of the agricultural systems: the greenhouse structure (metals, plastics, concrete, etc.) and the irrigation system. As we can see in the Figure 1, all the greenhouse cases (organic and conventional crops) have a NREE less than one; this means that energy input is greater than energy output. The influence of the irrigation system can be seen in vegetables, the majority of which have an NREE under 2; some cases are energy-inefficient.

## Conclusions

Based on the results obtained, it could be concluded that organic farming is contributing effectively to improving NRE efficiency and to saving NRE in Spain. Nevertheless, there is room for further improvement in the sustainability of organic farming through greater self sufficiency within the territory it occupies and, consequently, lower flow of imported energy originating from other ecosystems. The use of local resources such as compost and temporary plant covers (mainly in trees) is a strategy that helps to reduce non-renewable energy consumption. Moreover, it is feasible to cut down further on the unnecessary use of machinery for soil preparation and weed control. This should be limited to those occasions when it is strictly necessary.

## Acknowledgments

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# The Comparative Energy Efficiency of Organic Farming

Azeez, G.S.E & Hewlett, K.L.<sup>1</sup>

Key words: organic farming, energy, climate change, agriculture, food

## Abstract

*Organic farming is generally a more energy efficient system of food production. Comparative analyses of fifteen crop and livestock sectors indicate that UK organic farming uses around 26% less energy per tonne of output on average. The main energy saving is from the non-use of industrially produced inorganic nitrogen fertiliser. Organic farming is more energy efficient for wheat, most field vegetables, milk, red meat and pigs, but it is less efficient for poultry production.*

## Energy use in agriculture

Agricultural fossil fuel energy use is important for its contribution to climate change via carbon dioxide emissions and is the only global warming factor which has been fully measured for several organic and non-organic farming sectors in one country. It also has important socio-economic implications due to the predicted long-term decline in global supplies of oil and gas and the associated rise in energy prices. This is expected to increase the cost of food and may increasingly affect food availability and security in some cases, adding to the problems for future food supplies that are likely to arise from climate change and population increase.

In UK, most of farming has been industrialised. This means that most of the energy used in agriculture is now used *before* the farm in the manufacture of inputs such as fertilisers, pesticides, farm machinery, animal feed grain, and veterinary drugs. On the farm, energy is used in the form of transport fuel for machinery and heating glasshouses, for operations such as crop drying and milking, and for heating, lighting and ventilating the 'factory' farms that rear indoor pigs and chicken.

Organic farming aims to replace industrial processes with natural processes, as far as possible. It is intended to be a more sustainable system, so it is important to know to what extent this is true for energy. The UK Government has funded 'Life Cycle Analyses' of ten organic and non-organic sectors. These were carried out by Cranfield University (Williams *et al*, 2006) and updated recently (Williams, 2007). An earlier government-funded desk-study had also looked at organic energy use for five vegetables (carrots, onions, calabrese, cabbage and leeks) that were not analysed by Williams *et al*. (MAFF, 2000). These findings are analysed in this paper.

The results of the two studies are shown in the table below, columns 3 and 4, and from these a comparative energy efficiency figure was derived for organic production in each sector and on average. To determine the significance of these findings, we multiplied the energy use/t by the annual national production of each of the sectors. This enabled us to establish the total energy use for each sector and to assess the energy reductions that could be achieved if the whole national production of these sectors were organic. However, we excluded tomatoes from our calculation of the

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average energy use of organic farming on the grounds that the energy data is only for 'long-season' tomato production in heated glasshouses. This is little used in the UK organic sector

## Results

Table summarising the findings of UK Government studies on non-organic and organic farming energy use and of the further analysis by the Soil Association:

Sector	Organic energy use/t as % of non-organic	Non-organic energy use/t, GJ	Organic energy use/t, GJ	UK production t/yr, 2006 (Defra, 2006, 2007)	Total UK energy use, GJx10 <sup>6</sup>	Total UK energy use if all organic, GJx10 <sup>6</sup>	Change in energy use if all organic, GJx10 <sup>6</sup>
Milling wheat	84%	2.40	2.02	6,115,000	14.67	12.35	- 2.33
Oilseed rape	103%	4.85	4.99	1,870,000	9.07	9.33	0.26
Potatoes	114%	1.49	1.71	5,684,000	8.49	9.70	0.21
Carrots	75%	0.60	0.45	718,500	0.43	0.32	-0.11
Cabbage	28%	0.90	0.25	262,700	0.24	0.66	-0.17
Onion	84%	1.25	1.05	404,500	0.51	0.42	-0.08
Calabrese	51%	3.70	1.90	86,900	0.32	0.17	-0.16
Leeks	42%	0.95	0.40	49,800	0.05	0.02	-0.03
Beef	59%	26.54	15.56	869,000	23.06	13.52	-9.54
Sheep	43%	24.99	10.79	333,000	8.32	3.59	-4.73
Pigmeat	65%	21.97	14.28	670,000	14.72	9.57	-5.15
Milk (unit =1 m <sup>3</sup> )	72%	2.55	1.83	13,720,000	34.99	25.13	-9.86
Eggs (unit=20,000 eggs)	110%	13.66	15.00	443,000	6.05	6.64	0.59
Poultrymeat	111%	15.17	16.89	1,500,000	23.40	26.04	2.57
Long season glasshouse tomatoes	130%	122.00	159.00	82,684 (for all tomatoes)	10.09	13.15	3.06
Average (excluding tomatoes)	74%						-27.51 (-19%)

### Results: how the agricultural sectors compare in their energy use

Of the fifteen sectors, the results of the studies show that cabbages, leeks, carrots and onions, i.e. traditional British vegetables, are the least energy demanding foods (using less than or around 1GJ/t). Arable crops and milk are next (using a few GJ/t). Then

come meat and eggs (10-30 GJ/t). Finally, heated glasshouse vegetables are highly energy intensive (using over 100 GJ/t). This is an order of magnitude greater than other foods.

However, the real significance of the energy use/t figures depends on the comparative production of each food, as a food with a low energy use/t can still have a significant impact nationally if it is produced and consumed in large quantities. Despite its relatively low energy use per unit volume, the single largest user of energy among the food sectors is milk because of the large quantity produced.

### **Results: organic farming energy use**

According to these studies, UK organic farming is more energy efficient than non-organic production in nine sectors, similar in one, and less efficient in four sectors. Organic farming is more energy efficient for the production of wheat, green vegetables (calabrese, leeks, cabbage), carrots, onions, milk, red meat (beef and sheep) and pigs. On average, these sectors used 40% less energy/t when produced organically, with the biggest energy savings in green vegetables and red meat. Energy use for oilseed rape was similar in both systems, while organic farming was found to be less energy efficient for: potatoes (using 14% more energy); poultrymeat (11% more); eggs (10% more); and 'long season' heated glasshouse tomatoes (30% more).

On average (excluding data for tomatoes), UK organic farming is about 26% more energy efficient per tonne. When total national energy use is considered, it can be seen that switching current UK production to organic farming would reduce agricultural fossil energy use by around 20%. Organic farming offers the greatest contribution to reducing national energy use in the milk and beef sectors, also with significant energy savings for sheep and pigs, and smaller savings for wheat.

### **Discussion: factors in organic energy use**

The main reason for the energy efficiency of organic farming is because it does not use inorganic nitrogen fertiliser. Nitrogen (N) fertiliser is the single main use of energy in farming, accounting for 37% of the total energy use (Defra, 2005). N fertiliser is extremely energy intensive, because the raw material is fossil fuels (usually natural gas) and also due to the high energy demands of the manufacturing process - each kg of N in fertiliser requires 41MJ of energy to produce (Mortimer, 2003). UK farmers use about 1 million tonnes of N in the form of fertiliser each year (AIC, 2005). More broadly, organic farming is energy efficient because it does not rely on industrial inputs, instead harnessing natural ecological and biological processes to carry out the functions that farmers need.

In North West Europe, lower yields are the main weakness of organic farming for energy efficiency. However, this is not true for the rest of the world, where organic yields are similar or higher in comparison to non-organic yields. Contrary to perceptions, organic and non-organic field crops use a similar amount of machinery per hectare: there is more use of mechanical weeding for some crops, but less use of machinery for spraying agro-chemicals. The yield differential between the systems is likely largely due to the disproportionate R&D investment into non-organic crop development over the last 60 years. As the development of organic systems progresses, yields and thus energy efficiency should continue to increase. An exception is poultry. Non-organic poultry production is very energy efficient because of the high 'animal feed to meat' conversion rates of factory farmed chickens. However,

the organic movement does not believe that continued factory farming is a valid option due to its unacceptable standards of animal welfare and reliance on antibiotic drugs.

There are several concerns about the farm management data used in Cranfield University's study, according to an independent critique (Watson, 2007), suggesting that more accurate data would yield figures even more favourable for organic farming.

### **Recommendations for reducing energy use**

In conclusion, the harnessing of natural biological and ecological processes employed by organic farming is more energy efficient than using industrially manufactured farm inputs. Policymakers should therefore promote a wider uptake of organic farming to reduce agricultural energy use. Food choices are important too; for an energy-efficient and climate-friendly diet it is recommended that people and businesses buy food that is: organic, seasonal, local, unprocessed, and with less meat.

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# Impact of different Agricultural Systems and Patterns of Consumption on Greenhouse-Gas Emissions in Austria

Freyer, B.<sup>1</sup> & Weik, S.<sup>2</sup>

Key words: greenhouse-gas emissions, CO<sub>2</sub>-equivalents, organic farming, nutrition patterns, scenarios

## Abstract

*Agricultural systems as well as consumer patterns influence the green house gas emissions. Therefore, we analysed different farming systems, consumption patterns and seasonal oriented food consumption. Whereas conventional production and the current meat oriented nutrition patterns lead to high green house gas emissions, there is a tremendous reduction potential, if products are organically produced and if there is a shift to vegetarian-based diets.. Nevertheless, there is a need for research in terms of data quality, and a differentiation of farming systems as well as nutrition patterns.*

## Introduction

Agricultural systems follow different approaches in their energy budget. Conventional crop rotation systems uses plants with a low capacity for potential carbon sequestration in soils, e.g. with cropping systems like – winter wheat - winter barley - rape, where the root mass of the rotation is on average 0.8-1.5t DM ha<sup>-1</sup>a<sup>-1</sup>. In the contrary, organic cropping systems have the following rotation patten:- red clover - red clover - winter wheat - green manure – potatoes - grain legumes - green manure - winter rye - green manure - summer barley. The biomass output of the root system in organic crop production is 2.5-3.5t DM ha<sup>-1</sup>a<sup>-1</sup> (Freyer 2003), which is more than double the conventional output. Additionally the organic system fixes between 50-90 kg N ha<sup>-1</sup>a<sup>-1</sup>. Several authors outline that the organic system has a high potential to reduce greenhouse-gas emissions (Dalgaard et al. 2003, Haas et al. 2001, Bockisch 2000, Haas et al. 1995). Furthermore, animal husbandry systems, where the whole fodder is organic, the fodder input and livestock per hectare are limited, and serve to impact positively on the reduction of greenhouse gas emissions (Koerber and Kretschmer 2000).

Agriculture is responsible for 14% of the global greenhouse-gas emissions (Stern 2006). Rough estimations state that nutrition and all related processes are responsible for 15 to 20% of the current energy consumption in developed countries (Jungbluth 2000). The most important factor in the food chain is animal production as well as consumption patterns with a high share of meat (Taylor 2000). There is no doubt that consumer nutrition habits influence the green house gas emissions, especially if they prefer vegetable instead of meat. Besides these positive effects, the adoption of nutrition would reduce human diseases, which are a result of malnutrition and super-nutrition (Elmadfa et al. 2003; Kiefer et al. 2002).

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## Objectives

The aim of the study was to investigate the impact of agricultural production systems and different nutrition patterns on greenhouse-gas emissions in Austria.

## Methods

The potency of the individual greenhouse gases is taken into account by the concept of the global warming potential (CO<sub>2</sub>-equivalents). Based on this indicator we compared the current status quo with three scenarios to make a total of four scenarios:

- Scenario 1: Status quo: conv. agriculture/nutrition-average: average of Austrian nutrition pattern with conventional products.
- Scenario 2: org. agriculture/nutrition-average: average of Austrian nutrition pattern with bio-products.
- Scenario 3: conv. agriculture/nutrition-opt.: optimised nutrition pattern with conventional products.
- Scenario 4: org. agriculture/nutrition-opt.: optimised nutrition pattern with bio-products.

The average nutrition pattern of adult Austrians (S1) was derived from Austrian consumption statistics (Statistik Austria 2003). These we compared with standard nutritional science recommendations (DGE 2004). Data on greenhouse gas emissions for the production cycle of foods from the databank GEMIS 4.2 and from literature were used to calculate and compare the annual per capita emissions of the different nutrition patterns. Greenhouse-gas emissions for agricultural production and processing of foodstuff were calculated. Some simplifications and estimations were necessary because of lack of data on organic drinks, coffee, tea, cocoa, nuts, alcohol, processed organic foods among others. The food life cycle phases at transportation, trade and at household levels, which take place after agricultural production were not part of the analysis. Also in this sector we assumed, that if we account for these effects, the organic result would be better than conventional, because of regional oriented consumption patterns.

## Results and discussions

There is a higher consumption of bread, vegetable and fruits in the recommended nutrition level. As a result of this, the fresh matter (FM) of recommended food consumption increased from 644.4 kg capita<sup>-1</sup> a<sup>-1</sup> in the average to 723.0 kg capita<sup>-1</sup> a<sup>-1</sup> in the recommended nutrition levels (Table 1). The analyses showed that greenhouse gas emissions caused by the current Austrian nutritional pattern can be reduced fundamentally. The change of products from conventional (S1) to organic production (S2) reduces the emissions by 30%. A change of nutritional pattern from the average (S1) to the recommended level of conventional products (S3) results in a reduction of the emissions by 16%, but the emission further reduces to 39% if there is change to the recommended level of bio-products (S4). The realisation of scenario 4 means a tremendous change in nutritional style; the food quality change (to organic products) as well as the daily food consumption pattern (to recommended levels). Based on a total of 10.6t CO<sub>2</sub>-equivalents per capita and year, the adaptation contributes to a reduction of 4.7% (the last statement is not in the table).

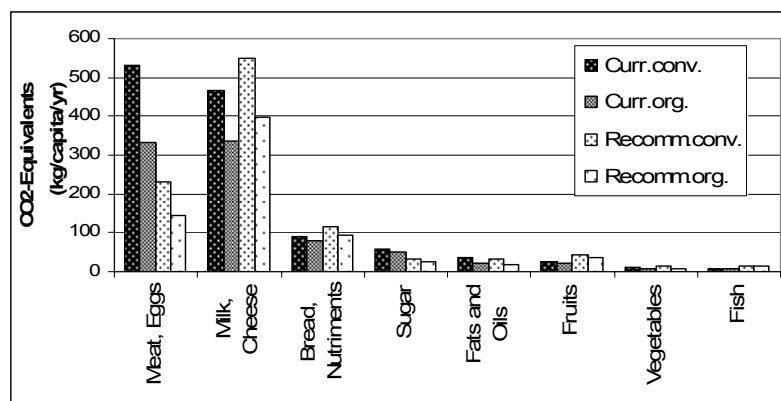


**Tab. 1: Scenarios on greenhouse-gas emissions based on agriculture system and nutrition patterns**

Agriculture and Nutrition Pattern	Total Food Consumption	CO <sub>2</sub> -Equivalents (E)	Savings versus Scenario 1	
Scenarios (S)	kg FM capita <sup>-1</sup> yr <sup>-1</sup>	kg capita <sup>-1</sup> yr <sup>-1</sup>	kg CO <sub>2</sub> -E	%
1 Conv. Agriculture (S1)	644	1230	-	-
2 Org. agriculture (S2)	644	856	374	30.4
3 S1+recomm. Conv. Nutrition (S3)	723	1031	199	16.2
4 S2+recomm. organic nutrition (S4)	723	742	489	39.7

Source: own

Our results further indicated that the most important effects is realised with a change of meat, milk and cheese production and consumption to vegetable-based diet (Figure 1).



**Figure 1: Greenhouse-gas emissions for product groups and nutrition patterns**

Source: own

The most important effect is realised with a change of meat, milk and cheese production and consumption (Figure 1). There is a slightly increase of CO<sub>2</sub>-equivalents with organic products and recommended nutrition pattern in terms of bread, nutriment, fruits, vegetables and fish, but not essential for the total emissions.

### Conclusions

The calculations have shown that there is a high potential to reduce greenhouse-gas emissions by changing the agricultural system as well as the nutrition pattern towards a healthy nutrition. Several data of the organic production are over estimated in the estimation process, because of a lack of data on organic production. Both the conversion to organic agriculture as well as in nutritional patterns imply a high

challenge for society. Additional costs are common arguments against the purchase of organic products, but the change in nutritional patterns implies the possibility to reduce costs because of lower meat consumption. In contrast to this, the change in consumption of milk products to the recommended levels, which could be an increase of cost for the consumer, does not change the carbon emissions. Further investigations are needed for a detailed analysis of different nutrition patterns and their effect on both greenhouse-gas emissions as well as food costs. The production potential of organic products also need to be studied.

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# Emission of Climate-Relevant Gases in Organic and Conventional Cropping Systems

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Key words: greenhouse gas emission, carbon cycle, C sequestration, farming system

## Abstract

*In 81 commercial farms in Germany, emissions of the greenhouse gases CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O from crop production have been computed by model-based analyses. The considered influence factors comprise farm structure, mass and energy inputs as well as cultivation methods. A linear correlation was found between energy input and greenhouse gas potential. Due to lower N and energy inputs and also higher C sequestration as a result of humus restoration, the organic farms revealed area-related emissions (785 kg CO<sub>2</sub> eq ha<sup>-1</sup> a<sup>-1</sup>) that were 2.75 times lower than the emissions from conventional farms (2165 kg CO<sub>2</sub> eq ha<sup>-1</sup> a<sup>-1</sup>).*

## Introduction

According to the latest IPCC report, the mean global temperature is going to increase by 1.0 to 6.3 °C by the end of the 21st century, if greenhouse gas emissions continue to rise unhampered. Rainfall intensity and flood hazards will increase just as the duration of drought and heat periods, with other words: extreme weather situations will occur more frequently. In all spheres of the society, especially in agriculture, strategies have to be developed for an adaptation to the climatic changes, but also for the protection of the global climate. Is organic farming able to render an effective contribution to the protection of the atmosphere? Which level reach greenhouse gas emissions in organic farming compared to other forms of land use? Are there mitigation potentials and if so, how efficient can they be used? Statements to these questions will be made below using results from model-supported analyses of the greenhouse gas emissions from organic and conventional farms in Germany.

## Materials and methods

In recent years, a model program has been developed by us that allows to estimate the emission of the greenhouse gases CO<sub>2</sub>, N<sub>2</sub>O und CH<sub>4</sub> on the level of farm systems in form of energy and mass balances. The emissions are converted into CO<sub>2</sub>-equivalents [CO<sub>2</sub> eq]. Depending on the radiation absorption and the retention time in the atmosphere, the greenhouse potential of CH<sub>4</sub> amounts to 23, that of N<sub>2</sub>O to 296, related to the efficiency of CO<sub>2</sub> (= 1).

The following balancing methods have been integrated into the model:

- Balancing of energy fluxes. Consideration is made of direct (diesel fuel, electricity, solid fuels) and indirect energy input (manufacturing and transport of

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<sup>2</sup> As Above

fertilizers, pesticides, machines). The energy input is the basis for deriving CO<sub>2</sub> emissions (Küstermann et al. 2007).

- Balancing of nitrogen fluxes in the system soil – plant – animal – environment. Our model program includes methods for estimating N flows and N pools by means of management data like N<sub>2</sub> fixation efficiency, manure N production, N turnover in the soil (Küstermann et al. 2007). N<sub>2</sub>O emissions from the soil are calculated with regard to the N input.
- Balancing of carbon fluxes in the system soil – plant – animal – environment (Küstermann et al. 2007a). We estimate the C sequestration in soils depending on crop rotation, fertilization and tillage (humus accumulation and depletion). In livestock keeping, metabolic CH<sub>4</sub> emissions are calculated with consideration of feeding.

The model software has been applied in 33 organic (org) and 48 conventional farms (con) located in different soil and climatic regions of Germany. To ensure comparability, only emissions from crop production have been demonstrated.

## Results

Between organic and conventional farms, grave differences were disclosed concerning structure, mass and energy inputs, yields, C-sequestration and greenhouse potentials (Table 1), but also among organic as well as conventional farms deviations are enormous. The mean energy input in organic farms reaches 5.6 GJ ha<sup>-1</sup> a<sup>-1</sup>. Due to differences in cropping structure and intensity, some farms exceed this level by up to 100 %. In the conventional farms, mineral fertilizer and pesticide application cause markedly higher energy inputs (12.6 GJ ha<sup>-1</sup> a<sup>-1</sup>). Yields and energy fixation in the ecofarms (28 to 192 GJ ha<sup>-1</sup> a<sup>-1</sup>) reveal a wider variation than the corresponding values of the conventional farms (51 to 192 GJ ha<sup>-1</sup> a<sup>-1</sup>). Energy fixation depends on the cropping system, site specific yield potentials and the use of the produced biomass. High energy fixation is achieved with a high harvest index, for example when the byproducts and also catch crops are used. Organic farming consumes clearly less energy per unit area and reaches higher efficiency levels per unit product (output/input ratio, Table 1). C sequestration in the soil organic matter varies broadly. On average, organic farms accumulate humus (+ 110 kg C ha<sup>-1</sup> a<sup>-1</sup> = reduction of the greenhouse potential by 415 kg CO<sub>2</sub> eq ha<sup>-1</sup> a<sup>-1</sup>), whereas conventional farms have depleting humus contents (-40 kg C ha<sup>-1</sup> a<sup>-1</sup> = 150 kg CO<sub>2</sub> eq ha<sup>-1</sup> a<sup>-1</sup>). This can be explained by differences in crop rotations (high legume share (org) vs. high root crop and cereal proportion (con)) as well as in quantity and quality of the supplied organic matter.

Due to lower N and energy inputs, clearly lower N<sub>2</sub>O and CO<sub>2</sub> emissions were computed for the organic farms than for the conventional counterparts. The conventional farms emitted 2165 kg CO<sub>2</sub> eq ha<sup>-1</sup> a<sup>-1</sup> on average. This exceeds the calculated emissions from the organic farms (785 kg CO<sub>2</sub> eq ha<sup>-1</sup> a<sup>-1</sup>) by the 2.75 fold. The product-related differences (per GJ) are smaller on grounds of much lower energy fixation on organic farms.

**Tab. 1: Farm structure, mass and energy budget as well as greenhouse gas emissions in crop production. Analysis of 81 commercial farms in Germany**

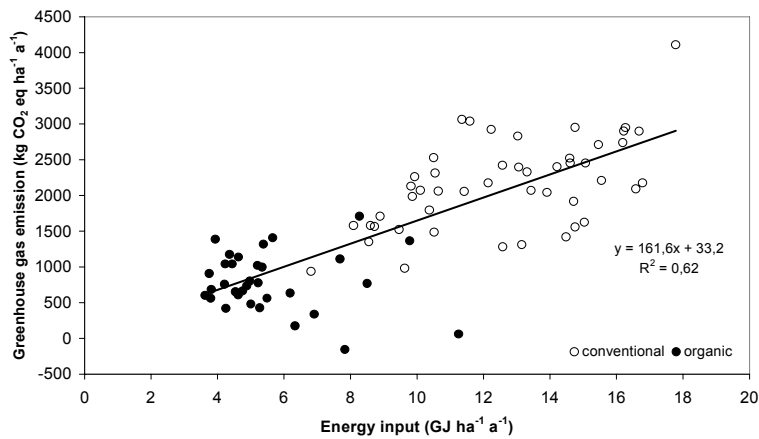
Parameter	Measuring unit	org (n = 33)		con (n = 48)	
		Mean	(Min – Max)	Mean	(Min – Max)
<b>Farm structure</b>					
Livestock density	LSU ha <sup>-1</sup>	<b>0.3</b>	0 – 1.5	<b>0.6</b>	0 – 2.7
Cereal proportion	% of AA	<b>48</b>	14 – 67	<b>57</b>	30 – 77
Legume proportion	% of AA	<b>33</b>	15 – 46	<b>7</b>	0 – 18
<b>Inputs and Outputs</b>					
Energy input	GJ ha <sup>-1</sup>	<b>5.6</b>	3.6 – 11.3	<b>12.6</b>	6.8 – 17.8
N input	kg N ha <sup>-1</sup>	<b>149</b>	69 – 285	<b>236</b>	116 – 339
Energy fixation	GJ ha <sup>-1</sup>	<b>75</b>	28 – 192	<b>127</b>	51 – 192
Output/Input ratio	GJ GJ <sup>-1</sup>	<b>12.6</b>	5.6 – 24.4	<b>9.9</b>	6.4 – 13.6
<b>Greenhouse gas potential</b>					
CO <sub>2</sub> emission, (energy input)	kg CO <sub>2</sub> eq ha <sup>-1</sup>	<b>349</b>	215 – 526	<b>707</b>	337 – 1023
C sequestration in humus*	kg CO <sub>2</sub> eq ha <sup>-1</sup>	<b>-415</b>	-575 – 1766	<b>150</b>	-915 – 1255
N <sub>2</sub> O emission	kg CO <sub>2</sub> eq ha <sup>-1</sup>	<b>852</b>	387 – 1552	<b>1307</b>	643 – 1865
Greenhouse potential	kg CO <sub>2</sub> eq ha <sup>-1</sup>	<b>785</b>	-155 – 1709	<b>2165</b>	937 – 4109
Greenhouse potential	kg CO <sub>2</sub> eq GJ <sup>-1</sup>	<b>12.6</b>	-1.1 – 28.7	<b>17.4</b>	10.7 – 27.4

\* Positive values indicate humus reduction and release of soil-bound C to the atmosphere, negative value indicate humus accumulation and recovery/return of C from the atmosphere into the soil.

There is a linear relationship between energy input and greenhouse potential; with increasing input of mineral N and energy rise the area-related N<sub>2</sub>O and CO<sub>2</sub> emissions (Fig. 1). Calculations of greenhouse potentials take into account also C sequestration, symbiotic N<sub>2</sub> fixation, energy inputs with the use of machines and fuel. This explains the enormous variability of CO<sub>2</sub> emissions from organic and conventional farms.

## Discussion

The statements made here agree basically with the results obtained by use of the same method in a spatially more limited agricultural region, the Tertiary hills in Bavaria (Küstermann et al. 2007). The increased number of investigated farms (81 vs. 28) makes the results presented in this paper more reliable. Moreover, farm-specific and site-related effects on greenhouse gas emissions can be analysed more profoundly because of the widely differing farm systems involved in this study.



**Figure 1: Greenhouse gas emissions in dependence on the energy input**

At present, major uncertainties exist in modelling N<sub>2</sub>O emissions; our model as well can only estimate potential emissions. This is problematic because of the high specific greenhouse gas potential of N<sub>2</sub>O. Therefore, additional N<sub>2</sub>O measurements have to be made in order to survey site and management effects, to mark the scope of error and to improve the model software.

### Conclusions

Our investigations allow to draw conclusions on management optimization and mitigation of greenhouse gas emissions. The farm enterprise lies in the focus of our analyses, because on this level management decisions have to be taken, which have impacts on environment and climate. The mitigation of emissions requires to identify problematic sectors in farms and to derive coordinated measures and strategies.

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# Can Organic Farming Contribute to Carbon Sequestration? A Survey in a Pear Orchard in Emilia-Romagna Region, Italy

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Key words: Organic Carbon Sequestration, Organic farming, Pear orchard

## Abstract

*The effect of organic fertilisation on the level of total organic carbon (TOC) in an 18-years old pear orchard (cv. Abate Fetel) was evaluated vs. a conventional pear orchard mineral fertilized (control). In both orchards soil samples (Typic Udochrept loamy soil) were taken at two depths (0-15 and 30-50 cm) along the row (tilled and mainly amended with compost) and in the inter-row space (grassed with different Graminaceae species in the organic orchard, bare in the conventional orchard). The area (elevation 20 m), located in Bologna province, Emilia-Romagna Region (Italy), is characterised by mean annual temperature 13.1 °C and rainfall around 750 mm.*

*In the horizon 0-15 cm of the row an increase of about 14 tons ha<sup>-1</sup> of TOC has been calculated after 18-years of cultivation and amendment compared to the control soil, which had received just mineral fertilisation. A significant increase of TOC (about 6.3 tons ha<sup>-1</sup>) was also measured in the top layer (0-15 cm) in the grassed inter-row, where this C sink is exclusively due to the cover crop. A survey of the role of organic vs. conventional farming on soil C sink/source is started in 2007 in 8 typical organic orchard farms located in Emilia-Romagna Region and it is still running.*

## Introduction

Soil organic carbon (C) preservation in agro-ecosystems is a crucial point to maintain soil fertility and productivity and to reduce losses of CO<sub>2</sub> in the atmosphere. The use of different soil management can contribute to the soil carbon sequestration and its distribution in the soil profile (Lal, 2002) to mitigate the greenhouse effect (Lal, 2003).

Organic farming has been reported to have a positive effect on C sequestration as a result of increased root yields, higher humification rate constant and the direct application of organic matter through organic amendments (Ciavatta et al., 1997; Francioso et al., 2000; 2005; Kundu et al., 2007; Bhattacharyya et al., 2007). In order to increase the level of organic C in the top layer of soil, perennial grass species are often used in organic orchards.

Aim of this study was to determine the contribution of organic amendment to the soil carbon sink in an 18-years old pear orchard (cv. Abate Fetel) vs. a conventional pear orchard mineral fertilized (control).

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<sup>2</sup> As Above

<sup>3</sup> As Above

## Materials and methods

Soil samples (Typic Udochrept loamy soil) were taken from an 18-years old, organically fertilised pear orchard (cv. Abate Fetel) of a certified organic farm located in San Matteo della Decima (Bologna), Emilia-Romagna Region (Italy) and from a mineral fertilised pear orchard of a conventional orchard (control) located about 100 m far away. The area (elevation 20 m) is characterised by the following mean climate conditions (1921-2004): mean annual temperature 13.1 °C and rainfall around 750 mm. Along the 18-years the main organic fertilisation was done with 4-6 tons ha<sup>-1</sup> of compost (28% organic C, 2.5% total N, 2.3 organic N, P<sub>2</sub>O<sub>5</sub> 1.4%, K<sub>2</sub>O 1.7%). Compost was prepared by composting (130 days period) a blend of 70% (v/v) plant trimming (mowing and pruning) and 30% (v/v) sewage sludge (50% waste waters and 50% food processing). The yearly nitrogen mineral fertilisation was around 90 kg N ha<sup>-1</sup> (ammonium sulphate and urea).

In both orchards soil samples (4 samples per plot) were collected at the end of April 2006 from four plots at two depths (0-15 and 30-50 cm) along the row (tilled and mainly amended with compost) and in the inter-row space (grassed with different perennial Graminaceae species in the organic orchard, bare in the conventional orchard). The choice of the two sampling layers was related to the tillage depths (around 20 cm): the top layer (0-15 cm) was annually tilled, while the deep layer (30-50 cm) did not undergo any tillage. After sampling soil samples were air dried, crushed to pass a 2 mm sieve and stored in sealed bags, according to Italian Official Methods of Soil Analysis (2000).

The main physical-chemical characteristics of the organic orchard soil were: pH (in water) 7.98; Texture: sand 30%, silt 48%, clay 22%; Total carbonates (CaCO<sub>3</sub>) 14%; Bicarbonates (HCO<sub>3</sub><sup>-</sup>) 5.1%; Cation exchange capacity 23 cmol<sub>c</sub> kg<sup>-1</sup>; Total organic carbon (TOC) 9.5 g kg<sup>-1</sup>; Total Kjeldahl nitrogen (TKN) 1.3 g kg<sup>-1</sup>; those of the control soil were: pH (in water) 8.00; Texture: sand 32%, silt 49%, clay 19%; Total carbonates (CaCO<sub>3</sub>) 16% g kg<sup>-1</sup>; Bicarbonates (HCO<sub>3</sub><sup>-</sup>) 4.8%; Cation exchange capacity 21 cmol<sub>c</sub> kg<sup>-1</sup>; TOC 8.4 g kg<sup>-1</sup>; TKN 0.9 g kg<sup>-1</sup>.

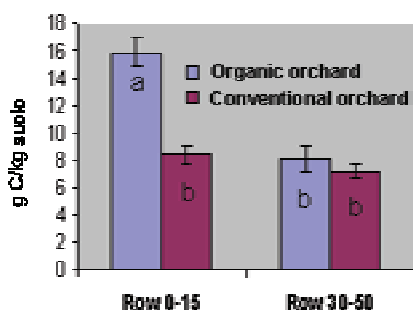
## Results and discussion

Total organic carbon (TOC) content of soil samples of the organic and conventional pear orchard taken at two depths (0-15 and 30-50 cm) along the row is shown in Fig. 1. The top layer of the organic orchard was significantly richer in TOC compared to the conventional one. These differences disappeared in the deep layer, indicating that the effect of the amendment was not distributed along the soil profile. The inter-row zone showed a similar trend with a significantly higher content of TOC in the upper layer of the organic orchard compared to the conventional one (Fig. 2). In this case the greater amount of TOC was due to the C released from grasses as rhizodepositions. However, even in the inter-row, the deep layer of the two orchards had similar TOC content suggesting that any C contribution to soil only affects the upper part of the soil profile.

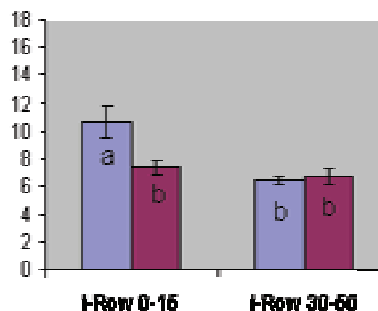
From a quantitative point of view, it can be calculated that a concentration of 1 g kg<sup>-1</sup> of soil TOC corresponds to 1.875 tons ha<sup>-1</sup>, assuming a soil depth of 15 cm and a density of 1.25 kg dm<sup>-3</sup>. Applying this assumption, it can be estimated that in the horizon 0-15 cm of the row there was an increase of about 14 tons ha<sup>-1</sup> of TOC after 18-years of cultivation and amendment vs. the control that has received just mineral fertilisation (Fig. 1). On the same basis, the presence of grasses in the top layer of the



inter-row caused a significant increase in TOC that could be quantify in about 6.3 tons  $\text{ha}^{-1}$  and that was due to the accumulation of their rhizodeposits.



**Figure 1: Total organic carbon (TOC) content in soil samples taken at two depths (0-15 and 30-50 cm) in the row. Tukey-HSD test: similar letters are not significantly different at  $p \leq 0.05$ .**



**Figure 2: Total organic carbon (TOC) content in soil samples taken at two depths (0-15 and 30-50 cm) in the inter-row. Tukey-HSD test: similar letters are not significantly different at  $p \leq 0.05$ .**

## Conclusions

The management of the organic orchard with the annual addition of compost over 18-years and the presence of grasses was able to significantly increase the amount of TOC in the 0-15 cm layer compared to the conventional orchard used as control. These increases were equal to 14 and 6.3 tons  $\text{ha}^{-1}$  in the row and in the inter-row respectively.

In order to confirm these preliminary results, a survey of the role of organic vs. conventional farming on soil carbon sink/source is started in 2007 in Emilia-Romagna Region. Eight typical organic orchard farms and eight conventional orchard farms (control), located in different provinces of the Region, have been sampled and results will be available in 2008.

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# Energy efficiency of biomass production in managed versus natural temperate forest and grassland ecosystems

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Key words: net primary production (NPP), natural ecosystems, harvested biomass, carbon storage, energy balance

## Abstract

*In a conceptual model study based on literature data from Danish ecosystems, energy yield from biomass production was compared in two semi-natural ecosystems (broadleaved forest and grassland) and their managed counterparts. The highest net energy yield of harvested biomass was obtained in the managed grassland system. The energy efficiency in terms of output:input ratios were about 190:1 in the managed beech forest and 6:1 in the managed grassland. This is discussed in relation to nitrogen cycling, carbon storage and energy efficiency of biomass production.*

## Introduction

Biomass (natural and cultivated) is globally a limited resource since available land is limited and the inputs which are needed for cultivation are costly in terms of energy input, e.g. fertiliser (organic or non-organic), fuel, machinery and human labour. Global total terrestrial net primary production (NPP), of which 50% is carbon (C), has been estimated to 56.8 Pg C y<sup>-1</sup> (1 Pg is 10<sup>15</sup> g) and humans are exploiting this resource very intensively; the current human consumption is estimated to 15-25% of this amount (Imhoff and Bounoua, 2006).

Net primary production is a quantitative measure of ecosystem productivity (yield) reflecting the influence of soil and site conditions and the level of cultivation among others. In comparison with natural ecosystems, such as forests and permanent grasslands, cultivated land may yield higher annual NPP with the aid of plant breeding and cultivation technologies. However, most land cultivation methods require inputs of fossil energy and irrigation water which are increasingly scarce resources (Scanlon et al., 2007, Pimentel and Pimentel, 2006). Use of these limited resources may be well-argued if high quality food crops or valuable materials are produced but less so if primary biomass is considered for bioenergy production.

Nitrogen (N) is the nutrient that generally limits plant growth, and the global cycling of biologically available N has been doubled by humans. The elevated N cycling has caused eutrophication, acidification, emissions of nitrous oxides (strong green house gas) and higher species extinction rates (Vitousek et al., 1997). The extension of fertilised cropland areas for biomass production will aggravate this trend.

To meet multifunctional goals of landscape management, ecosystems may be managed to act as a sink for green house gases, preserve habitat quality, and offer recreation and aesthetic pleasure; this includes securing the functional integrity of energy, water and nutrient cycles observed in natural ecosystems. Over long ranges

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of time, the production of biomass in undisturbed ecosystems balances the decomposition and mineralisation carried out by the organisms that feed on living and dead biomass. Utilization of biomass (i.e. harvest for food, feed, fibre and fuel) is a spatial and temporal decoupling of the carbon, nutrient and energy cycles of natural ecosystems. Here, we investigate the energy use efficiency of biomass production in Danish (humid temperate) ecosystems by comparing biomass utilisation from organic/nature-friendly managed and semi-natural forest and grassland. The results are discussed in relation to nitrogen cycling, green house gas storage and biomass production for human utilisation.

## Materials and methods

Humid temperate nemoral forest and grassland on nutrient rich sandy loam soils were selected to compare a managed biomass utilisation system with the semi-natural ecosystem counterpart as a reference: 1) a broadleaved, deciduous forest reserve (site Suserup, Vesterdal and Christensen, 2007) versus a managed beech forest in continuous cyclic management (harvest of mature stems by target diameter according to the target dimension principle, considered a fundamental principle in close-to-nature forest management), and 2) a grassland mixture (70-50% *Lolium sp.*, and 30-50% *Trifolium sp.*) managed according to organic agriculture principles (14 t/ha manure (pig slurry) and 1 t/ha lime per year (i.e. 4 t/ha every 4 years), 4x harvest per year for silage (Danish Agricultural Advisory Service, 2007)) versus permanent grasslands assuming no harvest and only wildlife grazing (Statistics Denmark, 2007). A comparison of energy balances was made. We focused on carbon storage in above-ground biomass (g dry matter  $m^{-2}$ ), energy yield per year (EY) of above-ground NPP (g dry matter  $m^{-2} y^{-1}$  and converted to  $MJ m^{-2} y^{-1}$  by the lower heating value at 0% water content) and the energy input (EI) required to harvest this yield ( $MJ m^{-2} y^{-1}$ ). Energy input data were collected from national statistics and literature (see references in Table). The net energy yield was found by correcting for the harvested biomass as (EY-EI) multiplied by harvest %. Finally, the energy output:input ratio was calculated from the energy yield.

## Results and discussion

The net primary production (NPP) in dry matter above ground ranged from 310 to 860  $g m^{-2} y^{-1}$  corresponding to energy yield of 5.1 to 15.6  $MJ m^{-2} y^{-1}$  (1  $MJ m^{-2}$  is 10  $GJ ha^{-1}$ ); the highest energy yield was obtained in the grassland mixture. In the managed beech forest the net energy yield was 6.7  $MJ m^{-2} y^{-1}$  with an energy input of 0.05  $MJ m^{-2} y^{-1}$  for harvesting of stems. In comparison with the forest reserve, the production (above-ground NPP) in the managed forest was higher since trees are younger and more vital. In conclusion, the management of the forest lead to an increase in NPP and energy yield with an energy output:input ratio (EY:EI) of 190:1. In the grassland mixture, the net energy yield was 11.9  $MJ m^{-2} y^{-1}$  and the energy input 2.3  $MJ m^{-2} y^{-1}$ . The main energy input came from animal manure calculated as the energy needed to produce the manure without allocating energy to the meat production. Manure application to grassland increased the NPP, but may also increase the nitrogen status of the ecosystem and cause N losses (as well as phosphorus, potassium and micro nutrient levels). In conclusion, the management of the grass land lead to an increase in NPP and energy yield with an energy output:input ratio of 6:1 due to the annual inputs of fuel and fertiliser. Multifunctional land use is linked with the green house gas issue, since production system, material inputs, biomass products, standing biomass, and ecosystem gas exchange are intertwined. The higher biomass storage in the

forest ecosystems measured as above-ground biomass after harvest (about 150-fold in managed forest and 300-fold in forest reserve in comparison with the grassland mixture) demonstrated a large storage potential for carbon dioxide in above-ground biomass. Carbon storage in trees provides flexibility in the biomass utilisation: NPP can be stored in living biomass to be utilised at a later stage or be a permanent reservoir (Kirschbaum, 2003, Righelato and Sprackeln, 2007). Soil organic matter incl. forest floor constituted about 50% of the total biomass in the two forest types (above- and below-ground) indicating a soil C storage potential in forest reserves (Vesterdal and Christensen, 2007).

**Tab. 1: Above-ground biomass production and energy inputs and outputs of two pairs of Danish semi-natural and managed temperate ecosystems**

<i>Ecosystem</i>	Forest reserve Suserup <sup>a</sup>	Managed beech forest <sup>b</sup>	Semi- natural grassland <sup>c</sup>	Grass- land mixture <sup>d</sup>
<i>Standing living biomass</i>				
	<b>g dry matter m<sup>-2</sup></b>			
Above-ground biomass after harvest <sup>e</sup>	25000	13000	<310	<80
<i>Production</i>				
	<b>g dry matter m<sup>-2</sup> y<sup>-1</sup></b>			
Above-ground annual NPP <sup>e</sup>	400	530	310	860
Harvest (% of NPP) <sup>e</sup>	0 (0)	350 (67)	0 (0)	780 (91)
<b>MJ m<sup>-2</sup> y<sup>-1</sup></b>				
<b>Energy yield (EY) of NPP<sup>e</sup></b>	<b>7.4</b>	<b>10.1</b>	<b>5.1</b>	<b>15.6</b>
<i>Energy input<sup>f</sup></i>				
Fuel		0.04		0.80
Machines		0.01		0.09
Seeds				0.01
Manure				1.41
Liming				0.02
<b>Total energy input (EI)</b>	<b>0</b>	<b>0.05</b>	<b>0</b>	<b>2.3</b>
<b>Net energy yield</b>	<b>n.a.</b>	<b>6.7</b>	<b>n.a.</b>	<b>11.9</b>
<b>EY:EI</b>	<b>n.a.</b>	<b>190:1</b>	<b>n.a.</b>	<b>6:1</b>

**a.** Vesterdal and Christensen, 2007, **b.** Larsen and Johannsen, 2000, **c.** NPP adapted from permanent grasslands out of rotation, assuming no harvest (Statistics Denmark, 2007) **d.** Danish Agricultural Advisory Service, 2007, **e.** Lower heating values adapted from [www.bioplex.dk](http://www.bioplex.dk). Grass and grassland mixture heating values assumed similar to straw~18,2 MJ kg<sup>-1</sup> d.m., **f.** Based on Dalgaard et al., 2001. **g.** Own calculations based on references mentioned. **n.a.** ~ not applicable.

## Conclusions

Based on literature data, a few specific ecosystems were chosen to demonstrate the kind of assessments needed to evaluate consequences of different land use and potentials for primary biomass production. We calculated that cultivation increased the NPP in both forest and grassland in comparison with the semi-natural counterparts. The biomass production potential (above-ground NPP) versus the carbon storage potential in standing living biomass showed a potential sink for carbon in forest. Biomass production from close-to-nature beech forest management required much less input energy to extract NPP per ha than organically grown grassland mixtures, which was reflected in much higher energy efficiency of the former. Further, the manure application in grassland mixtures may cause N-losses to the atmosphere (GHG emissions) and to aquifers, which also disfavours biomass from such systems. The flexibility of land use and its products should be considered in a multifaceted evaluation, since primary biomass may be used for food, feed, fibre and fuel. Forest cover is a long term land use that can not be changed annually, whereas grass can enter a crop rotation. Hardwood is a non-food commodity whereas grass can be used in a sequence of food and non-food purposes, e.g. animal feed and biofuels. Altogether, land use type and cultivation intensity influences the utilities provided.

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# Wood Chips from Hedgerows – Biomass Potential for On-Farm Mulching and Bioenergy?

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Key words: agro-eco-systems, soil protection, landscape, bioenergy

## Abstract

*Hedgerows are landscape features with ecological value and agricultural benefits which are appreciated in organic farming. Biomass from periodical cutting down of hedgerows is often unutilized litter. The study assesses different ways how to use wood chips from hedgerows, and quantifies the biomass potential for either mulching arable land with wood chips or, alternatively, for bioenergy use. The calculations are based on experiments at the experimental station for organic farming Kleinhohenheim and on literature. The yield of wood chips was clearly too low to mulch the total arable land of the model farm. Hedgerows on an area equal to 1% of the farm area yielded wood chips for 0.05 ha if 160 m<sup>3</sup> ha<sup>-1</sup> were applied. This layer significantly reduced weeds. Hedgerows covering 5% or 20% of the farmland would provide wood chips for about 0.2 or 1 ha for mulching or, used as firewood, they would cover the corresponding fuel oil demand of more than one average household. Compared to poplars in short rotation coppice on the same area, the energy output is low. Since an energy use of wood chips is ecological and economical inefficient, mulching seems a reasonable way to use wood chips from cutting hedgerow, in spite of low yields. Wood chips should be applied to thoroughly selected areas, such as slopes (protection from soil erosion), crops with wide inter-row-distance or to perennial, high-value crops.*

## Introduction

Hedgerows have many functions and benefits in agricultural systems (Baudry *et al.* 2000). Organic Farming standards explicitly state the relevance of hedgerows for a sound agro-ecosystem. From time to time, usually in a period of 10–15 years, hedgerows have to be cut back to maintain the functions of a hedgerow. The material is mostly chopped to wood chips, and then often left on site unutilized. Safeguarding hedgerows would be facilitated if the “by-product” wood chips would produce some profit. Since the majority of the material is twigs and small stems with a high proportion of bark and moisture, the efficiency of wood fuel from hedgerows seems to be low. An alternative is mulching, e.g. for weed control, as presently done in ornamental gardening, in orchards or urban landscapes (Ferguson *et al.* 2004; Rathinasabapathi *et al.* 2005). Very little is known about the use of wood chips for mulch on arable land, and about the amount of biomass which can be produced by semi-natural hedgerows on a farm. The University of Hohenheim has established a long-term experiment to examine effects of wood chips mulch from hedgerows in an organic cropping system. Among multiple aspects of the experiment, the current paper focuses on productivity and should 1. assess the size of the hedgerow area which is needed to produce sufficient quantities of biomass for mulching a certain area of arable land; 2. discuss the alternative use of wood chips for bioenergy instead for mulching; 3. exemplarily

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contrast the productivity (biomass and energy yield) of hedgerows with the productivity from short rotation coppice (SRC). Simple linear scenarios based on the experimental station Kleinhohenheim as a case study should assess the biomass potential of hedgerows both for mulch and bioenergy, and point out approaches how to use wood chips from hedgerows best.

## Materials and methods

Size and structure of the experimental station for organic farming Kleinhohenheim, Stuttgart, Germany, were adopted for this study, completed by additional data from literature for scenario calculations. The farmland is structured with hedgerows along the main field lanes, and at some field boundaries. Hedgerows are composed of autochthonous hardwood species. A section of the hedgerows is routinely cut down every year in a rotation of about 10 years, and the stems and twigs < 5 cm diameter are chopped by a disc wheel chopper. A part of the wood chips is then used in a field trial for mulching, and the rest is left on site. The total farmland is 60 ha, 40 ha of which is arable land. Wood chips were applied on arable land in an amount  $80 \text{ m}^3 \text{ ha}^{-1}$  and  $160 \text{ m}^3 \text{ ha}^{-1}$ . Several characteristics of the wood chips were determined in own experiments (Tab. 1). Further data on productivity of hedgerows and SRC were taken from literature. Simple scenarios were calculated to describe the productivity of hedgerows and of SRC from a calculative area. Wood chips would be used for energy only outside the farm, and the ash would not be returned to the fields.

**Tab. 1: Basic data for calculation and discussion**

Data from own experiments <sup>1)</sup>		Literature data <sup>2) 3) 4)</sup>	
1 m <sup>3</sup> wood chips	= 0.4 t FM	Mean biomass production by hedgerows	5 t FM ha <sup>-1</sup> a <sup>-1</sup>
Water content of wood chips	36%	Mean biomass production by short rotation coppice	13 t DM ha <sup>-1</sup> *a
C:N ratio of w. chips	47	Width of hedgerows	4 m
Bark weight of wood chips	25% of FM	Caloric value of wood chips from hedgerows	12.6 MJ kg <sup>-1</sup> DM
Wood chips mulch applied	80 or 160 m <sup>3</sup> ha <sup>-1</sup> a <sup>-1</sup>	Caloric value of wood chips from SRC	18.5 MJ kg <sup>-1</sup> DM
Application of N <sub>t</sub> by mulch	4 kg m <sup>-3</sup>	Caloric value of fuel oil	11.4 kWh l <sup>-1</sup>
Application of C <sub>t</sub> by mulch	189 kg m <sup>-3</sup>	Energy consumption /household	3000 l fuel oil

<sup>1)</sup> Gruber et al. (2008), <sup>2)</sup> Rösch 1996 (annual mean), <sup>3)</sup> Boelcke (2006): 3-years rotation; FM: fresh matter, <sup>4)</sup> calculated after Kaltschmitt et al. (2000); DM: dry matter, FM: fresh matter.

## Results

A percentage of 1% hedgerows (Scenario 1, Tab. 2) on the total model farm area would equal to 0.6 ha, or a hedgerow length of 1.5 km. The wood yield from these



hedgerows would be sufficient to mulch a maximum of 0.05 ha of arable land (recipient area) each year if 160 m<sup>3</sup> wood chips ha<sup>-1</sup> were applied. The recipient area would be twice as much if 80 m<sup>3</sup> ha<sup>-1</sup> were applied. Scenario 2 with 3 ha of hedgerows (7.5 km) would produce wood chips for a maximum of 0.23 ha recipient area, and in scenario 3, hedgerows on 12 ha land (30 km) produced biomass for mulching 0.94 ha. As a comparison, the annual energy yield of the same hedgerows ranged from 7 to 134 MWh, corresponding to a fuel oil equivalent of approximately 600–12,000 l. If the same area would be planted with poplars in SRC instead of hedgerows, the energy yield ranged from 35 to 700 MWh, corresponding to 3,000 to 60,000 l fuel oil.

**Tab. 2: Maximum area per year for mulch application (recipient area) and annual energy yield of wood chips produced from hedgerows in three scenarios, in comparison to poplars in short rotation coppice (SRC) on the same calculative area of land; mulch application: 160 m<sup>3</sup> ha<sup>-1</sup>.**

Scenarios % of farm area for hedgerows	Hedgerow area (ha) or length (km)	Mulch	Bioenergy			
		Recipient area (ha)	Energy yield (MWh)		Fuel oil equivalent (l)	
			Wood chips	SRC	Wood chips	SRC
Scenario 1: 1%	0.6 (1.5)	0.05	7	35	590	3,000
Scenario 2: 5%	3.0 (7.5)	0.23	33	174	2,900	15,200
Scenario 3: 20%	12.0 (30.0)	0.94	134	696	11,700	60,100

## Discussion

The annual biomass yield of hedgerows is not enough to mulch all arable land, independently from whether 80 m<sup>3</sup> ha<sup>-1</sup> or 160 m<sup>3</sup> ha<sup>-1</sup> are applied. Since only an application of 160 m<sup>3</sup> mulch ha<sup>-1</sup> was significantly weed-suppressing (Gruber *et al.* 2008), planting semi-natural hedgerows specifically for mulch production is not useful. Though the biomass produced in scenario 2 and 3 is enough for the energy supply of one to three households, using the hedgerow area alternatively for SRC would result in a 5-fold higher production of bioenergy. Poplars are fast-growing trees and genotypes are used which are specifically selected for SRC thus explaining the higher yield of SRC compared to hedgerows. Semi-natural hedgerows are mainly composed of autochthonous shrub species with low capacity for biomass production and often grow on marginal land, e.g. field clearing cairns which additionally reduces yield. The biomass production of hedgerows may highly vary by the composition of species and the management, but at present, little reliable information is available about yields. However, today's primary purpose of hedgerows is to provide ecological benefits (Baudry *et al.* 2000). Under this assumption, wood chips are a by-product that emerges if the ecological value of a hedgerow is maintained by periodical cutting. Using wood chips from hedgerows for combustion seems not reasonable due to high proportions of bark (Tab. 1), which means a high ash content of more than the 6-fold than from pure wood (Hartmann 2005), so that combustion could cause technical difficulties. Recycling of nutrients, input of C<sub>org</sub> and soil cover by mulch promise to be more beneficial for the agro-ecosystem. Therefore, in spite of low biomass production, the by-product wood chips should be used for mulch rather than for combustion in organic farming. The area and the crops the mulch is applied to have to be selected

thoroughly. Wood chips should be applied with decreasing priority to: 1. erodible areas (slopes, silty soils) 2. crops with wide inter-row distance (faba beans) 3. perennials with high economic value (raspberries, black currant). As an alternative, farms could offer organic wood chips for sale to private consumers for gardening. Though this means an export of nutrients, a direct profit from hedgerows is provided. All scenarios and alternative uses have to be evaluated economically in detail in further approaches. Basically, a semi-mechanised process of harvesting and chopping, as usual for cutting hedgerows, causes twice as much costs as a wood combine harvester used in SRC (Textor 2008). Presuming the ecological value is high at low cutting intensity and in wood with diverse structure as recommended by Hinsley & Bellamy (2000) for protecting birds, hedgerows cut in a rotation of ca. 10 years would be more beneficial than SRC in a 3-years-rotation.

## Conclusions

To safeguard hedgerows and their ecological benefits, possible economical incentives should be considered and used. The amount of wood chips produced from hedgerows is only sufficient to mulch a very small area of arable land. A use for energy is possible but not efficient in comparison to SRC, and in terms of possible technical difficulties. Co-combustion with other fuels could be taken into consideration. The best solution seems to be the application of wood chips mulch on sensitive areas or to specific crops. Another solution to make economical use of the hedgerows could be the production of "Organic Wood Chips" for sale to private consumers. Though a replacement of hedgerows by SRC is not intended, the ecological effects of both should be compared directly in further studies. To maintain ecological values of hedgerows, only a part of it should be cut back per year.

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# Does Organic Farming have Greater Potential to Adapt to Climate Change?

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Climate change, adaptation, resilience, organic agriculture

## Abstract

*Organic agriculture are highly resilient systems based on sustainable soil fertility management, on the maintenance of diversity on landscape, farm, field and crop level and on a combination of indigenous, locally adapted knowledge with innovative technology. Such agro-ecosystems might be very adaptive to climate change scenarios.*

## Introduction

Agricultural production worldwide will face less predictable weather conditions than experienced during the intensification of agriculture. Weather extremes will become predominant. Lobell et al. (2008) expect severe humanitarian, environmental, and security implications. Specific, regionally adapted investment in order to improve adaptation of agricultural production will be necessary. In this context it is important to improve technical measures like irrigation or breeding programs on drought or heat tolerant crops, but even more important is the design of highly adaptive and resilient production systems. Organic farming might be a starting point worth to study in detail.

## Traditional knowledge as a key to adaptation to climate change

Traditional skills and knowledge have been abandoned in intensive agriculture. Organic agriculture, on the other hand, has always been based on practical farming skills, observation, personal experience and tacit knowledge. Knowledge and experience are the conditions *sine qua non* to use natural processes and reduce dependence on external inputs (Boron, 2006). This knowledge is a 'reservoir of adaptations' as it provides the skills for manipulating complex agro-ecosystems.

## Improved soil fertility as a key to adaptation to climate change

Soil fertility is a corner stone for resilient agro-ecosystems. Nonetheless, intensive agriculture neglects sustainable land use. Pimentel et al. (1995) calculated a loss of nearly a third of the World's arable land to erosion within the last 40 years with an on-going loss of more than 10 million ha per year.

Organic farming consists of different soil fertility-building and soil conserving techniques such as i) the on-farm flux of manure from livestock production to cropland,

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<sup>4</sup> As 1

ii) the use of composts, iii) the use of leguminous crops and green manure in rotations, iv) diversified crop sequences with permanent soil cover and different rooting depths as well as v) minimum or shallow tillage. These practices bring organic farming in a good position to maintain productivity in the event of drought, irregular rainfall events with floods, and rising temperatures.

The most important findings concerning soil improvement by organic farming are:

- Reganold et al. (1987), found that humus rich topsoil layers of organic fields were 16 cm thicker than the ones of neighboured conventional fields in Washington, USA. This resulted in reduced erodibility.
- The DOK trial, a long-term Swiss field experiment on loess soil that began in 1978 (Mäder et al., 2002) showed that organic yields were only 20 % lower than in conventional. Soil microbial biomass and the physiological functions of soils as well as plant-microbe interactions were enhanced by organic agriculture. Furthermore, the aggregate and percolation stability of both bio-dynamic and organic plots were significantly higher (10 to 60 percent) than conventionally farmed plots. This also affected the water retention potential of these soils in a positive way and reduced their susceptibility to erosion. Soil aggregate stability was strongly correlated to earthworm and microbial biomass. Other soil macrofauna, such as carabids, spiders and staphylinids were more abundant in the organic fields than in the conventional ones (Pfiffner and Niggli, 1996; Pfiffner and Mäder 1997) with positive effects on soil structure, water infiltration, drainage, water-holding capacity and soil aeration.
- The Rodale farming trial that began in 1981 in Pennsylvania, USA, compared manure and legume-based organic agriculture systems to a conventional one based on mineral fertilizers (Pimentel et al., 2005). Whilst the long-term results show similar soybean and maize yields in organic and conventional systems, soil carbon increased in the organic system. The amount of water percolating through the top 36 cm was 15–20% greater in the organic systems indicating an increase in groundwater recharge and reduced run-off. In dry years, the organic plots yielded 28 to 34 % more corn and 56 to 100 more soybean. It was also found that water capture in organic plots was twice as high as in conventional plots during torrential rains. This may significantly reduce flood risk when practised on large areas.
- Marriott and Wander (2006) analyzed soil samples from nine farming system trials that were started in the USA between 1981 and 2000. The soil organic carbon concentrations were 14 percent higher in organic systems than in conventional ones. The labile fraction of the soil organic matter – a source of mineralizable C and N with important implications for plant nutrition – showed 30 to 40 percent higher values in organic soils.
- In the Netherlands, an investigation was done on farms that had been under organic and conventional management for 70 years on a polder soil (Pulleman, et al., 2003). The percentage of water stable macro-aggregates on organically farmed sites was 72 percent higher compared to conventional. The higher physical stability was linked to significantly increased soil organic matter content and to a larger volume percentage of worm-worked soil (organic 28 percent and conventional 8 percent).
- A study of organic cotton production in India found yield levels similar to a modern cultivation technique, however, soil organic matter, water stable aggregates and mean weight diameter showed advantages for organic (Eyhorn et al. 2007).
- In the Tigray province of Ethiopia, agricultural productivity was enhanced by compost application and introduction of leguminous plants into the crop sequence.

By restoring soil fertility, yields were increased to a much greater extent than by using purchase mineral fertilizers under summer drought conditions (Edwards, 2007).

### **Water retention and water quality in organically managed soils**

Currently, 70 percent of the available water is used for agriculture. As water becomes increasingly scarce in certain regions of the world, it will be important to increase water use efficiency in irrigation and rain-fed agriculture. *Per se*, organic agriculture is not designed to use water as efficient as possible. Nonetheless, some agricultural techniques such as shallow tillage, disruption of capillarity by superficial mechanical weeding, soil residue management, improved soil cover and structure may have positive effects on soil moisture, water infiltration, water use efficiency and soil surface temperature in organic crops. It can be assumed that organic systems are quite good in terms of water and soil erosion management, but that in combination with elements of minimum tillage, it would be most powerful.

In addition to maximizing water use efficiency in agriculture, it is important to reduce water pollution for the sake of drinking water and aquatic biodiversity. Organic practices reduce pollution in water effluents since pesticides and inorganic fertilizers – major pollutants of the aquatic environment – are prohibited. Organic agriculture has demonstrated 40 to 64 percent reduced nitrate leaching rates compared to conventional in different soil types in Europe (Stolze et al., 2000).

### **Diversity enhances farm resilience**

An additional strength of organic farming systems is their diversity – including the diversity of crops, fields, rotations, landscapes and farm activities (mix of various farm enterprises). The high level of diversity on organic farms provides ecological services that significantly enhance farm resilience (Bengtsson et al., 2005; Hole et al., 2005). Biodiversity is an important driving factor for system stability. Organic agriculture has been shown to harbour more species at higher abundance of organism groups than conventional farming.

Positive effects of enhanced biodiversity on pest prevention have been shown by Zehnder et al. 2007, and similar effects of diversified agro-ecosystems on diseases and better utilization of soil nutrients and water are likely. The establishment of an organic production system needs to consider aspects such as landscape complexity to ensure that sufficient semi-natural landscape elements are present to serve as natural and attractive refuges for enemies and predators (e.g. planting hedges, sowing weed strips, installing beetle banks). In other words, biodiversity in organic agriculture has a distinct function, a functional biodiversity that stabilizes the agricultural systems.

The potential of genetic diversity at the crop level for stabilization of low-input farming systems and for adaptation to environmental changes is considerable (Kotschi, 2006). There are many small initiatives by plant and animal breeders in the context of organic farms scattered around the world. As resistance and robustness to environmental stress are characteristics encoded by multiple genes, the in situ conservation and on-farm breeding are likely to be more successful than genetic engineering.

In conclusion, organic farmers strive for the protection of a diverse landscape with habitats managed to host and attract beneficial organisms. This biodiversity-driven

stability leads to a more stable food supply even under less favourable or less predictable weather conditions.

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## **Biogas in Organic Agriculture**



# Effects of Biogas Digestion of Slurry, Cover Crops and Crop Residues on Nitrogen Cycles and Crop Rotation Productivity of a Mixed Organic Farming System

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Key words: nitrogen, nutrient management, digestion, renewable energies

## Abstract

*Manures and crop residues can be utilised for digestion, without any significant losses of nutrients. This paper presents the results of field trials about the effects of biogas digestion in a mixed organic cropping systems on nutrient cycling and yield of a whole crop rotation. Digestion of slurry affected yields and N uptake only after soil incorporation. The inclusion of crop residues for digestion increased the amounts of "mobile" manure. N uptake and yield of non-leguminous main crops increased about 10%, due to a more adapted allocation of nutrients within the whole cropping system by reallocation of N towards the crops with higher N needs. Additionally, removing the cover crops in autumn and their digestion increased the fertilizing efficiency of N, lowering the risk of leaching losses.*

## Introduction

Nitrogen (N) is frequently considered to be one of the key limiting factors responsible for the limited productivity of organic farming systems (e.g. Berry et al., 2002). The supply of N from organic resources is difficult to synchronize with crop N demand (Pang and Letey, 2000). Crops under organic farming management are almost exclusively dependent on soil biological processes which provide nutrients by mineralization of applied organic matter like animal manure, crop residues, or green manuring. Improved agricultural management practices to meet crop N demand while avoiding N losses to the environment is a challenge, particularly for organic farming systems. During the anaerobic digestion, slurry dry matter is degraded. The elevated  $\text{NH}_4^+$ -N concentration in the digested material indicates its special suitability as plant-available N manure, making the nitrogen readily available for the crops. Commonly it was assumed, that digestion was connected with an enhanced N availability of applied slurry-N. The objectives of the trials presented were (i) to measure the impact of digestion of slurry on N uptake and yields within a whole eight year crop rotation, (ii) to determine the effect of digestion of crop residues (CR) like straw and of cover crops (CC) (iii) and of additionally introduced external substrates (equivalent to 40 kg N ha<sup>-1</sup>) on fluxes of N, N uptake and yields within the rotation.

## Materials and methods

The experiments were carried out between 2002/03 and 2004/05 at the research station for organic farming "Gladbacherhof" of the University of Giessen, situated 17 km east of Limburg in Hessen. The research station is located 140 - 230 m above sea level. The average annual temperature is 9.3 °C and the mean annual precipitation is

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682 mm (1960-2000). The soils are of a silty loam texture derived from loess with pH values of 6.6 - 6.9 and are classified as Calcic Luvisols with a field capacity of 330-370 mm m<sup>-1</sup>. The field experiments were designed as a mixed system with crops on arable land (70%) and on grassland (30%). The designed arable crop rotation comprises eight years. It includes: 1-2. Clover/grass-ley (2 years); 3. Winter wheat+CC; 4. Maize (at 80% of the area) and potatoes (at 20% of the area); 5. Winter rye+CC; 6. Peas+CC; 7. Spelt+CC, and 8. Spring wheat. The CC mixture consisted of summer vetch (*Vicia sativa*) at 90 kg ha<sup>-1</sup> and oil radish (*Raphanus sativus*) at 5 kg ha<sup>-1</sup>. The plots were set at fixed places. All field experiments were carried out fourfold in a completely randomised design.

A common farmyard manure (FYM) and undigested slurry (US) system were compared to three manuring systems in which the cattle slurry and other substrates were digested in a biogas plant prior to field application. In DS only slurry was digested. In DS+FR slurry and all kind of CR and CC were digested, the effluents of the percolation digester producing solid and liquid effluents were reallocated within crop rotation. DS+FER was similar to DS+FR, additionally purchased substrates at 40 kg N ha<sup>-1</sup> were digested. More details: Möller et al. (2006).

## Results

Comparing digested and undigested cattle slurry showed that total N content did not differ after digestion. However, the ammonia content in the slurry arose through digestion from 43 to 53% of the total N. The organic dry matter content (ODM) decreases significantly, as well as the C/N ratio decreased by about 25% due to slurry digestion. The pH arose 0.8 points, which means, that the concentration of protons due to digestion decreased by the factor of 6.3. Also, the mineral nutrient content in DM arose due to the concentration process of the partly decomposed dry matter in the digester. Digestion of CR and CC produced solid residues very similar to farmyard manure. The liquid residues of digestion in the percolation digester showed very similar properties than dung water obtained from farmyard manure staple in all relevant parameters, showing very high K and N contents, and a narrow C/N ratio.

No differences in total available manure N were registered in the three systems US, DS and DS+FR. In systems without CR and CC digestion (FYM, US, DS) ca. one half of total manure N was available as manure N and the other half as immobile green manure N. As far as additional digestion of CC and CR are concerned similar amounts of N were available as in US and DS. However, 87% of the total available N was mobile as effluents of the digester. The higher amounts of N in manures allowed a reallocation of nutrients within crop rotation towards crops with a higher N demand (winter wheat), at the cost of crops with a lower N demand like peas or spelt.

Differences yields were caused mainly by differences in the yields of the high N demanding non-legume cash crops (winter and spring wheat) within the crop rotation. No differences in total biomass yields were measured in crops with a lower crop N demand (rye, spelt and the three legume main crops). The cereals with lower N demand (rye and spelt) showed in DS+FR and DS+FER a strong tendency to lodging, which results in serious damage to the crop during the main growing period (Tab. 1).

**Tab. 1: Crop dry matter yield (t ha<sup>-1</sup>) and total N uptake main crops (kg N ha<sup>-1</sup>)**

<b>DM yields:</b>	FYM	US	DS	DS+FR	DS+FER
Clover/grass-ley 1	13.3	13.7	13.7	13.8	13.9
Clover/grass-ley 2	12.1	12.2	11.9	12.3	12.5
Winter wheat	5.25a	5.73b	5.67b	6.09c	6.21c
Root crops:					
Potatoes (0.2 parts)	6.42	6.36	6.72	6.88	6.65
Maize (0.8 parts)	14.7	14.9	15.2	15.9	15.9
Rye	5.02	4.69	4.66	4.26	4.48
Peas	2.88	2.84	2.74	2.82	2.62
Spelt	3.57	3.60	3.52	3.40	3.23
Spring wheat	3.83a	3.76a	4.17b	4.33b	4.93c
MV Crop rotation	7.38a	7.47a	7.48a	7.63b	7.74b
MV non-legumes	6.15a	6.19ab	6.30ab	6.44bc	6.58c
MV legumes	9.43	9.59	9.44	9.62	9.66
<b>Crop N uptake:</b>					
Clover/grass-ley 1	414	423	422	427	433
Clover/grass-ley 2	375	378	364	372	381
Winter wheat	112a	129b	129b	152c	170d
Root crops:					
Potatoes (0.2 parts)	98	97	103	103	103
Maize (0.8 parts)	143a	150ab	149ab	173b	176b
Rye	113a	113a	112a	120ab	126b
Peas	151	152	146	147	140
Spelt	114	128	120	116	121
Spring wheat	98a	111ab	119b	145c	166d
MV Crop rotation	189a	197b	194b	205c	212c
MV non-legumes	114a	124b	124b	139c	149d
MV legumes	313	318	311	315	318

Values with the same letter are not different at  $P \leq 0.05$

The lowest N yields were obtained in FYM (Tab. 1). US and DS showed significant higher N uptakes as a sum of whole crop rotation as FYM. The inclusion of CR and CC in digestion process (DS+FR) caused a further substantial increase of N yields. In legumes the N uptake and yields didn't differ in any way. The main differences in crop N uptake were related to the non-legumes within the crop rotation. Non-legumes were able to take much more N in US than in FYM, whereas digestion of slurry did not influence N uptake of non-legumes. Digestion and reallocation of nutrients of CC and CR (DS+FR) resulted in a further increase of N uptake of non-legumes, without any adverse effect on N uptake of leguminous crops such peas. The highest N yields were obtained by inclusion of external substrates in digestion process (DS+FER).

Further effects of digestion were a strong reduction of the balance of emissions of greenhouse gases and the replacement of fossil fuels due to the production of heat and power energy. Harvest and digestion of CR and CC reduced furthermore the nitrate leaching risk (for more details: Möller et al. (2006)).

## Discussion

Digestion of slurry had only small effects on the overall yields and the N use efficiency of the whole arable crop rotation. Probable causes are: (i) Higher ammonia losses after spreading digested slurry (not shown), or (ii) the organically bound N of undigested slurry seems to have enough time, for example in long cycle crops like maize to become mineralized and available to crops. The higher yields of the manuring system which includes CC and CR in digestion process (DS+FR) are strongly related to a higher N use efficiency of the system. In the system similar amounts of nitrogen circulated than in US and DS (Table 5), but the non-legume main crops yielded significant higher amounts of nitrogen, and grains with higher nitrogen content (not shown). The harvest of CC in autumn and posterior digestion and application directly to the following main crop enhances N use efficiency significantly. Including not only CR, but also external substrates in the system (DS+FER), led only to a small further increase in yields on the arable land in comparison to DS+FR, in spite of the high amounts of N introduced into the system by the purchased substrates. The causes are strong lodging of less N demanding cereal crops and a higher weed infestation through *Gallium aparine*.

## Conclusions

Biogas plants may act as nutrient bank where the nutrient harvested from crop residues and cover crops can be released and used as manure on high-value crops. Digestion of CC and CR will increase the amounts of mobile manures, allowing a more pronounced manuring of high N demanding crops. Furthermore, N use efficiency of manuring was higher if the biomass is digested and reallocated within the same crop rotation in comparison to direct soil incorporation. However, digestion is only a first step towards a higher efficiency of the N cycle in organic farming systems. Digestion can constitute an important key technology for implementation of more appropriate techniques for manure application by reducing solid concentration and by having a significant effect on particle size distribution. A subsequent solid-liquid separation of the residues combined with slurry injection techniques might allow further improvement of organic manuring systems.

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# Biogas in stockless organic Farming: Effects of Digestion of Clover/grass, Cover Crops and Crop Residues on Nitrogen Cycles and Crop Rotation Productivity

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Key words: nitrogen, nutrient management, digestion, renewable energies, stockless farming system

## Abstract

*A common practice in stockless organic farming systems is to leave the biomass from clover/grass-ley and crop residues in the field for their residual fertility effect. No farmyard manures for transfer of nutrients within the system are available. Clover/grass-ley biomass and crop residues represents an unexploited energy potential that could be harnessed by the digestion in biogas plants for production of methane, thus replacing ruminants by the biogas digester. In field trials by implementing a whole crop rotation comprehending six crops were carried out in 2002-2005 to evaluate whether the use of N could be improved by processing biomass described above in a biogas digester and using the effluents as a fertilizer, compared to general practice.*

*Results indicate that digestion of crop residues resulted in more efficient manuring systems, not only by the implementation of an additional "product" (power energy), but also by getting more efficient cropping systems with higher DM and N yields of most of the non-legume crops, combined with a reduction of N losses due to denitrification and a reduction of the nitrate leaching risk. The causes were a better and more evenly allocation of nutrients within the whole crop rotation, a higher N input via N<sub>2</sub> fixation, lower N losses and probably a higher N availability of digested in comparison to the same amounts of nutrients in undigested organic manures.*

## Introduction

In stockless organic farming systems clover/grass biomass, cover crops (CC) and crop residues (CR) represent a large unexploited energy potential that could be harnessed by the anaerobic digestion in biogas plants for production of methane. Some authors assumed that simultaneously, the availability of the nitrogen of the effluents would be increased due to reduced emissions to the air and water and enhanced nitrogen mineralization. The digestion of legume-grass leys, a fundamental component in those crop rotations due to N<sub>2</sub> fixation and weed suppressing effect, would create a mobile fertilizer.

The experimental evidence for beneficial effects of using green manure crops for biogas digestion is very scarce. There is a need for a system approach which includes measurement of all N loss pathways from management clover/grass-ley crops as either by traditional green manure or by removing for methane production with recycling of the digested residues to the same crop rotation. The complex interactions connected with described changes in manuring system need to be quantified in order

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to evaluate the whole-chain differentiation of N use efficiency and other effects on crop productivity and environmental impact of farming systems. The objectives of the presented trials were (i) to measure the impact of digestion of residues like clover/grass-leys, straw and cover crop biomass (ii) and of additionally introduced external substrates (equivalent to 40 kg N ha<sup>-1</sup>) on N fluxes, N uptake and yields within a whole crop rotation. A further objective are (iii) to assess the impact on nitrate leaching risk and soilborne nitrous oxide emissions.

## Materials and methods

A field trial with a block design were carried out between 2002 and 2005 on the research station Gladbacherhof. Soils are silty loams derived from loess (calic Luvisols). The cropping system consisted of a six-field crop rotation including: 1. Clover/grass-ley; 2. Potatoes; 3. Winter wheat+CC; 4. Peas+CC; 5. Winter wheat+CC; and 6. Spring wheat. The CC consisted of summer vetch (*Vicia sativa*) at 90 kg ha<sup>-1</sup> and oil radish (*Raphanus sativus*) at 5 kg ha<sup>-1</sup>. The plots were set stationary. Field experiments were carried out fourfold with experimental plots of 72 m<sup>2</sup> (6 m x 12 m). All crops were cropped in each year. In the trials the common mulching practice in organic agriculture without livestock was compared with two strategies of biogas digestion (Tab. 1). Further informations can be seen in MÖLLER et al. 2006.

**Tab. 1: Manuring treatments**

Manuring treatment	Abbreviation	Management of clover/grass ley, crop residues and cover crops
Usual stockless management	wL	Remained on field (ploughed in, mulched)
Stockless management with digestion of field residues	wL-FR	Harvested, digested, effluents reallocated as manure within crop rotation
Stockless management with digestion of field residues, and external substrates at 40 kg N ha <sup>-1</sup>	wL-FER	Harvested, digested, effluents reallocated as manure within crop rotation

## Results

The total amounts of N in manures didn't differ between wL and wL-FR (approx. 127 kg N ha<sup>-1</sup>). However, in wL-FR more than 80% of N circulating within the system were transferred by the biogas effluents (104 kg N ha<sup>-1</sup>), and was applied more evenly through the whole crop cropping system, mainly on non-legume crops (not shown). In spring the measured soil mineral content differed only slightly as a mean of the whole crop rotation. However, in the non-legume crops the soil mineral N was higher in both biogas variants than in wL, disadvantaging legume crops.

The yield of saleable non-legume main products was highest in wL-FR with 5.24 t DM ha<sup>-1</sup> and lowest in wL with 4.78 t DM ha<sup>-1</sup>, a difference of c. 10%. The average yield of winter wheat in both positions within crop rotation was significant higher in wL-FR than in wL, with grain yield differences of 13%. Simultaneously, the yield variation of non-leguminous crops in different position of the crop rotation differed in a lesser degree in wL-FR than in wL, as showed by a lower coefficient of variation. The winter wheat crops in wL-FER were affected by lodging and by a strong development of *Gallium*

*aparine*. No differences in DM yield were measured in legume main crops (clover/grass-ley and peas) between the different manuring systems (Tab. 2).

**Tab. 2: Dry matter yields (t DM ha<sup>-1</sup>) and N uptake (kg N ha<sup>-1</sup>), including straw**

	Yields			Total N uptake		
	wL	wL-FR	wL-FER	wL	wL-FR	wL-FER
CG ley	12.9	13.7	13.3	368	383	383
Potatoes	7.43	7.48	6.77	97.5b	98.3b	82.0a
WW 3	12.7	14.1	13.0	133	156	143
Peas	6.99b	5.92a	7.07b	160	147	159
WW 5	11.3a	13.8b	12.6ab	97.4a	126b	115b
SW	5,83a	6,84b	75,3b	62.0a	72.3a	85.6b
MV non-legumes	9.30a	10.5b	9.95b	97.5a	113b	106b
MV winter wheat	12.0a	13.9b	12.8ab	115a	141b	129ab
MV crop rotation	9.54a	10.3b	10.0b	153a	164b	161b

The system wL-FR showed higher (+16%) mean N uptake by non-legumes (113.2 kg N ha<sup>-1</sup>) comparing to wL (97.5 kg N ha<sup>-1</sup>). Highest differences were measured in winter wheat: digestion of crop residues (wL-FR) increased N uptake at 23% in comparison to wL.

Soilborne nitrous oxide emissions from the common stockless system accounted for 2.914 kg N<sub>2</sub>O-N ha<sup>-1</sup>. Main source were the mulched clover/grass-ley and autumn incorporated CC. Digestion of field residues decreased this emissions to 1818 kg N<sub>2</sub>O-N ha<sup>-1</sup>, which corresponds to a reduction of about 38% (results not shown).

In autumn the measured soil mineral content in 0-90 cm differed significantly as a mean of the whole crop rotation. A significant reduction of ca. 20% were measured in wL-FR (43,4 kg N ha<sup>-1</sup>) due to harvesting the residues including clover/grass-ley and CC in comparison to wL (52,4 kg N ha<sup>-1</sup>). The values of wL-FER were intermediate (48,2 kg N ha<sup>-1</sup>). The highest effects were measured after incorporation of CC in autumn prior to a winter cereal crop and in the clover/grass-ley. Differences were measured mainly on the upper soil layer (data not shown).

## Discussion

Harvesting by removing clover/grass-ley, CR and CC for digestion in a biogas plant not only avoid the concentration of high amounts of N in certain segments of the crop rotation prone to get loss, but also it resulted in the build up of considerably amounts of mobile manures, able to apply to different crops, i.e. reallocating the available nitrogen more evenly within crop rotation. The higher yields of the systems with digestion of the crop residues resulted probably due to the combined effect of at least four factors: (i) A higher N Input via di-nitrogen fixation of the harvested clover/grass-ley: Mulching, leaving the clover/grass biomass on the field induced negative feedback effects through enhancing soil N supply of the legumes (Heuwinkel et al., 2005). (ii) A higher allocation of the main growth limiting nutrient N on the non-leguminous crops. (iii) A more evenly allocation of the available nutrients across the different non-leguminous crops within crop rotation. Due to the law of "the diminishing response of yield to increasing N supply", yield improvements are possible by a reduction of N

supply of previously high supplied crops, providing the nutrients to crops former very low in N. And, (iv) a further possible cause for higher DM and N yields could be the C losses due to digestion and a related reduction of processes resulting in N immobilization related to the supply of C.

An improved N availability of the systems with digestion of residues can be deduced from the higher N uptake, the higher grain and straw N content obtained in both systems with digestion and the higher weed infestation with *Gallium aparine*. The higher N availability as a consequence of digestion and reallocation of nutrients resulted also in lodging of the winter wheat, mainly in wL-FER. Lodging and weed infestation probably counteracts to some extent the yield improving effects of the improved N availability due to the digestion and reallocation of nutrients within the system.

## Conclusions

Digestion of crop residues like clover/grass-ley and CC is an instrument to get more efficient organic stockless systems, not only by the implementation of an additional "product" (power energy) replacing fossil fuels, but also by getting more efficient cropping systems with higher DM and N yields, combined with a reduction of the risk of N losses due to leaving a lot of organic residues on the fields in autumn. The causes of the described effects were a more evenly allocation of nutrients within the crop rotation, a better matching of crop N demand and soil N supply by application of manures just at the beginning of the most N demanding period, a higher N inputs via N<sub>2</sub> fixation, lower N losses due to emissions and probably a higher N availability of digested in comparison to undigested organic manures due to a reduction in C returned to the soil.

In the ley/arable system, livestock, particularly ruminant livestock, plays an important role in utilising the leys, and are also important as a source of manure for transferring fertility to priority crops around the farm. Livestock also fulfil an additional role through their utilisation of arable CR. Implementation of biogas digesters in stockless organic farming systems replaced to a some extent the function of ruminant animal husbandry, by exploiting the residues and the biomass produced by clover/grass-leys, CC and CR. By harvesting the crop residues and CC the nitrogen gets free to be used wherever and whenever desired, instead of a location-bound and time-bound amount of organic manures, increasing the "state of freedom" for organic manuring. A feature common to the new technologies is the increased scope for N application at a time and place when needed by the crop, as opposed to the necessity of incorporating untreated material during the normal ploughing season.

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# Energy balance of different organic biogas farming systems

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Key words: biogas, energy balance, energy crop, farming system

## Abstract

*The ecological impact of biogas plants depends on their integration into a given farming system. Therefore only farm-specific and no general statements are possible. In this paper, two different concepts of biogas production for an organic cash crop farm have been energetically balanced using a model software. The analysis of input and efficient use of fossil energy carriers provides information on the environmental relevance of the farm operations. Apart from this, renewable energy production in the farming systems is compared to food production, and changes in the farm output are described. It turns out that organically run cash crop farms can benefit from a reasonable integration of a biogas plant, both in food crop and energy production. An increased orientation on the growing of energy crops, however, leads to worse utilization of fossil energy carriers and reduced food production.*

## Introduction

Striving for largely closed nutrient cycles and the conservation and improvement of soil fertility are intrinsic to organic farming systems. Reaching these aims, organic cash crop farms are faced with limits due to the absence of livestock. However, these limits can be overcome by integrating a biogas plant (BGP) into the farm system. The ecological consequences of integrating a biogas plant into a farm are complex and farm-specific. A model program for energy balancing on different technological levels (from crop cultivation to energy production) has been developed that not only allows one to analyse both existing and planned biogas systems, but also to estimate the effects prior to the erection of a plant. The paper describes the application of the model to an organic cash-crop farm, for which two management scenarios with different biogas intensity were elaborated. The input of fossil energy carriers is compared with the output in form of utilizable energy and food crops.

## Materials and methods

Energy balancing includes the whole technological chain from the field (growing and harvest of food and energy plants) through storage (preservation) to the biogas plant (conversion) and the CHPP (combined heat and power plant). The energy input in the form of electricity and fuel (direct energy input) as well as the upstream energy input for the manufacturing of machines, equipment, and other expendables (indirect energy input) is considered. The energy output as well is described throughout the whole technological chain (yield of food crops / yield of energy plants – preserves – biogas – power and heat) with consideration of loss paths (storage and preservation losses, conversion losses, technical losses). To estimate the resource efficiency, the output/input ratio is computed. Energy balancing of crop production is performed according to Hülshbergen et al. (2001) on the basis of farm-related operational and

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yield data. The gas-forming potential of the substrates is calculated according to Keymer (2007), power and heat quantities correspond to those of a modern Otto gas engine with an efficiency up to 40 %<sub>el</sub> and 53 %<sub>therm</sub> (FNR 2005). To test its suitability for scenario calculations, the new energy balancing approach has been applied on the Experimental Farm Viehhausen. The results are taken into account in the current planning of an experimental biogas station in the investigated farm. The tested experimental farm (80 hectares) is located about 35 km north of Munich in the Bavarian Tertiary hills (480 m above sea level, 780 mm, 7.8°C). In the farm, data records from field trials on yield potentials of cereals and energy crops and also on the development of grass/clover crops in biogas crop rotations were used to cover the computed model results. The five-field crop rotation of the stockless ecofarm (Sc REAL) is dominated by cereals (Table 1). The grass/clover gets mulched; cereals and grain legumes are sold. For the farm, two experimental management systems were designed representing different strategies of how to integrate a biogas plant into an organically run cash crop system. The extensive biogas system (Sc BGe) maintains the cash-crop-dominated crop rotation of Sc REAL, except grass/clover is used for energy production instead of being mulched (Table 1). The yield increase of grass/clover has been ascribed to cutting management, and that of cereals to increased N-supply and the high N use rate of the biogas slurry (about 60 % soluble N in the total N (FNR 2005)). The second scenario shows an intensive four-field rotation with mainly biogas crops (BGi). The acreage of cash crop growing declined from 80 % (Sc REAL and Sc BGe) to 25 %. Yield and quality levels of grass/clover and cereals correspond to those cutting in Sc BGe (Table 1).

**Table 1: Crop rotation, yield and use of the products on the real farm (Sc REAL) and in the two experimental farming systems (Sc BGe and Sc BGi)**

Sc REAL			Sc BGe			Sc BGi		
crop rotation	dt DM	use	crop rotation	dt DM	use	crop rotation	dt DM	use
grass clover 50*	80	mulch	grass clover 70*	120	biogas	grass clover 70*	120	biogas
winter wheat	34	sale	winter wheat	45	sale	winter wheat	45	sale
triticale + wcc	34	sale	triticale + wcc	45	sale	silage maize	154	biogas
pea + scc	23	sale	pea + scc	23	sale	+ rye for silage	27	biogas
winter wheat	34	sale	winter wheat	45	sale	cereal for silage	69	biogas

\* proportion of clover 50 and 70 % respectively; wcc - winter catch crop; scc - summer catch crop

## Results

A total farm analysis of the three systems and a comparison among the food crop and the energy production chains in each variant is given in Table 2. In the biogas scenarios, energy input in cash crop production rises vis-à-vis Sc REAL due to the spreading of biogas slurry. The yield increase involves an enhanced energy output per hectare of cropping area of 28 % (BGe) and 37 % (BGi), respectively. The output/input ratio in food crop production differs little among the scenarios (Table 2). Although the area-related energy output of cash cropping increases in both biogas scenarios, only in Sc BGe does food production really increase (58 GJ ha<sup>-1</sup>; 46 GJ ha<sup>-1</sup> in Sc REAL) due to a constant cropping structure. In Sc BGi, food production decreases (20 GJ ha<sup>-1</sup>) owing to the drastically reduced cropping area in favour of the cultivation of energy crops.

Power generation on the basis of biomass fermentation involves several conversion steps; each involving energy losses (Fig. 1). Correspondingly lower is the output/input ratio (6 to 7) compared with food cropping (15) (Table 2). Table 2: Total farm and

product related (food crops, power/heat) energy balance in the cash crop farm and under the two biogas scenarios

	hectare	Sc REAL		Sc BGe			Sc BGi		
		farm	food	farm	food	energy	farm	food	energy
<b>field</b>									
direct		2.5	2.2	3.7	2.8	6.5	5.3	3.0	6.1
indirect		1.7	1.8	2.3	1.9	3.5	3.4	2.4	3.7
<b>Input fossil energy</b>		<b>4.2</b>	<b>4.0</b>	<b>5.9</b>	<b>4.7</b>	<b>10.0</b>	<b>8.76</b>	<b>5.3</b>	<b>9.8</b>
Output energy crops		-	-	43.8	-	219.1	169.7	-	226.3
Output food		<b>46.4</b>	<b>58.0</b>	<b>58.0</b>	<b>72.5</b>	-	<b>20.1</b>	<b>80.4</b>	-
<b>Output/Input-ratio food production</b>		-	<b>14.6</b>	-	<b>15.5</b>	-	-	<b>15.3</b>	-
<b>BGP store</b>									
Output preserved energy crops		-	-	36.8	-	184.2	141.0	-	188.0
<b>BGP fossil energy</b>									
Input fossil energy				0.7		3.7	3.3		4.4
Output biogas				18.5		92.7	82.3		109.7
<b>CHPP*</b>									
Output									
power				7.4		37.1	32.9		43.9
heat				9.8		49.1	43.6		58.1
power + heat				17.2		86.2	76.5		102.0
<b>Output/Input-ratio energy production</b>				-		<b>6.3</b>	-		<b>7.2</b>
heat						3.6			4.1
power						2.7			3.1
<b>farm</b>									
Input		4.2		6.7			12.0		
Output farm		46.4		75.2			96.6		
food		46.4		58.0			20.1		
energy		-		17.2			76.5		
<b>Output/Input-ratio farm production</b>		11.0		11.2			8.1		

\*CHPP - combined heat and power plant

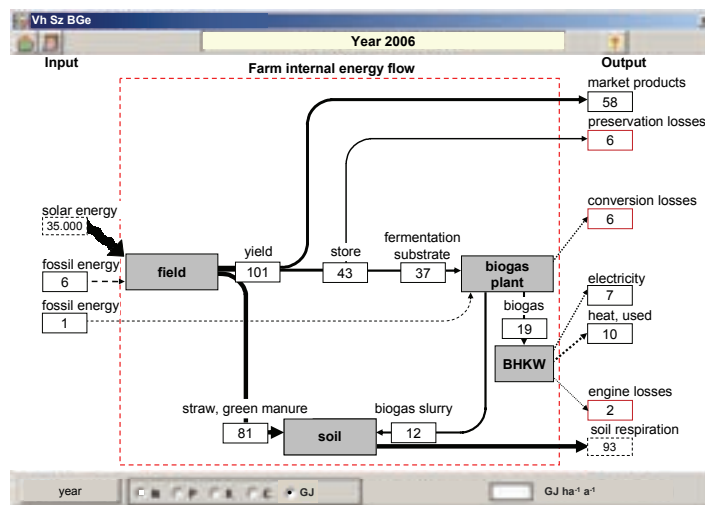


Figure 1: Energy flow in an organic cash crop farm with biogas plant: fossil energy input, energy fixation in the biomass, energy output (food products, electricity, heat) and energy loss paths in Sc BGe. Screenshot from the REPRO model (Hülsbergen 2003).

In the biogas scenarios, apart from cash crops, utilizable renewable energy in the form of electricity and heat is generated by fermentation of by-products (BGe) or energy crops (BGi). This entails an increase in the total energy output of the farm in both biogas scenarios (75 and 97 GJ ha<sup>-1</sup> in BGe and BGi; 46 GJ ha<sup>-1</sup> in Sc REAL) (Table 2). In Sc BGi the output/input ratio deteriorates markedly: more fossil energy carriers are consumed (12 GJ ha<sup>-1</sup>; 4 and 7 GJ ha<sup>-1</sup> in Sc REAL and Sc BGe) with reduced use efficiency.

### Discussion

The main argument for an expansion of renewable energy sources is the CO<sub>2</sub>-neutral energy provision. Energy balances allow one to draw conclusions on the utilization efficiency of fossil energy carriers and the resulting CO<sub>2</sub>-emissions. Reliable information, however, can only be obtained from farm-specific analyses over the entire farm production chain. Such an approach has also been called for by Berglund & Börjesson (2006). Producing bioenergy may also entail changes in cropping structure and yields. Rising yields of cash crops increase food production only when the cropping area is kept constant; a decline in the cash crop area in favour of energy plants may reduce food production despite enhanced yields per hectare.

### Conclusions

Apart from biogas generation, there are further possibilities for providing energy by using agricultural biomass, which may turn a farm enterprise into a net energy producer already at a low proportion of energetically converted biomass. However, not only is the highest possible energy gain required for complying with the principle of sustainability; the objective must also be maximum utilization of the input of fossil resources. In this connection, power generation on the basis of biogas turns out to be more energy efficient than, for example, RME or bioethanol production (output/input ratio 1 to 6) (Venendaal et al. 1997).

### Acknowledgments

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# Biogas and Organic Farming: Empirical evidence on production structure and economics in Germany

Anspach, V.<sup>1</sup> & Möller, D.<sup>2</sup>

Key words: economics, energy, biogas plants, modelling, internal benefits

## Abstract

*Biogas production has an increasing importance on organic farms in Germany. Biogas plants have the possibility to produce energy, soil fertility and positive returns on capital. Yet previously no studies on the structure, economic outcomes and internal benefits of biogas production on organic farms existed. Therefore in 2006 and 2007 an empirical study, designed as a census, has been carried out to investigate these questions. Based on the empirical study a simulation model was built to analyse the economic potential. The highest economic potential, particularly if organic food and energy production are to be accomplished, was found for biogas plants which are mainly residual-based and on a farm scale size. The construction of small but also low priced biogas plants for organic farms will be a challenge.*

## Introduction

Biogas is one out of a set of new biomass based technologies intended to reduce the use of fossil fuels. In addition to the discussion on the potential, costs and energy efficiency of bio-energy in general, especially biogas seems to have the chance to play a major role in future energy scenarios. Farmers have already adapted to the given situation and started to grow energy crops for biogas. In organic farming the discussion has even more complex aspects. Due to the ideas and regulations of organic farming the material flows and economics are much more complex. Farmers and consultants are facing an information gap which has to be closed to offer realistic decision support for future farms investments.

The study presented here consists of two parts. First, an empirical study ("BioBiogas-Monitoring 2006-2007" at the University of Kassel, Germany) was conducted to investigate the structure of biogas production on organic farms and to get insights into technology specifics, use of heat and slurry and on the selection of substrates. Based on the results of the empirical study a simulation model was built and used to analyse the economic potential of biogas in organic farms.

The hypothesis is that organic farms can produce energy (electricity) from biogas in an economic way because of three typical characteristics. First, many farms face a surplus of grass-clover mixtures, which are needed to maintain soil fertility. Especially farms without or with low livestock are looking for reasonable usage of clover instead of mulching. Second, the diverse structure of organic farms in Germany often gives the opportunity to use the waste heat from combined heat and power plants (in stables, dairies, residences, etc.). Finally, the use of slurry coming from the biogas

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plants can improve the on-farm nitrogen cycles significantly. The economic value of a time and spatially flexible fertiliser on organic farms is – due to the overall low nitrogen level – considerably higher than on conventional farms. In fact, biogas production may enhance the “on-farm production” of soil fertility (ANSPACH AND MÖLLER 2007).

### **Materials and methods**

The empirical study was designed as a census instead of sampling. The database consists of 120 notably known organic farms with a biogas plant (experts assume at least 150 biogas plants). A semi-structured questionnaire was sent together with known farm specific data and a paper summing up previous results of the BioBiogas-Monitoring 2006. Around 80% of farmers were contacted by a follow-up call to improve the quantity and quality of answers. 100 out of the 120 farms answered the questionnaire, a 83% response rate.

Due to the challenge that the empirical data does not contain satisfactory information on the economics of biogas production on the farm level a cost and performance accounting model was developed and used as a simulation model. The full cost approach follows the standard set by the German Agricultural Association (DLG) (see MÖLLER 2006). The assumptions of the model, based on real farm examples, are a medium sized biogas plant with an engine power of 200 kW<sub>el</sub> (electricity) and investment costs of 4000 €/kW<sub>el</sub>. On average, 50% of waste heat is used, which can be sold for 4 cent/kW<sub>therm</sub> (thermal). For the monetary value of using biogas slurry as a fertiliser, 6€/m<sup>3</sup> are assumed to coincide with a value of at least 1€/kg nitrogen. The substrate production of organic maize and cereal silage is calculated with full costs, grass and clover only with the harvesting costs, the acquisition of conventional maize with 1400€/ha. One third of the daily substrate ration on all three types of biogas farms is liquid manure.

### **Results**

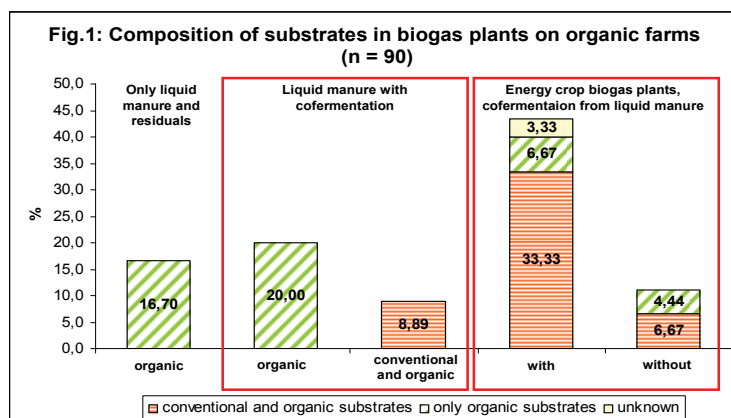
Organic farmers belong to the group of pioneers in the biogas sector and the relevance of biogas on organic farms is still increasing. Today at least 150 biogas plants with an electrical capacity of 15-20 MW<sub>el</sub> are installed. Since 2005 the number of biogas plants has increased by about 50%, the electrical capacity by about 30%. The plant size ranges between 15 kW<sub>el</sub> and 700 kW<sub>el</sub>.

Today around 5% of all biogas plants in Germany can be found on organic farms. Most of the plants are located on feed growing and crop growing farms, but currently more and more so-called “biogas farms” have come into existence. Biogas farms are mostly cooperations of farmers to share a plant and collect the needed substrates together. Most of the biogas plants are really well integrated in the agricultural circuit of the farms. This means that the technological and biological handling of plants is mostly under control and most of the waste heat can be used reasonably for heating houses, intra-farm use like heating stables or the dairy, drying or selling it via small local heat pipes in the neighbourhood. The average use of waste heat from biogas plants on organic farms is about 50%, in comparison with newly constructed conventional biogas plants with a waste heat utilization of about 30% (SCHOLWIN AND FRITSCH 2007).

The main reasons for producing biogas – beside generation income from electricity sales - are positive effects on crop production, upgrading of organic fertilisers and a profitable use of grass/clover and grassland. We could find very strong internal

benefits by using the biogas slurry as an organic fertiliser, especially, but not only, on crop growing farms. The investigated biogas farms show yield increases between 10 and 30%, especially in grain production as well as higher backing quality in grain production and better fodder quality and efficiency of grass silage (see also MÖLLER ET AL. 2006).

Regarding the composition of substrates, we can differentiate three types of biogas farms. The first type is a small plant that uses liquid manure and some fodder residuals only. Second are biogas plants based on liquid manure with more than 50% of the ration; the remainder are co ferments from energy plants. The third type describes biogas plants based on energy crops with and without cofermentation of liquid manure (Fig. 1). The acquisition of conventional substrates has a great importance; about 50% of the farms are using those substrates, mostly maize and cereal silage.



The economics of biogas production on organic farms can be characterised as follows: The use of “waste” heat and the consideration of intra-farm benefits improve the overall profitability significantly (Tab. 1).

**Tab.1: Return of capital of different Types of Biogas-Farms in %**

	Type of Biogas Farm 1 (Utilisation of residuals)	Type of Biogas Farm 2 (Energy crop grower)	Type of Biogas Farm 3 (Conventional acquisition)
Substrate	Clover, grassland, liquid manure	Clover, cereal silage, maize silage, liquid manure	Clover, conventional maize silage, liquid manure
Base (only sold power)	0,5	- 4,3	0,2
incl. use of heat	4,3	- 0,7	3,9
incl. internal effects	4,5	- 1,2	3,1
incl. internal effects and use of heat	8,3	2,3	6,8

The production of energy crops (maize and cereal silage) on organic farms is not profitable under the current framework. Highest profitability is reached when low-cost residual materials (clover and mixtures, intercrops, straw, etc.) are used as a basis for energy production. Many organic farming associations and the EU-regulations on

organic farming allow the purchase of additional input material (e.g. maize and cereal silage) originating from conventional farms. Especially larger biogas plants are often dependent on that source, the economic performance can thus be stabilised significantly.

## Discussion

The empirical data source can be considered as very good because of the high share of German organic biogas farmers interviewed. The reliability of the data could be improved by personal interviews (as the follow-up calls showed), but the overall picture can be considered as quite realistic. However the gained data is not in itself sufficient for detailed economic modelling exercises. The presented results of model simulation runs are very dependent on the underlying assumptions, but the use of up-to-date data and the congruence with other result and farmers estimates generate meaningful outcomes. Further research is needed with real farm data e.g. of 10-20 examples.

## Conclusions

We found a strong interest for biogas plants on organic farms; the importance is equal to conventional farms. Today, positive returns on capital are possible. New capital investments are or could be profitable, if the biogas plants are imbedded into reasonable integrated concepts. Biogas plants have to be adapted to the flow of materials on the farms and their business environment. The main factors of success are high waste heat usage, internal benefits like positive effects on crop production. These are created by the improvement of liquid manure and the use of cost effective substrates such as residuals or by-products of crop production. Currently exclusive production of energy crops is uneconomic, because of the high production costs of organic substrates. Therefore the acquisition of conventional substrates, especially maize, is feasible from an economic point of view. However, this depends on future developments of substrate prices. Also the growing demand for conventional substrates is very critically observed by organic farming associations.

If the aim is to accomplish the production of both organic food and energy, an adequate biogas plant should be mainly residual-based and in a farm scaled size. The construction of small but also low priced biogas plants for organic farms is an important challenge for engineers. Additional research is particularly needed into the internal benefits of biogas slurry and improved heat use concepts.

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# A New Lease on Life for Marginal Farmland: Convergence of Prairie Restoration with Biofuel Production

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Key words: biofuels, biomass, organic agriculture, tallgrass prairie, sustainability.

## Abstract

*The prairie ecosystem that occupied most of the North American continent has been mostly converted into agricultural farmland. The looming global scarcity of fossil fuels has spurred interest in producing ethanol from corn (*Zea mays*) but legitimate objections remain to the idea of supporting this vision. The purpose of this study was to initiate a prairie restoration on marginal soil of a 16.2 ha. farm in southeastern Minnesota and to determine which restoration procedure (only native grass species versus a mixture of grasses and forbes) was most effective for the establishment of prairie on the land that may yield biomass for biofuels. We planted 11.4Kg./ha. of grasses on 4.7 ha. and 0.70Kg./ha. of forbs on 3.2 ha., in June 2007. An evaluation of species richness was conducted after 90 days in the 5 restored plots. The mean percent cover in the grass plots was 0.935, whereas the one in the grass-and-forbs plots was 0.944. A t-test with two independent samples complemented the computation of the diversity index and indicated that there was not a statistically significant difference in species diversity among the plots. This paper postulates a model of prairie rehabilitation in synergy with renewable energy production from native prairies. This could inspire agriculture in the Midwest of the U.S. to a vision of ecological restoration and sustainability.*

## Introduction

The fertile tallgrass prairie of North America stretched through 68 million hectares before European settlement (Smith 2001) and since then, the development of large scale agriculture, aided by mechanization and cheap fossil fuels, enhanced monoculture and an extirpation of prairies (Jackson 2002). Despite restoration efforts, a looming global scarcity of fossil fuels has spurred interest in renewable energy, especially ethanol from corn (*Zea mays*). However, legitimate objections remain to the idea of diverting significant quantities of corn into ethanol as corn remains a major food and thus increases in food prices could become inevitable. Its cultivation is best on fertile land and expanding its production to marginal soils may require ever-increasing off-farm inputs. The arguments sketched out above have recently been supported by the work of Tilman *et al.* (2006). They showed that low-input high-diversity (LIHD) mixtures of native grassland perennials are superior to corn or soybean in terms of usable energy, greenhouse gas reductions and agricultural pollution. Even though the study was conducted on small plots its outcome inspired the authors to verify the applicability of these findings on a real-farm situation.

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## Materials and methods

We have initiated a restoration effort in 2007 over a larger area in an effort to further validate the findings of Tilman *et al.* (2006), and to demonstrate the synergism that can exist between biofuel production and prairie restoration. The work consisted in restoring prairie on marginal soil of a 16.2 hectare farm in south eastern Minnesota to verify on a landscape scale how biomass production for biofuel can be combined with grass and restoration. Additionally, we intended to learn which restoration procedure (only native grass species, versus a mixture of grasses and forbs) was most effective for the establishment of prairie perennials on the land that may yield viable stalks to be pelletized and used, on-site, for heating purposes. The study area (Pork & Plants Farm) is located in the Whitewater watershed in Winona county, southeastern Minnesota, U.S.. To reduce reliance on the costly corn, 7.9 hectares were planted (4.7 ha of mixed grasses and 3.2 ha of mixed grasses and forbs) in June 2007 (Table 1).

**Tab.1: Prairie plant species that were sown at Pork & Plants Farm.**

Native grasses Scientific name	Pure live seed, kg	Native forbs Scientific name	Pure live seed, kg
Big Bluestem <i>Andropogon gerardii</i>	22.7	Long Head Coneflower <i>Ratibida columnifera</i>	0.3
Indian Grass <i>Sorghastrum nutans</i>	16.3	Maximilian Sunflower <i>Helianthus maximilianii</i>	0.3
Little Bluestem <i>Schizachyrium scoparium</i>	4.7	Partridge Pea <i>Chamaecrista fasciculata</i>	0.3
Side Oats Grama <i>Bouteloua curtipendula</i>	7.9	Black-eyed Susan <i>Rudbeckia hirta</i>	0.31
Blue Grama <i>Bouteloua hirsuta</i>	4.5	White Prairie Clover <i>Dalea candida</i>	0.42
Green Needle Grass <i>Stipa viridula</i>	9.0	Oxeye Sunflower <i>Heliopsis helianthoides</i>	0.42
Switch Grass <i>Panicum virgatum</i>	7.2	Purple Prairie Clover <i>Dalea purpurea</i>	0.25
Slender Wheatgrass <i>Agropyron trachycaulum</i>	9.0		
Virginia Wild Rye <i>Elymus canadensis</i>	9.0		
Total:	90.8		2.3

With the above mentioned mixes and hectarage, the plantings came down to an average of 11.4 kg/ha of grasses on 4.7 ha and 0.70 kg/ha. of forbs on 3.2 ha, as recommended by the local soil and water conservation district office that donated the seed. An evaluation analysis of the vegetation in the 5 restored plots was conducted after 90 days (August 2007). Random quarter meter quadrats were used to assess plant cover (n=10), along a west-east transect of each of the five restored plots. Our interest focused primarily on measuring diversity (species richness) and plant cover (percentage) within the sampled areas. Species richness was evaluated by considering the Margalef's index of diversity ( $diversity = s-1/\log N$ ), where s is the number of species and N is the total number of individuals (Longino *et al.*, 2002). Data collection occurred on August 25, 2007, when the plants had emerged from the soil (which had been disked prior to planting), and were already at a 'rosette' stage.

This allowed for an easy identification and measurement of the percent of plant cover in each sample quadrat.

## Results

All five plots were uniformly covered by herbaceous vegetation and this included primarily unwanted weeds that infest corn crops. The mean percent cover in the grass plots was 0.935, whereas the one in the grass and forbs plots was 0.944. In the grass only samples we identified 2 prairie species, which occurred in 12 of the 30 samples (*S. scoparium* and *P. virgatum*). The mixed samples had a total of 4 prairie species in 11 of the 20 samples (*S. scoparium*, *P. virgatum*, *C. fasciculata*, *R. hirta*). A number of annual, early succession species were also found in all the samples. A count of the prairie plant species was accomplished in the 10 samples along each transect, for each plot. The mean number of prairie and non-prairie species and their respective Margalef's index are reported (Tab. 2). The Margalef's index of diversity may not be the best value to consider because it does not include the evenness of the individual plants distribution in the system. Despite its limitations however, the Margalef's Index provided a preliminary indication that diversity (species richness) in the grass and forbs plots was slightly higher than in the grass only plots (Table 2).

**Tab. 2: Descriptive statistics and Margalef's Index of species richness for the grass and grass + forbs plots at Pork & Plants Farm in August 2007.**

Sample number	Mean spp. # (grass plots)	Percent cover (grass plots)	Margalef's Index (grass plots)	Mean spp. # (grass & forbs)	Percent cover (grass & forbs)	Margalef's Index (grass & forbs)
1	1.0	0.92	0.5	6.0	0.96	5.0
2	2.0	0.95	0.5	4.0	0.95	1.5
3	2.0	0.95	1.0	5.0	0.92	2.5
4	3.0	0.94	1.0	6.0	0.92	2.5
5	3.0	0.98	1.0	4.0	0.96	1.5
6	4.0	0.96	1.5	7.0	0.94	3.5
7	3.0	0.90	1.0	3.0	0.94	1.5
8	3.0	0.93	0.5	4.0	0.94	1.5
9	4.0	0.91	1.5	4.0	0.95	3.5
10	1.0	0.91	0.5	7.0	0.96	3.5

A t-test with two independent samples complemented the computation of the diversity index and indicated that there was not a statistically significant difference in species diversity between the grass only and the grass and forbs plots ( $t = (48) = 1.76$ ,  $p > 0.05$ , two-tails).

## Discussion and Conclusion

The restoration effort at Pork & Plants farm was limited in its first year as the vegetation may take a few more years (2-3) before it establishes a diverse community (Reichman 1987). The restoration technique (seed drilling) may be inexpensive and fast to accomplish but not as effective as transplanting seedlings that are capable of competing more aggressively against non prairie plants. This is evident in that non-prairie species covered most of the surface in all the sample quadrats indicating the challenge for the native seedlings to emerge when the soil might have had a

conspicuous seed bank community of common agricultural weeds in place, before the restoration took place. However, more research is needed in order to discover what specific prairie establishment might produce a specific prairie type, e.g., mainly grasses versus mainly forbs. Our effort demonstrates a feasible approach to a reestablishment of ecological services in our bioregion that is sustainable and supportive of organic farming practices. The pellets produced from the prairie plots that were restored at Pork & Plants Farm will be used as biofuel to heat one of the farm greenhouses. A pelletizer is a needed equipment to mince the dry biomass, at the end of the growing season. Questions concerning with costs, social and environmental benefits, energy ratio and carbon footprint remain unanswered at the moment. However, we remain convinced that prairie restoration has potential to reshape the design of farms and restore a sustainable agrarian culture in our bioregion. To this end, there is a need to educate farmers, ranchers and land owners about these and similar opportunities. More importantly there is a need to inspire students and educate them (Borsari and Vidrine 2005) to remediate to the impacts of disturbance upon the environment, which is inexorably caused by human activities. Thus, synergizing prairie restoration with biofuel production may become a promising model for the future of agriculture in the Midwest region of the U.S. and supportive of a vision of sustainability in modern agroecosystems.

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## **Food safety and quality management**

## Effect of cultivar and soil characteristics on nutritional value in organic and conventional wheat

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Key words: micronutrients, soil organic matter, quality, organic wheat cultivars, soil pH

### Abstract

*Evidence of greater nutritional value in organic crops is currently a subject of intense debate. Our objectives in this study were to test for grain mineral concentration in 35 winter wheat cultivars in paired organic and conventional systems, and to determine the influence of cultivar, soil characteristics and farming system on mineral concentration. Here we report preliminary results that show that the grain mineral concentration in organic wheat was higher for copper (Cu), magnesium (Mg), manganese (Mn), phosphorus (P) and zinc (Zn) and lower in calcium (Ca), than the grain mineral concentration in conventional wheat. No difference was found between systems for iron (Fe) concentration. Cultivar was significant in determining mineral concentration for Ca, Cu, Mg, Mn and P. Soil mineral concentration was not responsible for grain mineral concentration, with the exception of P. The organic wheat farming systems had higher grain mineral concentrations of Cu, Mg, Mn, P and Zn than the conventional systems, possibly due in part to increased soil organic matter and pH in the organic systems. Growing specific cultivars capable of exploiting particular soil conditions may be necessary in order to optimize the nutritional value in organic farming systems.*

### Introduction

While global cereal grain yields have increased dramatically since the Green Revolution (Borlaug 1983), global food systems are not providing sufficient micronutrients to consumers (Welch 2002). Over 40% of the world's population is currently micronutrient deficient, resulting in numerous health problems, inflated economic costs borne by society, and learning disabilities for children (Sanchez and Swaminathan 2005). Though a diversification of diet to include micronutrient rich traditional foods is a preferred solution to these challenges, staple cereal grains are the primary dietary source of micronutrients for much of the world's population without access to varied food crops (Bouis 2003).

Genetic variation among wheat cultivars have been shown to be responsible for considerable differences in both mineral content and grain yield (Garvin et al. 2006, Murphy et al. in review). Cropping system can also have an impact on grain mineral

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concentration and yield among wheat cultivars (L-Baeckström et al. 2006; Murphy et al. 2007). We are conducting a study that compares the mineral nutrient concentration of calcium (Ca), copper (Cu), iron (Fe), magnesium (Mg), manganese (Mn), phosphorus, (P), and zinc (Zn) among 35 wheat cultivars grown in both organic and conventional systems. The objectives of this study are to compare the mineral concentration of wheat in organic and conventional systems and to estimate the variation in mineral content due to cultivar, soil characteristics and cropping system.

### **Materials and methods**

Thirty-five soft white winter wheat cultivars were grown in side-by-side organic and conventional fields in Pullman, Washington (latitude 46°73'N, longitude 117°18'W) in the 2004-2005 and 2005-2006 growing seasons on a Palouse silt loam soil. Annual precipitation is approximately 500 mm/year. The organic and conventional fields were separated by buffer strips (7m minimum), though otherwise located in similar microclimatic conditions with comparable soil properties. Cultivars were grown in a randomized complete block design with four replicates. Samples were analyzed simultaneously for Ca, Cu, Fe, Mg, Mn, P, and Zn using Inductively Coupled Argon Plasma techniques. Four NIST (National Institute of Standards and Technology, Gaithersburg, MD, USA) durum wheat standards and four acid blanks were run with each batch of samples. Twenty soil samples from each field in each system were randomly collected to a depth of 18-cm and pooled for analysis. Soil organic matter, pH, and available Cu, Fe, Mg, P and Zn were determined by the University of Idaho soil lab (additional replicates of soil samples are currently being analyzed). This study was expanded to two locations in 2006-2007 and 2007-2008 (results not yet available) to strengthen the statistical power of the data and increase the geographical scope of the results to include a larger area of the wheat growing region of the Pacific Northwest (PNW) in the US.

The organic fields in Pullman have been certified organic since 2002. The two-year rotation in the organic systems was winter wheat/winter pea plowdown. The organic fields were fertilized with ~40 kg/ha of N from the winter pea plowdown and supplemented with certified organic PerfectBlend<sup>®</sup> fertilizer at the rate of 6 kg/ha each of N, P, and K, drilled with the seed at planting. This management practice was intended to reflect low-input, organic soft white winter wheat production in the PNW. The conventional fields were fertilized with 100, 23 and 17 kg/ha of nitrogen, phosphate and sulphur, respectively, and managed as a 2-year winter wheat/fallow rotation. Seed was treated with fungicide and insecticide before planting and weed control was accomplished with herbicide and hand weeding throughout the growing season in the conventional systems. All plots were harvested with a Hege plot combine with stainless steel sieves and cleaned with a Hege seed cleaner with stainless steel sieves.

### **Results**

Grain grown in the organic system had significantly higher levels of Cu, Mg, Mn, P and Zn than grain grown in the conventional system. In an analysis of variance for each mineral, only P had a significant cultivar x system interaction. Grain Ca concentration was significantly higher in the conventional system than in the organic systems; no significant difference between systems was found for grain Fe concentration (Tab. 1). Cultivar was a highly significant source of variation for Ca and Mg ( $P < 0.001$ ) and Cu, Mn and P ( $P < 0.01$ ). There were no significant genotypic differences for Fe or Zn.



**Tab. 1: Mean mineral concentration (mg/kg) between organic and conventional systems**

System	Ca	Cu	Fe	Mg	Mn	P	Zn
Organic	339	2.78*	28.6	971*	45.1*	2845*	17.1*
Conventional	349*	2.40	29.2	929	43.6	2650	15.8

\* significantly higher value (P<0.05)

Soil organic matter, pH, and available soil P and N (nitrate + nitrite) were greater in the organic systems. Available N (ammonia) Cu, Fe, Mn and Zn were greater in the conventional system (Tab. 2). Cation exchange capacity was similar in both systems.

**Tab. 2: Soil characteristics between organic and conventional systems**

System	Organic Matter (%)	Cation Exchange Capacity cmol(+)/kg	pH	N (Ammonia)	N (Nitrate + Nitrite)	Cu	Fe	Mn	P	Zn
Organic	3.4	24	6.1	14	12	2	54	61	11	0.8
Conventional	2.4	23	5.2	32	9	2.4	81	81	6	1.7

## Discussion

The organic grain had slight, though statistically significant, increases in the levels of Cu, Mn and Zn over the conventional grain, despite lower concentration of these minerals in the organic soil. Only P had greater concentration in both the grain and the soil. Concentrations of available Cu, Mn, Zn, and Fe in the soil were greater in the conventional system. Micronutrient availability in the soil has been shown to increase in more acidic soils (Fageria et al. 2002). The lower soil pH in the conventional fields may be due to the higher applications of inorganic N fertilizer and higher levels of available soil N in the form of ammonia.

How then does the lower soil micronutrient availability in organic soils translate into higher micronutrient concentration in organic grain? Organic matter has been shown to positively influence available soil micronutrients (Fageria et al. 2002; Wei et al. 2006) and the organic matter was 1.0% higher in the organic systems. Additionally, root colonization by mycorrhizal fungi can improve acquisition of Cu, Zn, Mn, and Fe (Marshner and Dell 1994), and has been found to be greater in organic as compared to conventional wheat cropping systems (Ryan et al. 2004). Both the increased organic matter and the potential for greater root colonization by mycorrhizal fungi may have played a role in the greater nutrient concentrations in grain from the organic system.

All cultivars used in this study were in the soft white market class. Soft white wheat represents the most important market class in the PNW and is typically used for products where high protein content is unnecessary, including steamed bread, cookies and sponge cakes. Within each system, cultivar was important in determining Ca, Cu, Mg, Mn and P concentrations. This suggests that certain cultivars may be optimally adapted to organic farming systems in a way that allows for higher grain mineral concentration. These cultivars are likely capable of exploiting the higher organic matter in the organic systems to achieve higher nutritional value.

Our previous results have shown that a biological trade-off between yield and mineral concentration likely does not exist (Murphy et al. in review). Our preliminary results from this study show several cultivars with both high yields and high concentrations of minerals, which suggests the potential for simultaneous selection of both grain yield and nutritional value.

## Conclusions

Grain mineral concentration was higher in organic systems than conventional systems for Cu, Mg, Mn, P and Zn. Only Ca had a higher grain concentration in conventional systems than in organic systems. It is plausible that increased root colonization by the mycorrhizal fungi present in organic fields with higher percent organic matter may have resulted in enhanced uptake of soil nutrients and higher grain nutrient concentration. This hypothesis is currently being tested. Of further interest is the apparent ability of certain cultivars to achieve both high yields and increased nutritional value specifically within organic fields. Mechanisms for this evident adaptation to organic systems will be explored in greater detail in an expanded, multi-location, multi-year continuation of this trial.

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# A multidisciplinary approach to improve the quality of organic wheat-bread chain

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Key words: organic wheat, flour, bread, nutritional quality, baking quality, taste, flavour

## Abstract

*The main challenge for organic farmers, millers and bakers is to fulfill consumers' expectations of providing healthy and safe products. The quality of organic grain can be modulated by agronomic modifications on genotypes, crop management, crop rotation and soil fertility, but the milling process and finally the baking process are also key factors in producing bread of high baking quality, nutritional value, taste and flavour. Nitrogen (N) is a key nutrient in achieving acceptable yield levels of sufficient bread-making quality, but previous results have shown that organic wheat tends to have lower protein content, dough mixing tolerance and loaf volume. The selection of genotypes with high N use efficiency, weed competitiveness and disease resistance allowed improving the agronomic performance. Besides protein content and protein composition, the baking performance of organic wheat bread also depended on flour starch damage, amylase activity, ash content and particle size distribution. The milling technique had a critical effect on both baking performance and nutritional value whereas the baking process may improve the bioavailability of minerals through acidification process (sourdough). Finally, this programme allowed to better characterize stakes and constraints of the whole organic wheat-flour-bread chain due to a multidisciplinary approach.*

## Introduction

Nowadays, the protein content is frequently used as the (unique) predicator of the bread making quality of organic wheat grain. Nonetheless, bread making quality is determined by several factors, namely wheat quality, flour properties and baking process. Previous results have shown that, compared to non-organic wheat, organic wheat has lower protein content, dough mixing tolerance and loaf volume (Gooding et al., 1993). Häglung et al. (1998) emphasised that flour with a protein content of less than 12g per 100g of grains required a longer mixing time for optimum dough development. Furthermore, they noticed that baking bread with an acceptable bread volume was difficult to obtain when flour protein content was lower than 8 g per 100g. As a consequence, artisan bakers adapt their baking processes to organically-grown flours with low protein content while others still request highly standardized flour with high protein content.

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The quality value of organic bread can also be expressed by nutritional value and sensory attributes (flavour and taste). Previous results have shown that nutritional value could be improved through the milling process (Chaurand et al., 2005). The nutritional value of whole-meal is generally considered higher to that of refined flour. Therefore, the sensory attributes depends on flour starch damage, amylase activity, ash content and particle size distribution (Kihlberg et al, 2004). Following recommendations of nutritionists, the future trend for the milling industry will be to produce flours richer in micronutrients and fibres.

This paper looks different ways to improve the baking quality, the nutritional value and the sensory attributes of organic bread through agronomical and food processing ways.

## **Materials and methods**

A French national research programme on *Organic Wheat-Bread* was carried out in 2003-2007 to assess and to adapt crop management and processing methods to improve baking quality, nutritional value and sensory attributes of organic bread (Taupier-Letage et al., 2007). Different methodologies were set up in order (1) to evaluate the influence of crop management (genotype, fertilization management, others...) and environmental conditions on grain protein content and bread making quality, (2) to analyse the effect of the milling technique on the nutritional value and baking properties, (3) to improve the fermentation process of flour with yeast or surdough and, (4) finally, to optimise bread production recipes according to the consumers demand. Then, interviews and focus group provided new knowledge on stakes, requirements and constraints of the different actors (producers, collectors, millers, bakers and consumers) in the *organic wheat-flour-bread* chain.

## **Results and discussion**

### *Consumer's preferences and attitudes*

Sensory test had been realised from two focus groups with usual and occasional consumers (120 panellists in total). Four prototypes and two controls of organic bread differing from the type (French baguette vs unsliced bread) and from the milling yield (more or less refined) were tested to evaluate consumers attitudes and preferences. The preference of organic bread consumers is strongly explained by authenticity and healthy dimension in relation with ethical and ecological values of organic production. Usual consumers are stressed by safety and nutritional values linked with ecological principles guarantee by organic certification. Occasional consumers mentioned the need for better consumer information, especially on nutritional value, a better availability of organic bread, a strong authenticity but also a wider diversity. The major constraints for increasing consumption of organic bread are the high consumer price and the poor availability in the mass distribution.

### *The incidence of crop management on bread making quality*

The relationship between grain protein content and baking test appears strongly determined by the genotype. Following the work of Goyer et al. (2005), a new criteria was defined to identify genotypes suitable for organic and low-input conditions as (1) weed competitiveness, (2) quality index with grain protein content and Zeleny reference and (3) yield performance obtained in low-input and organic conditions. Accordingly, a national network of experimental assays has been set up in France to develop a breeding programme for organic wheat. David et al (2005) mentioned that

organic wheat yield and grain protein content (GPC) are strongly influenced by environmental and agronomic conditions. Grain filling of organic wheat varied according to water stress, temperature and soil compaction. Number of kernels was determined by N-deficiency and weed density. The weed density had a negative effect on kernel number leads to nitrogen concentration in grains, increasing GPC. Moreover our data demonstrated the incidence of the cropping system on yield and GPC performance. Arable systems with diversified crop rotation (including cereals, grain legumes and spring crops), regular N fertilization and weeding operations obtained higher results compared to mixed farming systems and extensive arable systems with low N fertilization and no weeding operations. This program provided a better understanding of the interactions of crop rotation, crop management and climatic conditions on yield and grain protein content performance.

#### *The incidence of the milling technique*

Flour obtained with stone milling exhibited a higher rate of starch damage compared to roller milling. This result is in accordance with those of Gélinas et al., (2006) who demonstrated that stones tightening reduced flour granulation, increased both starch damage and water absorption but did not change dough mixing stability of whole-meal flour. Conversely, the higher flexibility of the roller milling system allows separating all the parameters which can influence the nutritional value and the functional properties of flours, rate of starch damage, fiber and minerals content as well as the flour granulation. According to our results, at the same milling yield the baking performance of stone-milled flour was inferior to roller-milled flour. Indeed, stone milling is not as much efficient as roller milling to eliminate outer layers accurately. However this less efficiency results in a higher nutritional value for a given flour yield. According to these results, new milling diagrammes were developed to improve the baking quality of flour obtained with stone-milling and to improve the nutritional quality of flour originated from roller milling. All the resulting flours answer to the nutritional recommendations of the French national programme of health and nutrition (PNNS program).

Increasing fiber content in flour may result in a lower assimilation of minerals complexed by phytates. An optimisation of the fermentation step with surdough allowed to improve both the bioavailability of minerals as well as the sensory attributes of the resulted bread.

#### *Stakes and constraints of the different actors in the wheat-bread chain*

Finally, this programme allows us to characterise stakes and constraints of the whole cereal supply chain. Although the grain price is essentially determined by the grain protein content, collectors and millers noticed that the major obstacles for quality improvement are weevils and weeds contamination. Co-operation between organic cereal producers should be encouraged to allow better cleaning & storage, and bulking to create larger quantities for sale. Therefore, co-operation between producers, millers and distributors should be enhanced to fulfill consumer's expectations through innovations and quality improvement.

### **Conclusions**

This program allowed to gather a wide scientific and technical partnership. This multidisciplinary approach resulted in a significant headway in the field of the agronomy and the cereal processing:

- Protein content is not enough by itself to assess and guarantee the baking quality, it is more important to consider the interaction genotype-protein content to develop a grading system for wheat storage and to prepare milling batches. As a consequence, the cropping system appears as a key management tool.
- New milling diagrammes were developed to combine a high milling yield with good nutritional and sensory attributes either on roller milling and stone milling. In these conditions, the fermentation step must be adjusted to increase the micronutrient bioavailability.

Combining all these data leads to propose a range of nutritional and tasty breads well accepted by consumers. Further research should focus to support the following main points: (1) create a national field network to develop technical references and advices, (2) develop innovative methods to assess organic flour and bread and (3) support the development of the organic wheat-bread chain

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## Organic vs Conventional Suckling Lamb Production: Product Quality and Consumer Acceptance

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Key words: suckling lamb, physico-chemical composition, fatty acids, eating quality, consumer preference.

### Abstract

*Samples of suckling lambs (n=40) of two breeds reared under conventional and organic conditions were analysed to assess physico-chemical characteristics, including instrumental texture, and nutritional quality in terms of fatty acid composition. Consumer acceptance was also studied using the home-use test. Results revealed that organic suckling lamb meat is healthier as shown by the lower saturated fatty acid levels, the higher polyunsaturated fatty acid contents and the higher  $\omega6/\omega3$  ratio. The organic meat had lower instrumental hardness, received higher scores in all sensory parameters, and had statistically better fat sensation and higher ratings for overall liking. These results lend support to the notion among consumers that organic products are healthier and tastier.*

### Introduction

In recent decades world meat consumption has increased, but the economic, ecological and ethical sustainability of meat production is being questioned. However, organic meat production based on natural pastures, by-products and feed produced without artificial fertilisers and chemical pesticides might be more sustainable than conventional meat productions, because it can be produced on land where pasture and grass improve fertility, using by-products of vegetable crops or even wastes from the forest industry (Kum, 2002). It is true that production cost are usually higher in organic than conventional systems, and the higher meat price is the major reason given by consumers for not buying organic products (Angood et al., 2007). However, regular purchasers of organic foods believe they are healthier and taste better than conventional foods (Heaney, 2001).

Although there is a growing volume of literature comparing conventionally and organically produced meat, there have been few studies investigating the nutritional and eating quality of lamb (Nurnberg et al., 2006). Angood et al. (2007) found that organic lamb had better eating quality than conventional lamb in terms of juiciness, flavour, and overall appeal, thus providing some evidence for the perception among

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consumers that organic products “taste better”, but in suckling lamb there are no studies on this question. In the Mediterranean area, and more specifically in the “Castilla y León” region of Spain, fresh suckling lamb meat is a typical and traditional product, regarded by consumers as having high eating quality. Taking that into account, the aim of this work was to compare the two production systems for suckling lambs in terms of physico-chemical composition, including fatty acid composition, and sensory properties as perceived by consumers.

## Materials and methods

The material included 40 suckling lambs, ten animals per production system (organic or conventional) and breed, of two Spanish sheep breeds, all from the same production area (Fariza, Zamora, Spain). Suckling lambs did not receive any kind of feed and were raised exclusively on maternal milk from birth to slaughter. The suckling lambs reared under organic conditions spent the day on pasture with their dams. The organic ewes' diet (pasture of fresh oats) was supplemented (30% of the ration) with a certified organic mixture (17% oats, 13% barley, 10% sunflower seeds, 25% peas, 35% alfalfa forage). Suckling lambs reared under conventional conditions remained in a dry lot where their dams were fed with commercial concentrate (18% beetroot pulp, 26% alfalfa, 22% barley, 12% corn, 12% soy, 10% cotton). The animals were slaughtered at 11 kg ( $\pm 0.5$ ) live weight (20-25 days) in abattoirs licensed, inspected and certified by the Castilla y León Organic Agriculture Council (CAECYL). Carcasses were chilled under commercial conditions at 4°C and 80% RH for 24 hours.

Meat pH was measured on fresh meat 24 h after slaughter in the muscle *Longissimus dorsi* by means of a pH-meter HI8314 (Hanna Instruments) equipped with a penetrating electrode. Intramuscular fat (ether-extractable), was determined according to standard AOAC (1990) procedures. Water-holding capacity (WHC), expressed as the proportion of expressible juice was measured as described by Pla (2000). Lipids were extracted from meat using a standard chloroform/methanol procedure. Fatty acid composition of lipids was methylated and analysed by gas chromatography according to the method described by Revilla et al. (2005). Fatty acids were expressed as a fraction of total weight. Analyses were performed in triplicate. For instrumental texture analysis *L. dorsi* (9<sup>th</sup>-12<sup>th</sup> rib level) were grilled on a pre-heated double hot plate grill at 200°C until the internal temperature reached 70°C. The internal temperature was measured using a digital thermometer Checktemp1 (Hanna Instruments). Six rectangular parallelepipeds, 1x1 cm across and 2-3 cm long, were then cut parallel to the muscle fibres. A TX-T2iplus (Stable Micro Systems) equipped with Warner-Bratzler probe was used. The crosshead speed was 1 mm/s and maximum peak force was recorded.

The sensory analysis was carried out using a home-use test (Lawless & Haymann, 1998) involving 35 families (4 to 5 members) from the province of Zamora. Three-day mature half carcasses were delivered to each family with the instructions that the samples should be prepared by roasting at 175°C for two hours, with only salt added. Consumers were asked to taste the samples in a quiet setting, with no consumption of alcohol. Assessment characteristics of meat were collected from individual questionnaires delivered to each consumer. A 9-point hedonic scale, in which 1 corresponded to “I don't like it at all” and 9 corresponded to “I like it a lot” was used to measure the global relative preferences for the colour, taste, aroma, hardness, juiciness, fat sensation and overall appreciation.



Data of each variable were analysed by one-way analysis of variance (ANOVA). The statistical significance of a factor was calculated at the  $\alpha=0.05$  level using the *F*-test. In tables and figures, different letters (<sup>a,b</sup>) mean statistically significant differences.

## Results and discussion

The results showed no statistically significant differences between conventional and organic meat for pH, intramuscular fat, or water holding capacity (Table 1). This is in agreement with results previously reported for Churra and Castellana suckling lambs. The organic meat has lower Warner-Bratzler Shear Force (WBSF), indicating the higher tenderness of this meat. Organic production implies more mobility, and it may produce greater muscle volume and greater tenderness because of the higher ratio of myofibrillar protein to total collagen (Aalhus et al., 1991).

Statistically significant differences were observed between production system for fatty acid composition. The organic meat showed lower values for the sum of saturated fatty acids (SFA), and higher values for the sum of mono and polyunsaturated acids (PUFA); the differences were significant for SFA and PUFA. The ratio polyunsaturated/saturated acids (P/S), which was relatively low for both meat types (ideally >0.4), did not show statistical differences, although it was higher for the organic meat. Finally, the ratio  $\omega 6/\omega 3$  was lower than 5 (maximum recommended value) for both conventional and organic meat, and significantly lower for organic meat. These results indicate that the intramuscular fat from organic meat was healthier. In lambs reared on pasture, as with organic ewes, the percentage of PUFA, especially of the n-3 series, increased compared with lambs fed the concentrate diet. There is a correlation between fatty acid composition of suckling lambs and the ewes' diet, so that the intramuscular fat of suckling lambs also had higher levels of these compounds.

**Tab. 1: Mean and (SD) of meat quality characteristics and fatty acid composition**

	Conventional	Organic	p-value
pH	5.6 (0.2)a	5.6 (0.1)a	0.661
Intramuscular fat %	5.8 (2.5)a	6.5 (2.2)a	0.582
WHC %	15.8 (2.7)a	15.3 (1.7)a	0.325
WBSF (k)	2.02 (0.61)b	1.65 (0.48)a	0.000
Saturated fatty acids	68.54 (6.12)b	63.53 (6.93) a	0.001
Monounsaturated fatty acids	23.97 (5.47)a	25.96 (3.69)a	0.060
Polyunsaturated fatty acids	7.48 (2.27)a	9.25 (2.91)b	0.003
P/S	0.11 (0.04)a	0.15 (0.05)b	0.000
$\omega 6/\omega 3$	3.35 (0.92)b	3.47 (1.62)a	0.709

Regarding consumer appreciation, organic meat showed higher values for all the evaluated parameters, and the differences were statistically significant for fat sensation due to the higher unsaturation of the fat. As the fat unsaturation increases, the melting point decreases, improving the mouthfeel of the product. The hardness of organic meat received higher scores by consumers, although the difference was not statistically significant. Spanish consumers prefer pale, tender and less intense lamb flavor. The results for hardness indicated that consumers found this meat tenderer, which correlated with the lower WBSF of this meat. Finally, the scores for overall appreciation were significantly higher for organic meat.

## Conclusions

Organic meat is healthier as showed by the lower saturated fatty acid levels, the higher polyunsaturated fatty acid contents and the higher  $\omega 6/\omega 3$  ratio. Indeed, it had lower instrumental hardness, received higher scores in all sensory parameters and had statistically better fat sensation and had higher ratings for overall appreciation. These results lend support for the notion among consumers that organic products are healthier and tastier.

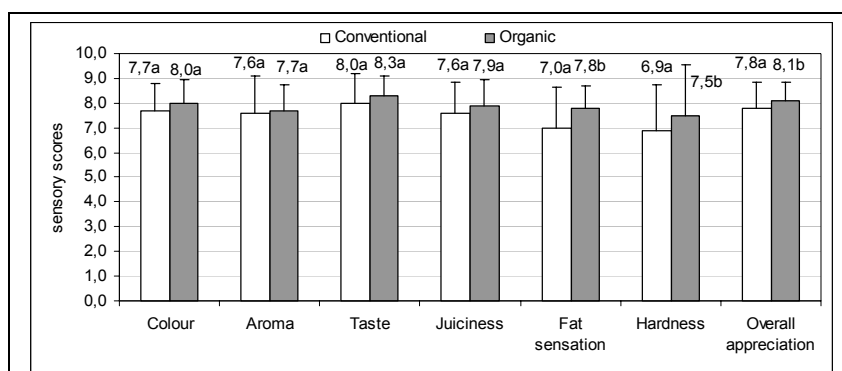


Figure 1: Sensory scores for the parameters evaluated by consumers

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# Animal welfare and food safety: danger, risk and the distribution of responsibility

Kijlstra, A.<sup>1</sup> & Bos, A.P.

Key words: animal welfare, food safety, dioxins, paratuberculosis, toxoplasma

## Abstract

*Increased animal welfare may pose risks for public health, such as increased bacterial, viral or parasitic infections or an increased level of environmental contaminants in the food product. Examples include Campylobacter in organic boilers, Toxoplasma in pigs and poultry meat and Mycobacterium paratuberculosis in milk. Concerning environmental contaminants it is known that free-foraging laying hens will produce eggs that contain higher dioxin levels than hens kept in cages. Furthermore, outdoor chickens are considered to play an important role in the case of Avian flu outbreaks. This review indicates that it is possible to tackle each of the issues mentioned. Risk management is not only a responsibility of the government, but also should be divided amongst the participants in the food chain, including the consumer. To this end it is important that transparency about risks be maintained and optimal communication employed.*

## Introduction

Animal friendly production systems may create new or reintroduce old risks in relation to public health. There is a great deal of differentiation between the possible adverse public health aspects that have been described with animal friendly production systems, of which some are related to food safety of the product and others to direct transfer of microbial agents between farm animals and humans. Some of the risks are due to poorly designed systems and therefore can be prevented, whereas others reflect a fundamental conflict between an attitude of zero tolerance towards public health risks and the wish to keep animals under natural and high welfare conditions that are inherently less controllable from a hygienic point of view. Other risks arise because the environment is no longer "natural", for instance due to historic pollution (dioxins).

To date, food safety issues associated with organic farming have been considered as a delicate issue and little attention has been paid to methods dealing with such dilemmas. In this paper we intend to highlight possible solutions and will illustrate this with recently described examples.

## Materials and methods

We identified food safety issues related to organic animal farming by assessing a number of databases. The Web of Science was assessed using the key words "organic", "animal friendly" and "food safety", using the advanced search option. Papers related to animal husbandry were selected and specific food safety issues

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were isolated. Subsequently repositories such as “Organic Eprints” or the “EFSA Journal” were studied for further papers related to the identified food safety issues.

Food safety issues were tabulated and type and source of risks were described. A proposed responsibility towards management of risks in the food chain were assigned to various players in the food chain.

## Results

**Tab. 1: Public health concerns associated with animal friendly production systems**

Type	Animal Husbandry	Source	Risk Management
<i>Campylobacter</i>	Poultry, pigs	Outdoor run, contact with wild fauna	Monitoring, decontamination, consumer education
<i>Avian influenza</i>	Poultry	Contact with wild birds, humans (farm hygiene)	Monitoring, temporary indoor keeping, vaccination
<i>Toxoplasma</i>	Pigs, poultry	Outdoor run, farm cats, rodents	Monitoring, farm management, post harvest decontamination, consumer education
<i>Mycobacterium paratuberculosis</i>	Dairy cattle	Faeces infected cows, pasture	Monitoring, farm management
Dioxins	Poultry (eggs)	Polluted outdoor run	Monitoring, farm management

The literature search revealed several issues where concerns were expressed regarding public health. Food safety in relation to animal welfare has not yet received much attention in the peer reviewed literature, and for each subject often no more than a few references were found. Examples of concerns that were identified are shown in table 1. Concerns associated with *Trichinella*, *Salmonella* and *Yersinia*, for instance, were not included in the table. The types of dangers, source and management are depicted in the table and will be shortly described in the following paragraphs.

Providing chickens outdoor access may increase the risk of poultry becoming infected with *Campylobacter* because of contact with wild fauna, an infected stable or outdoor run. Once a *Campylobacter* infection has been established on a farm it is very difficult to eradicate it because of the nature of the environment, i.e. the outdoor run cannot be cleaned. Engvall (2001) showed that almost 100% of the organically farmed flocks in Sweden might be infected with *Campylobacter*, compared with only 10% of the conventionally reared flocks. Danish and Dutch studies confirmed these findings

(Heuer et al., 2001; Rodenburg et al., 2004). It should be noted that *Campylobacter* is not a direct health problem for chickens. *Campylobacteriosis* in humans is considered a serious food-borne disease and in past decades many actions have been taken to reduce *Campylobacter* in poultry production systems. Organic (broiler) chickens should be monitored at slaughter so that farmers can investigate whether intervention programs are able to decrease the infection rate. Postharvest decontamination (freezing, high pressure) of meat can be performed between slaughter and retail stages in the food chain. Consumers should be educated to properly cook their meat and maintain proper kitchen hygiene.

Avian influenza, especially the H5N1 type, is considered to be an important pathogen for humans. Mutations of the virus may cause a worldwide influenza epidemic. Migratory birds are thought to play a role in the transfer of disease to farmed poultry. Poultry that are partially housed outside are considered to be at high risk for contracting infection from infected migratory birds. Poor hygiene management on animal friendly farms may also play a role in transfer of viral infection. Regular on-farm monitoring, temporarily keeping chickens inside, and vaccination are possible measures to control avian flu.

Toxoplasmosis is a disease caused by the protozoan parasite *Toxoplasma gondii*. A primary infection with *T. gondii* during pregnancy can lead to serious and sometimes fatal disease of the fetus or newborn. Individuals with latent infection may develop chronic ocular toxoplasmosis leading to visual impairment. Undercooked meat has been considered the main source of infection. The great changes in animal production hygiene have resulted in a significant decrease of the rate of *Toxoplasma* infection of pork meat. However, the introduction of animal friendly production systems may lead to a reemergence of *Toxoplasma* infections in pigs (Kijlstra et al. 2004) and poultry. Monitoring of farms and adjustment of farm management can play an important role in the control of *Toxoplasma* infections. Farms with a known positive *Toxoplasma* status should have their meat decontaminated, e.g. by freezing. Consumers should be educated to properly cook their meat and prevent cross contamination during meat handling in the kitchen.

*Mycobacterium avium* subsp. *paratuberculosis* (MAP) is the cause of a severe incurable gastroenteritis in ruminants, also known as Johne's disease. The mycobacterium responsible for paratuberculosis in ruminants has long been suspected to have a role in chronic inflammatory bowel disease in humans, especially Crohn's disease. Transfer to humans is thought to occur via milk products, since the bacterium is resistant to pasteurization. Although the paratuberculosis situation in Dutch organic herds does not seem to differ from that found in conventional herds (Kijlstra 2005), it is mandatory to keep monitoring the prevalence so that measures can be taken if the seroprevalence starts to rise again. Consumers can do little about prevention of contact with the bacterium and therefore the responsibility lies with the farmers, milk factories, and government.

Dioxins are considered the most toxic substances in the human food chain. Exposure to dioxins occurs via the ingestion of animal products, including eggs. For dioxins in eggs a maximum limit has been set. It is forbidden to sell eggs when their dioxin level exceeds 3 pg TEQ/g egg fat. The dioxin content of eggs from free-foraging chickens is much higher than that observed in chickens kept in wire cages (Kijlstra et al. 2007). It is assumed that uptake of soil, insects and worms leads to bioaccumulation of dioxins in egg fat. A monitoring program in combination with farm management can prevent eggs with increased dioxin levels from entering the market. Responsibility lies with

producers, egg packaging stations, and retailers to insist that only eggs participating in such control programs enter the market. Consumers should be aware of these quality assurance programs.

## Discussion

In the transition to improved animal welfare systems it is necessary not only to make a good inventory of possible risks and to communicate them well, but also to differentiate them concerning responsibility. Some risks are inherent to the choice of keeping animals in a more natural environment and could be judged as an inherent responsibility of the consumer, whereas others may need a further refinement or adjustment of the housing or farm management system used.

Governments with an ambition to develop a transition to animal friendly farming systems should be aware of the fact that veterinary dogmas and zero risk tolerance for public health are implemented as a norm without any further differentiation. In this view, public health should not be seen as an exclusive responsibility of the government.

In the dilemma between animal welfare and food safety we should not simply deal with communication of food safety aspects to the consumer, but also should try to provide the relevant background of types and sources of the risks and relate them to the distribution of responsibility among the various players in the field.

## Conclusions

Organic animal farming is associated with a number of concerns in relation to public health and food safety.

Responsibility with regard to food risk management depends on the type of danger and should be divided amongst the players in the food chain.

The ability to accept responsibility for the prevention of food-borne disease is important and communication of risks should be optimized.

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## **Biodiversity assessment and management**



# Impact of Organic Crop and Livestock Systems on Earthworm Population Dynamics

Kotcon, J.B.<sup>1</sup>

Key words: Long-Term Experiments, Farming systems, soil biodiversity, rotations.

## Abstract

*Earthworm population dynamics and diversity were evaluated in long-term farming systems experiments at the West Virginia University Organic Research Farm from 2000-2007. Farming systems included vegetable and field crop rotations, with versus without annual compost amendments. Field crop rotations with livestock included three years of clover-grassland. Earthworms were monitored by hand-sorting soil samples. Aporectodea caliginosa and Lumbricus rubellus were the most common species observed. Cultivation adversely affected earthworm populations in all systems, while compost amendments either had no effect or increased earthworm populations. The population structure shifted toward younger age classes and lower biomass. Inclusion of clover-grassland in the rotation for pasture and hay production for sheep had no significant effects on populations in the field crop systems.*

## Introduction

Earthworms are generally considered to be important indicators of soil quality and provide well-known benefits through cycling of organic matter and improving soil porosity and aeration (Edwards, 1998). Earthworms are also known to be sensitive to synthetic pesticides, thus transition from conventional to organic practices is believed to enhance earthworm activity in soil. The West Virginia University Organic Research Farm project was initiated in 1999 as a long-term evaluation of organic farming systems. Prior to this time, the Farm had been in conventional horticultural production, primarily tree fruits and vegetables. Soils are silt-loam and slopes range from 0-24 %, typical of Appalachian hill top farms. The initial three years of the project involved a transition from conventional to organic management, with organic certification granted in 2003. Since that time, farming practices in this trial adhere to USDA organic certification requirements. The project was designed to evaluate the impact of several organic farming systems on crop and livestock productivity, soil quality, populations of pests and beneficial organisms, and farm profitability. This paper reports on the changes in earthworm populations in these farming systems.

## Materials and methods

Two replicated farming systems experiments, market garden and field crop/livestock, were conducted. Each compared two treatments for managing soil quality during the transition from conventional to organic practices: a low input transition using cover crops only, and a high input treatment using off-farm compost amendments with cover crops. The field crop system also included two additional treatments, with- and

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without-livestock, arranged in a factorial design with the two transition (high vs low input) treatments. Prior to initiation of the experiment, all plots had been managed as permanent grassland or as a conventional apple orchard.

**Low Input Treatment.** Plots were cover cropped intensively beginning in Fall 1999 and throughout the 2000 growing season. Rye, sown in fall, 1999, was followed by clover in spring, 2000 and by rye and vetches in the fall of 2000. All cover crops were plowed in as green manure. This treatment was used to build soil quality and yielded no saleable product in 2000. Market garden plots were cropped, starting in 2001, with a 4-year rotation sequence of legumes, leafy vegetables (spinach and lettuce), solanaceous crops and cucurbits. Field crop plots in the without-livestock systems were cropped to wheat, potato, forage soybean, or Brussels sprouts. A rye-vetch winter cover was planted each year on all plots, except those with an established overwintering crop. Beginning in 2003, forage rape was substituted for brussels sprouts, and a summer cover crop of cowpea was inserted in the rotation. Field crop plots in the with-livestock systems followed a seven-year rotation, with cultivated crops for four years, followed by three years with orchard grass-red clover.

**High Input Treatment.** Following the rye cover crop planted in Fall 1999, plots were amended with a dairy manure compost at 10 T/acre in the spring of 2000. Crops in the field crop and market garden plots were the same rotation as for the Low Input system. Thus, the High Input treatment used off-farm compost to improve soil quality and produced saleable crops in the first year of transition. Compost was applied at 10 T/acre each year to High Input plots in the Market Garden and through 2003 in the Field Crop plots. Beginning in 2004, compost was applied at 20 T/acre in the potato and wheat crops, with no compost applied in the high input soybean, cowpea, or forage rape crops. The market garden had four replications of the two treatments and four crop families in all combinations (32 plots total). The field crop system had three replications of the low and high input systems with and without livestock, in all combinations (66 plots total). Sheep grazed the plots, with stocking density assigned at a level to minimize purchases of off-farm feed. Soil samples were collected to monitor soil earthworm fauna. Three soil cores (10-cm-diam by 15-cm-deep) were collected from each plot and earthworms were collected in the field by hand sorting. Worms were placed in vials on ice and returned to the lab where they were sorted by species and age class, and then oven-dried at 45 C to determine biomass. Worm fragments were counted as one-half of a worm, and fragments without an identifiable head were designated as unknown species. Worm populations were monitored in the Market Garden systems in spring of each year from 2000 through 2007 (except 2005), generally before the first tillage operations. Field crop systems and summer and fall populations in the Market Garden were also monitored through 2004.

## Results

The dominant species in both field crop and market garden plots was *Aporrectodea caliginosa*, with *Lumbricus rubellus* also occurring frequently. *L. terrestris* was rare, and largely disappeared from the plots after a few years of cultivation. Although population densities increased during 2006 and 2007, the proportion of adults declined from 57 % of identified individuals in 2001, to only 26 % by 2007. Population density was significantly greater in market garden plots with high compost inputs on 6 of the 15 sample dates (Figures 1A and 1B). Similar trends in field crop plots were observed, but differences were statistically significant only for biomass at one date (Fig. 1 C and 1 D).

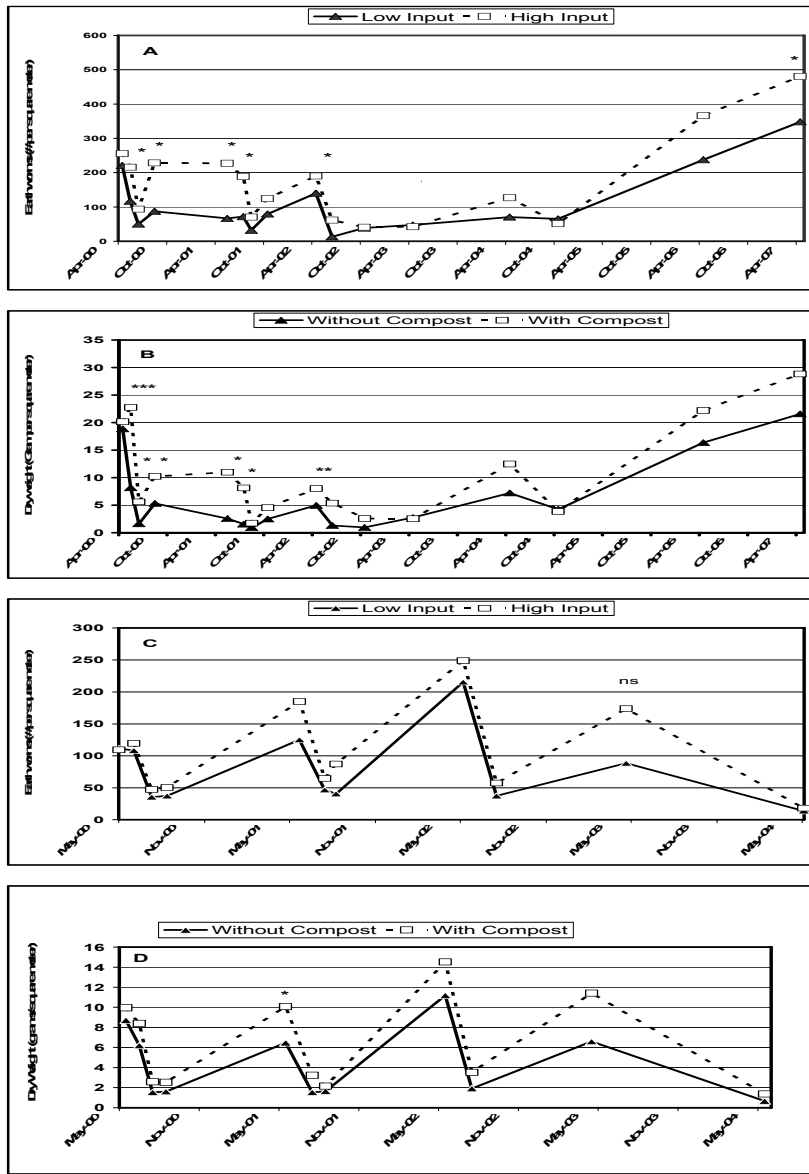


Figure 1: Earthworm population density (A) and biomass (B) in vegetable market garden systems and in Field Crop Systems (C and D) amended with 10 Tons Dairy manure compost per acre (High Input) or unamended (Low Input).

## Discussion

Earthworm populations respond to agroecosystem management practices. Adverse effects of tillage on earthworm populations are well known (Edwards and Lofty, 1982; Rovira, et al. 1987). Anecic species such as *L. terrestris* are particularly sensitive, and largely disappeared from plots in this study after continuous cultivation began. The population age structure of the less sensitive species in our plots was also affected, as the majority of individuals collected in 2000 and 2001 were adults, but the populations became increasingly dominated by juveniles, with adults constituting only 26 % of the population by 2007. The declines observed in mid-summer may have been a direct result of spring tillage operations, or simply a sampling artefact due to earthworms moving during hot dry weather to soil layers deeper than the depth of our samples.

Other studies show that addition of organic substrates that serve as food sources can stimulate earthworm populations (Curry, 1976). In our study, population density and biomass were consistently greater in both field crop and market garden plots receiving dairy manure compost than in plots without compost, although differences were not always statistically significant. The host crop planted rarely had a significant or consistent effect, although there was a trend toward higher populations in market garden plots with tomato and pepper, and in field crop plots planted to orchard grass-red clover grasslands. The higher earthworm populations in tomato and pepper plots may have been due to the use of hay mulch for weed suppression, rather than a specific effect of these crops.

Few studies have examined the effects of livestock on earthworms. Hutchinson and King (1980) indicated that earthworm populations were greatest when the stocking rate of sheep was kept at levels associated with maximum productivity, however few other studies have found comparable effects. While the absence of cultivation may tend to promote earthworm populations, trampling has been shown to adversely affect earthworms living near the soil surface. In our plots, sheep grazed only for short periods, and no effects were discernible.

## Acknowledgments

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## Eco-Regions: How to link organic farming with territorial development

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Key words: Eco-Region, territorial development

### Abstract

*Organic farming in Austria has seen a rapid development as all over Europe. In some alpine regions over 50% of the farms have converted to organic. Thus the idea of forming "Eco-Regions" ("Bioregionen" in German), transforming organic farming values from a farm level to a regional scale, emerged. The paper presents the results of an action research based project to develop a model for the formation of Eco-Regions and to monitor the success in cross-sectoral networking. Besides a number of prerequisites also bottlenecks for the formation become apparent. The paper describes the model and the implementation in two distinct regions.*

### Introduction

Organic farming in Austria has seen a rapid development as all over Europe. According to official data in 2006 13,4% of the agricultural area of Austria have been farmed organically by 11,6% of all farms (BMLFUW 2007). Some regions however, most of them in the alpine area have reached significantly higher percentages up to over 50%. These high percentages provoked the idea of transforming organic farming from a farm level to a regional scale. This is the basic meaning of "Eco-Region" ("Bioregion" in German), a concept which has entered the rural development debate since 2001 (Schermer & Kratochvil 2003). Thus the notion of "Eco-Region" in the Austrian context constitutes a sustainable territorial development approach based on local organic farming practices and products as ideational anchor points and on an active participation of organic farmers in such processes. This understanding of Eco-regions complies with the current shift from sectoral to territorial development policies. The CAP views rural spaces increasingly from a territorial perspective as opposed to the traditional sectoral view on rural development. It thus allocates partly funds under the measurements of the "second pillar" activities for integrated rural development, not only connected to agriculture. Organic farming is supposed to contribute to rural development more than other forms of farming, in particular due to the close ties between producers and consumers. The concept, building on the theory of neo-endogenous development (Ray 1998), provides benefits for organic farmers as well as for the region. For the organic sector the concept provides a possibility to reconnect production to a given territory and to focus on regional value chains as counterstrategy to the "conventionalisation trap" (Kratochvil & Leitner 2005) which is progressing with the increasing demand for organic products by consumers and the globalisation of trade relations. For rural development the concept provides the possibility to sharpen the notion of sustainability by providing a concrete example (Schermer, 2006).

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This contribution looks into the processes of formation, the preconditions and steps to link organic agriculture successfully with territorial development.

### **Material and Methods**

As in the recent past a number of Austrian regions started to declare themselves Eco-Regions, the concerned stakeholders called for a systematisation and codification of the approach in order to prevent free riders. A participatory action research approach was chosen as the methodological project for a research and implantation oriented project. Action research builds on a cyclical process in four stages: planning, implementation, monitoring and evaluation and finally reflection to adjust planning (Zuber Skerrit, 2002).

The national funded project on Eco-Regions as a model for sustainable development was commissioned by the federal ministry of agriculture and implemented between beginning of 2004 and November 2007. During the first phase (2004 until March 2007) at least four participative workshops were held in each of four regions. The participants came from various stakeholder groups involved in Eco Region initiatives in different geographical areas and stages of Eco-Region development. These workshops aimed at reflecting on the concept in order to define a basic set of criteria for developing a general model. The participants furthermore designed concrete activities linking different actors in the region (tourism, commerce, culture etc.). The number and type of actors varied according to regional circumstances. The monitoring of the implementation of the designed activities, carried out in the frame of bi-monthly meetings, contributed to a general understanding of various difficulties rural actors may have in promoting territorial development. It also helped to derive guidelines for the sequence of stakeholder involvement and for the establishment of a coherent vision for regional development including concrete activities for implementation.

In the second phase (April to November 2007) concrete concepts were developed on the basis of the results of phase one in two of the four initial regions. The activities foreseen in these concepts will be implemented within the frame of the new LEADER program.

### **Results**

The model, which was elaborated during the first project-phase, shows that Eco-Regions are conceptualised as an ongoing process rather than a fixed status. Therefore most of the criteria proposed are procedural. Minimum criteria as prerequisites include a clear delineation of the region, a percentage of organic farms above the national average and the setting up of a regional organisational structure for organic farming. The main instrument is the elaboration of a comprehensive development concept with concrete measures according to fixed obligatory development domains. These include measures on the further development of organic organisation, regional processing and marketing, cooperation with other sectors (gastronomy, tourism and commerce), internal and external communication, renewable energy, nature and cultural landscape. In addition to these compulsory topics the region is free to select further optional topics according to regional relevance.

The Eco-Region model postulates that the starting point is the local organic agriculture and their products. Different stakeholder groups (most often but not always organic farmers) start the process with an assessment on the potential fulfilment of the basic

requirements. Preferably the elaboration of the Eco-Region concept goes in parallel with networking activities. First local organic farmers form a group, in a second stage this group networks along the supply chain and in the third stage with other territorial partners. This model is an ideal situation, which in the second phase was applied to two regions, where detailed development concepts were elaborated in a participatory process. These two regions differ largely according to the basic criteria, although in both cases the percentage of organic farmers is above the national average. The two regions also display different possible situations and paths in Eco-Region development:

The first region, the "Bio-Heu-Region Trumer Seenland" is organised by an organic cooperative with roughly 180 members. The delineation of the region follows cultural practices (silage free, hay based dairy farming, which was a base of the local dairy industry) and geographical boundaries provided by the watershed of a series of lakes. However, administratively the region touches two provinces (Salzburg and Upper Austria). The overlap with different administrative regions makes it difficult to link up with regional development organisations as for instance there are three LEADER regions involved. The proponents of the Bio-Heu-Region are very active in promoting the region, by e.g. electing a "hay queen" as a representative and organising all kinds of activities. However, links to other sectors remain rather weak, besides building up supply chains for niche products (like spelt) they have punctual co-operations with a cultural centre and local tourism offices, but so far they failed to involve the local dairy industry which is the backbone of agriculture. On the contrary the conventional dairies operate with the designation "region of delicacy – hay-milk cheese" declared by the federal ministry of agriculture.

The second region, the "Bioregion Murau", comprises one distinct district with clear administrative, geographical and culture-historical boundaries. Other than in the first case the initial idea of installing an Eco-Region was not primarily developed by organic and/or agricultural actors, but rather by local entrepreneurs. A core group, consisting of a baker, a plumbing entrepreneur, an organic farmer and a local rural development advisor, who is also a (conventional) farmer, proposed the Eco-Region concept. They formed a platform installing working groups in different sections (energy, agriculture, tourism and commerce). The organisational structure however is not very well developed. The local organic farmers are barely organised in a group, which makes it easy for market actors to appropriate the image of the Eco-Region for their ends. This happened when a big discounter, which is the major customer of the regional milk processing plant, launched a new strictly conventional brand, which plays with the natural image of the region and promotes the silage free traditional production methods. Most organic farmers go along with this as long as the milk price is increased.

## **Discussion**

The most stunning result is that (so far) both Eco Regions, in spite of high percentages of organic farmers, did not defend their concept successfully against the conventional farming sector. The reasons are different in the two regions.

In the Bio-Heu-Region the distinction between the Eco-Region and the (conventional) hay-milk region is blurred in public although the president of the hay-milk region is an organic farmer himself and a member of the Bio-Heu-Region. Apparently, the organic farmers feel too weak to force the dairies, which operate both, conventional and organic processing lines, to market their cheese better and to pay a higher price to

organic farmers. They started a number of activities which were raising the profile of the Eco-Region, but they are lacking strategic planning in order to take the lead in territorial development. It is probably asked too much from farmers to act as regional development agents, but without strategic planning to secure a larger part of the added value, the regional networking remains weak. The elaboration of an Eco-Region concept can be seen as a first step in the right direction.

In the Bioregion Murau the main focus of the proponents is on enhancing the regional added value. This aim can be achieved in various ways, the Eco-Region being only one of them. The new brand finds widely support, although it is a conventional brand. Organic farmers are not organised in a strong group and cannot defend their case against conventional farmers, who are particularly happy to participate in the new program as they could not in the frame of the Eco-Region. The underlying problem is that contrary to the sequence proposed in the model the actors in Murau started with regional networking before the organic farmers were organised.

## Conclusions

Eco-Regions provide a frame which could allow organic stakeholders to play a key role for territorial development. The current experiences however show that their success has been limited so far, due to different reasons. In Murau one of the very prerequisites was and is missing: the formation of a group of organic farmers. Hence, the idea is weakly defended against usurpation by other actors. In the Bio-Heu-Region all prerequisites had been achieved, but strategic planning skills to build successful trans-sectoral cooperations is lacking.

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# Effects of landscape agricultural intensification and management on weed species richness in the edges of dryland cereal fields.

Romero, A., Chamorro, L., Blanco-Moreno, J. M., Armengot, L., Jose Maria, L. & Sans, F. X.<sup>1</sup>

Key words: Landscape agricultural intensification, weed diversity, crop edges, dryland cereals.

## Abstract

*An extensive survey of weed vegetation was conducted in the crop edges of 180 organic and conventional dryland cereal fields in nine localities of NE Iberian Peninsula to assess the effect of landscape agricultural intensification and management on weed diversity.*

*This preliminary results show that averaged weed species richness per edge (alpha-diversity) and floristic homogeneity among edges are higher in organic than conventional fields. Only in conventionally managed fields, elevated landscape intensification is associated to higher weed alpha-diversities and floristic homogeneity among crop edges.*

*The expression of high-quality weed flora is higher in organic than in conventional crop edges but, conversely, it is only sensitive to landscape intensification in organic fields, being clearly favoured in low-intensified landscapes.*

## Introduction

Organic farming enhances weed diversity and abundance in dryland cereal fields (Hole et al., 2005) and facilitates the settling of characteristic segetal weeds –i.e. weed species which thrive almost exclusively in cereal fields. Within each management type (organic or conventional), the observed variability in weed diversity patterns among different cereal areas may be due to different farming intensity levels but also to landscape features such as agricultural intensification.

Several authors have studied the effect of landscape agricultural intensification on weed diversity of dryland cereal fields (Roschewitz et al., 2005). Landscape agricultural intensification, easily measured by the percentage of arable land, has been shown to be negatively correlated to other landscape features such as diversity, density of edges among patches or fragmentation of arable habitat. These features may differentially affect some aspects of weed populations' dynamics such as dispersion or survival through the distribution of safe-sites and connected patches, and consequently, may be related to diversity patterns at alpha, beta and gamma levels.

The aim of this work is to test the hypothesis that landscape complexity may modulate the effect of management system on weed species richness. To achieve it, an extensive weed survey was carried out in the field edges of 180 conventional and

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organic fields, in nine cereal localities of central Catalonia (NE Iberian Peninsula). As crop edges allow for a higher expression of weed diversity and are less dependent on management intensity than inner fields, they were considered especially appropriate to register landscape effects over farming intensity effects.

## Materials and methods

In each locality a circular area of 12.57 km<sup>2</sup> was delimited. The nine studied localities shared brown lime soils and a Mediterranean climate. Between six and eight organically managed dryland cereal fields and between 12 and 14 conventionally managed ones were surveyed in each locality. Selection of fields was carried out *a priori* on orthophotographs and later in the field, those which were not sown with wheat or barley, or showed extreme values for aspect or size were discarded. In June of 2005, the weed vegetation of each field was surveyed in a rectangular sample of 20 x 5 m<sup>2</sup> set in the crop edge, half a meter inside the field from the cultivation limit and with the longest side of the rectangle parallel to the field margin. Each species in the sample was identified and its cover estimated by means of an ordinal scale which ranged from 1 to 5.

For each locality and management type, the averaged value of weed species richness per field ( $S_{\alpha}$ ) and the accumulated weed species richness across all the surveyed fields ( $S_{\gamma}$ ) were obtained. The homogeneity of weed species distribution across the fields was computed as the ratio of the alpha to the gamma value, corrected for the different number of surveyed fields (Jost, 2006). Characteristic segetal species richness for each locality and management type was computed through the pooling of six fields (the minimum number of fields surveyed in a locality and a management type). Then, the pooling was randomly repeated until 1000 resamples were achieved and the average value was calculated.

Landscape agricultural intensification in each locality was estimated by the percentage of arable land in the 12.57 km<sup>2</sup> area, obtained from official habitat maps (Generalitat de Catalunya, 2005) worked at 1:25.000. This value showed highly significant correlations with landscape physiognomic diversity ( $r = -0.93$ ,  $P < 0.001$ ), density of edges among arable land and natural habitats ( $r = -0.78$ ,  $P < 0.01$ ) and arable habitat fragmentation ( $r = +0.77$ ,  $P < 0.01$ ).

To test the effect of landscape and management type on the aforementioned weed diversity descriptors, weighted lineal models were designed. For each combination of landscape intensification and management, the weight was proportional to the number of fields surveyed and the inverse of the variance of each weed diversity descriptor. Differences between management types were tested with paired t-tests. One locality was considered outlier for organic management and removed from analysis. Statistical analyses were carried out using R (R Development Core Team, 2006).

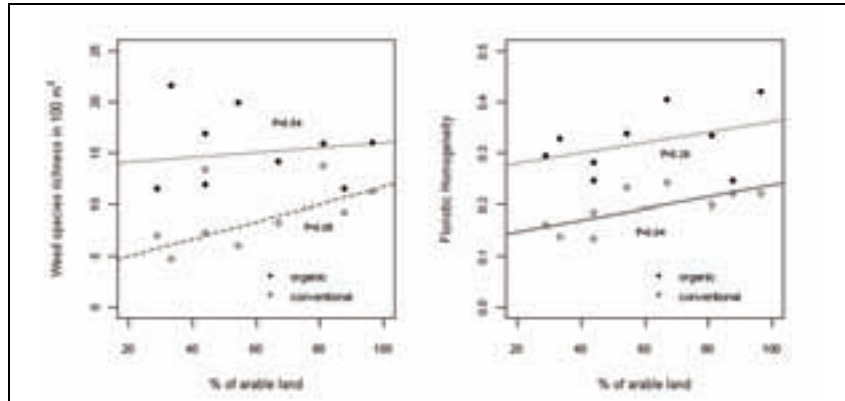
## Results

Crop edges of organic fields sustained higher averaged weed species richness than conventional ones, and a marginal lineal positive relation with the ratio of arable land was only observed in conventional fields. Homogeneity of weed species richness distribution in a locality followed a similar pattern, as it was also higher in organic than conventional fields and was linearly related to landscape intensification in the latter ones ( $P < 0.05$ ) (Tab. 1, Figure 1).

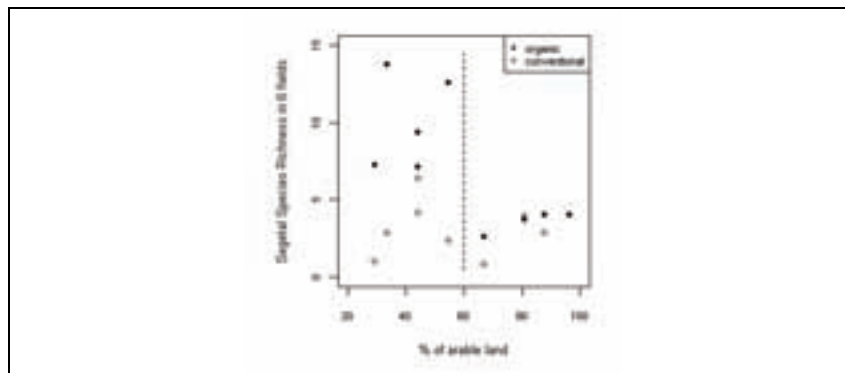
**Tab. 1: Mean ± standard error of the weed diversity estimators studied.**

	Conventional	Organic	
Averaged species richness per field	8.96 ± 1.062	15.45 ± 1.211	**
Homogeneity	0.19 ± 0.013	0.32 ± 0.021	***
Segetal species richness	3.16 ± 0.576	7.15 ± 1.345	*

\* Significant for  $P < 0.05$ , \*\* significant for  $P < 0.01$ , \*\*\*significant for  $P < 0.001$



**Figure 1: Mean species richness (left) and homogeneity of species richness distribution (right) of weeds with respect to landscape agricultural intensification. P-values of lineal models are next to each line.**



**Figure 2: Segetal species richness accumulated across 6 fields with respect to landscape agricultural intensification. The vertical line remarks the change in the pattern for organic fields.**

The pool of characteristic segetal weed species accumulated across six crop edges followed an interesting pattern. Differences in accumulated segetal species richness

between management types were unappreciable in the four localities with the highest percentages of arable land but became clear in the less intensified landscapes, where organic fields displayed more elevated values (Figure 2).

## Discussion and Conclusions

It is well-known that organic farming favours weed species richness. In this preliminary work we have shown that agriculturally intensified landscapes homogenize weed species distribution among dryland cereal crop edges only in conventionally managed fields. In intensified localities, dispersal and survival of ruderal/nitrophilous weed populations could be enhanced by the abundance of ruderal neighbouring habitats such as temporal fallows and highly disturbed roadsides. This hypothesis could also explain the increase in alpha weed species richness associated to landscape agricultural intensification in conventional crop edges. Though only marginally significant, this pattern does not seem to be consistent with other results obtained in central Europe (see Roschewitz et al., 2005). It is worth noting that this pattern was not observed in organic crop edges, probably because weed species richness is sufficiently high so that the contribution of neighbouring habitats cannot be detected.

Conversely, segetal species richness, which could be interpreted as high-quality diversity, seems to be negatively affected by landscape intensification (Figure 2), but only in organic fields. The high intensity of conventional management constitutes an unavoidable barrier to the presence of such specialist species that invalidates any possible landscape effect there, but organic farming seems to need low-intensified landscapes to achieve the highest levels. As an explanation, we propose that the pool of segetal species could have been lessened and substituted by a ruderal/nitrophilous species' one in intensified landscapes. Experimental studies should be conducted to determine the causes of the patterns highlighted in this work.

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# Comparative analysis of conventional and organic farming systems: Diversity and abundance of farmland birds

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Key words: Nature conservation, environmental sustainability, biodiversity, fauna, birds

## Abstract

*A comparative study of the abundance of breeding birds and wintering birds was carried out over the period 2005-2007 in conventionally and organically managed arable fields in Northern Germany. Birds were surveyed on 40 (breeding season) and 35 (non-breeding season) pairs of fields (conventional/organic), which were selected on similar field sizes, comparable boundary structures (hedges, shrubs) and representative crop rotations. Averaged over three years of investigation, skylarks (*Alauda arvensis*) and, less distinct, pheasants (*Phasianus colchicus*) occurred more often on organic fields. In contrast, yellow wagtails (*Motacilla flava*) showed higher abundances on conventional fields in one year. The diversity of farmland bird species was not affected by farming system (conventional/organic) neither during the breeding season nor during the non-breeding period. Over the winter, carnivore bird species occurred more often in organically managed fields while the total abundance of herbivore species was not affected by farming systems.*

## Introduction

Due to intensification in agriculture, populations of farmland birds have been declining in Europe during the last decades (Donald et al. 2001). Some factors which are responsible for the loss of breeding and foraging habitats are absent in organic farming. For instance, synthetic fertilizers, herbicides and pesticides are not permitted, and the diversity of field crops is usually higher in organic cropping systems (European Union Directive 2091/92). Despite these potential advantages of organic farming and the continuous increase of land area managed according to organic farming standards (Willer & Yussefi 2007), there are still surprisingly few scientific studies on the effects of organic agriculture on wild birds (Bengtsson et al. 2005; Hole et al. 2005; Piha et al. 2007). This paper presents the results of a three-year field study comparing breeding and winter bird communities in conventional and organic arable fields in Northwest Europe.

## Materials and methods

The study was carried out on eight conventional and nine organic farms (managed organically for more than 10 years) located in the hedgerow-landscape of Schleswig-Holstein in Northern Germany. The experimental design consisted of 40 (breeding period) and 35 (non-breeding period) pairs of conventionally and organically cultivated arable fields. Each pair of fields was characterized by similar field sizes and

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comparable boundary structures (hedgerows, shrubs). The selection of representative pairs of fields also accounted for typical crop rotations of conventional and organic farms in the region. After pairs of representative fields had been selected in the first year of investigation, both the choice of crops and the way of cultivation of these fields during the following seasons were left to the farmers (Table 1, Table 2).

The survey of breeding birds was restricted to birds which are known to breed and forage directly on agricultural land ('true field species'). Birds were recorded by territory mapping, which is a method that accounts in particular for behaviour patterns indicating the breeding of birds (e.g., alerting pairs, singing males; Bibby et al. 2000). Over the non-breeding seasons (October-April) bird mapping was continued on a reduced sample of field pairs. Fields were crossed in transects at four dates ('line taxation', see Bibby et al. 2000). Since both species diversity and total number of individuals were very low during winter, both parameters were analysed for the total non-breeding period (sum of four dates). Additionally, species were assigned to ecological groups, which were defined by food preferences of species during winter (primarily carnivore vs. primarily herbivore species; classification according to Bauer et al. 2005).

Statistical analyses were based on differences between conventional and organic agriculture. Pair-differences were analysed by a sign-test (probability of error 5%). Tests of abundances were restricted to species which were present in >10% of the fields. For a more detailed description of applied methods see Neumann et al. (2007).

**Tab. 1: Management of the investigated pairs of arable fields during the breeding seasons 2005 to 2007 (n: number of fields, ha: total area)**

Management	Breeding season 2005				Breeding season 2006				Breeding season 2007			
	Conventional		Organic		Conventional		Organic		Conventional		Organic	
	n	ha	n	ha	n	ha	n	ha	n	ha	n	ha
Maize <sup>1</sup>	12	80.4	1	11.0	11	53.5	2	14.1	11	46.8	2	4.1
Grass <sup>1</sup>	3	9.7			5	17.4			5	15.7		
Grass/clover <sup>2</sup>			12	93.1			14	80.6			13	104.7
Grain legumes <sup>3</sup>			7	35.7			4	23.3			5	32.7
Winter cereals	15	92.2	10	53.8	17	188.2	7	98.4	16	132.0	7	67.5
Winter rape	8	94.8	1	8.6	4	26.1			5	60.9		
Spring cereals	1	4.0	7	80.9	1	5.0	11	69.0	1	6.0	6	48.1
Root crops <sup>4</sup>	1	27.0			2	18.0	1	5.6	2	46.7	2	18.8
Seed production <sup>5</sup>			2	13.0			1	5.1			5	20.2
Crops total	40	308.1	40	296.1	40	308.1	40	296.1	40	308.1	40	296.1
Spring crops total	14	111.4	15	127.6	14	76.5	18	112.0	14	99.5	15	103.7
Spring crops %	35	36.2	37.5	43.1	35	24.8	45	37.8	35	32.3	37.5	35.0

<sup>1</sup> forage production; <sup>2</sup> forage production, green manure; <sup>3</sup> incl. mixtures; <sup>4</sup> sugar beet, potatoes; <sup>5</sup> oil seed radish, red clover, perennial ryegrass

**Tab. 2: Management of the investigated pairs of arable fields during the non-breeding seasons 2005/06 and 2006/07 (reduced sample of fields compared to Tab. 1; n: number of fields, ha: total area)**

Management	Non-breeding season 2005/06				Non-breeding season 2006/07			
	Conventional		Organic		Conventional		Organic	
	n	ha	n	ha	n	ha	n	ha
Intercrops <sup>1</sup>	1	8.5	7	27.2			1	11.6
Grass/clover after ploughing			8	42.4			15	74.2
Grass/clover undersown in pre-crop <sup>1</sup>			10	72.2			5	24.0
Grass	4	15.7	2	14.3	5	18.4	3	20.4
Winter cereals/rape after ploughing <sup>2</sup>	9	49.8	3	39.1	8	88.3	5	46.1
Winter cereals/rape direct drilling <sup>1</sup>	7	85.4			9	66.5		
Fallow land after ploughing	2	9.4	1	7.9			1	9.2
Fallow land not ploughed <sup>1</sup>	12	64.7	4	28.1	13	60.3	5	25.8
Fields total	35	233.5	35	231.2	35	233.5	35	231.2
Fields with crop residues total	20	158.6	21	127.5	22	126.8	11	81.3
Fields with crop residues %	57.1	67.9	60.0	55.2	62.9	54.3	31.4	35.2

<sup>1</sup> fields with crops residues, normally after stubble processing; <sup>2</sup> cultivation of winter rape only within conventional farming

## Results

The diversity of breeding bird species was not affected by management type (conventional vs. organic, Table 1). Skylarks were more abundant in organically managed fields in all breeding seasons. The mean presence of pheasants was higher in organic crops even though significant effects could not be observed in the individual years. Yellow wagtails, however, occurred more often in conventional fields in one of the breeding periods.

The diversity of bird species was also not affected by farming type during the non-breeding seasons. The group of carnivore/insectivore bird species showed a higher mean total presence in organic fields ( $M=-7.5$ ;  $Pr>=|M|$  0.0135). The presence of herbivore/granivore birds, however, was not affected by management type ( $M=1$ ;  $Pr>=|M|$  0.8555).

**Tab. 3: Levels of significance of the sign-tests conducted for the differences “conventional fields – organic fields” in the breeding seasons 2005 to 2007**

Parameter <sup>1</sup>	2005		2006		2007		Mean 2005-07	
	M	Pr	M	Pr	M	Pr	M	Pr
Abundance Skylark <i>Alauda arvensis</i>	-8.0	0.007	-6.5	0.029	-12.0	<0.001	-11.5	<0.001
Abundance Pheasant <i>Phasianus colchicus</i>	-3.5	0.092	-3.0	0.070	-1.5	0.453	-5.5	0.019
Abundance Yellow Wagtail <i>Motacilla flava</i>	3.0	0.070	4.0	0.022	4.0	0.077	4.5	0.064
Abundance Lapwing <i>Vanellus vanellus</i>	1.0	0.727	0.5	1.000	1.5	0.250	2.5	0.267
Number of species	-3.5	0.248	-1.5	0.690	-3.0	0.362	-1.5	0.690

<sup>1</sup> abundance: territories/10 ha

## Discussion

As in this study, none of the small number of comparable studies available in this area indicates positive effect of organic farming on the diversity of breeding bird species (Chamberlain et al. 1999; Belfrage et al. 2005; Piha et al. 2007). Farmland birds require relatively large breeding habitats. Therefore, they possibly benefit less from organic agriculture than taxa which are more directly affected by the way of cultivation (e.g., wild plants, see Bengtsson et al. 2005). For the same reason, differences in the colonisation of conventional and organic farmland by birds could possibly be better analyzed at larger spatial scales than single fields or small farms (Belfrage et al. 2005; Bengtsson et al. 2005).

However, as found in several other studies, the presence of skylarks was found also in this study to be strongly affected by different types of management. Organic agriculture might have been advantageous for skylarks due to more diverse crop rotations (Table 1) and potentially sparser canopy structures (Neumann et al. 2007).

Our results from the non-breeding seasons indicate higher amounts of feed for birds on organic fields. The widespread use of direct drilling techniques on conventional fields (Table 2) might have been responsible for the absence of differences in the availability of vegetable food between farming systems.

## Conclusions

With regard to species conservation, organic farming as practised in the investigation area might contribute in particular to the assurance of winter feed for resting carnivore

birds. Breeding populations of skylarks might also be promoted by organic farming practices. However, the latter aspect needs to be verified in comparative studies on the breeding success. Organic cropping usually requires mechanical weed control (harrowing, hoeing), which might negatively affect ground-breeding birds (Neumann et al. 2007; Kragten & Snoo 2007).

### Acknowledgments

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## The use of mulch to increase Spider (*Arachnidae*) numbers; a habitat approach to biological insect control

Manns, H.R., Murray, D.L. & Beresford, D.V.

Key words: mulch, population viability analysis, habitat diversity, spiders

### Abstract

*The potential for insect predators to contribute to a biological balance of insect species was explored with mulch. Insects were collected in pitfall traps in outdoor microplots over 3 seasons in southern Ontario, Canada. Treatments varied each season with crops of oats or soybeans, with residue of straw, corn stalks or paperfibre, and with residue tilled in or surface applied. In 2006 at the peak of spider population density there was a significant effect of the plant and the paperfibre residue on increasing spider density. Existing data sets on spiders by Spiller and Schoener (1988 & 1994) were analyzed to assess the potential to increase spider survival from improved carrying capacity of their habitat. Spider census data was tested with curve fitting models in Akaike Information Criteria (AIC). Spider populations of *Metepeira*, with sizeable numbers, were density dependent. Demographic data was assembled from Spiller & Schoener, 1988 and population size was projected with RAMAS Ecolab. Increasing the carrying capacity increased spider populations in the model projections. Mulch improves spatial diversity and could increase spider density from reduced intraspecific competition in the plot experiments. Increasing spider numbers with habitat complexity in agricultural systems could allow spiders to reduce specific pest problems through maintaining the balance of insect species.*

### Introduction

There is debate whether natural biological control by insect predators can be maintained in sustainable agricultural systems. Spiders (*Arachnidae*) are the most abundant generalist predator in agriculture and there have been many studies on spiders associated with reduction of pest damage (Wise, 1993). Spider populations in agriculture are decreased directly by pesticides and indirectly by tillage and monocrops that disturb habitat leading to increased intraspecific competition within the spider community. Spiders control their density in response to available "web space" (Schaefer, 1978), and in turn, establish an equilibrium of other insect populations (Strong, 1984). Increasing spider populations in organic agriculture could maintain the balance of insect species and reduce outbreaks of any individual pest.

The use of surface mulch may increase the volume of spiders from increased habitat diversity. Insect collection was added to existing microplots over 3 seasons, to test if the populations of ground insects, including spiders, was increased with surface mulch (straw, corn stalks, paperfibre biosolids) compared to bare soil, tilled in or surface applied and with crop plants of oats or soybeans. Existing data sets by Spiller and Schoener (1988 and 1994) were analyzed with population viability analysis to a) test for the type of density dependence/independence of spider populations, and b) project populations growth rates and carrying capacities that could be achieved through modelling demographic data. It was hypothesized that surface mulch would increase spider populations by increasing the carrying capacity from habitat diversification. Spider populations were expected to be density dependent.

## Materials and methods

Insect pitfall traps were added to outdoor plots 60 cm square x 15 cm deep located in southern Ontario, Canada, that were designed to compare the effects of fungal hyphae on soil carbon (Manns et al., 2007). Treatments formed a 2x3 factorial arrangement with 4 replications. Factors were no plant/ plants x 3 levels of surface residue; in 2004, no plant/oat plants x no residue, dried chopped oat straw/ chopped corn stalks, in 2005, no plant/oat plants x no residue/ corn stalks mixed into the soil/corn stalks set on the soil surface and in 2006, no plant/soybeans x no residue/paperfibre mixed in the soil/paperfibre surface applied. Oats were broadcast over the depth of mulch of straw/corn (5 cm) or paperfibre (1 cm) or raked into the bare surface in mid May of each year. Ground insects were collected daily over a 1 week period in 2004, 1 week each month in 2005 and weekly in 2006 in the May-August season. A plastic vial, 3 cm diameter x 10 cm high, containing 2 cm water, was inserted into the soil in the centre of each plot. Insects were collected and stored in 70% ethanol. Species were identified to order. Published data sets were analyzed for census information on spider populations with and without lizard predations, and for life stage matrix data to project population growth rates and carrying capacities; 1) Spiller & Schoener (1994), Bahamas, census data at 18 time intervals over 3 years of *Metepeira* and *Eustala* populations. 2) Spiller & Schoener (1988), Bahamas, census data for 16 months of *Metepeira* species along with life stage data.

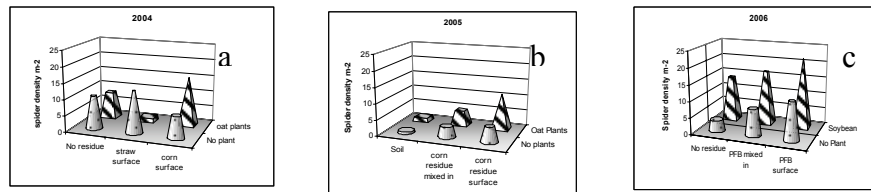
Statistics: Data was analyzed with 2-way ANOVA using MINITAB to separate the effect of surface residue and oat plants on pitfall trap catches. Census data were log transformed using  $\ln(t+1)/\ln(t)$ . The census data and log growth rates was entered into SYSTAT (Statsoft) to find the closest fit model of linear regression, Ricker curve, theta-logistic and inverse density dependent relationships. The residual sum of squares from each equation was entered into the Akaike Information Criteria (AIC) model formula in EXCEL (Microsoft) to calculate the weights of each equation. Demographic data was analyzed with POPTOOLS matrix analysis to derive population abundances. RAMAS Ecolab assessed the demographic data using the density dependence feature with life stage abundance. Differences between means of variables in the data set were compared with 1 way ANOVA with post-hoc Tukey test.

## Results

There was no significant treatment effect of mulch or oat plants on spider numbers in 2004 (Fig. 1a) or 2005 (Fig. 1b). At the peak of spider populations in June, 2006 (Fig. 1c) the number of spiders were significantly increased by the plant ( $p<0.001$ ) and by the paperfibre residue, both mixed into the soil ( $p=0.004$ ) and surface applied ( $p<0.001$ ). Treatments with both plants and surface residue had the highest spider numbers captured each year.

All spider census data, both with and without lizard predation, were density dependent, indicated by the close fit to the Ricker model. There was a greater number of spiders in each stage class with no lizards, but stable age abundances projected adult numbers around 45% and egg (30%) and juvenile (25%) of the total population with and without lizard predation. A stable distribution of the population was achieved at 254 spiders with no lizards and at 160 spiders with lizard predation using the density dependent feature in Ecolab with carrying capacity of 80 and growth rate of 1.0. Increasing only the carrying capacity decreased the projected abundance in the model.

Manipulating the model parameters in Ecolab, the spider population would be maintained at 400 with a growth rate of 1.1 in the life table matrix without lizard predation. The population could also increase linearly to a higher carrying capacity by increasing the growth rate over 1.25 with no lizard predation, and 1.1 with lizard predation. The population was projected to 5000, using 30 monthly intervals with a growth rate of 1.25.



**Figure 1:** Spider numbers caught in pitfall traps in 2004 (a) 2005 (b) and 2006 (c) in the factorial design with/without plants x residue treatments.

## Discussion

The numbers of spiders observed in this study ranged from 1 to 21  $m^{-2}$ . Lycosidae or hunting spiders are commonly caught in pitfall traps at representative density of 1  $m^{-2}$  in cereal fields (Honek, 1988). Movement between the small plots, separated only by a 5 cm height of the wooden frame, could occur, but as Lycosidae are highly sedentary (Edgar, 1969) treatment differences would be possible. This was most evident with the peak of spider populations in 2006 when many juveniles were counted in the pitfall traps. Straw bales were used years ago to preserve spiders in the fields where densities from 2 to 300  $m^{-2}$  were observed to reduce plant damage (Nyffeler & Sunderland, 2003). Spiders densities of 2-600  $m^{-2}$  were recorded with Linyphiidae, the most common species in Europe while in North American agriculture, Lycosidae were the dominant species with densities from 0.02 to 14  $m^{-2}$  (Nyffeler & Sunderland, 2003).

The census data for *Metepeira* was correlated with the Ricker curve in this study, which is consistent with the 1<sup>st</sup> order negative feedback process of intraspecific competition (Hunter, 2001). The Ricker model is identified by a uniform decrease in growth rate over the time period (Varley et al., 1973) which limits population growth. Density dependence is best fit to data with high rates of population increase, and thus was found only with the *Metepeira* species in the data set.

The carrying capacity was increased in the Ecolab model projection to simulate the addition of web sites. Manipulating the model parameters of the life stage matrix showed that increased carrying capacity greater than 1.0 was necessary for linear population increases. Adult survival had the strongest effect on the population abundance when there was no control by predation in the sensitivity analysis. If the habitat increases adult survival by reducing intraspecific competition, (the same effect as reducing predation), then population numbers should increase with the survival rate and number of web sites.

The object of ecology is to maintain stable populations. A modeling study on the strength of predatory interactions within the food web confirmed that weak to intermediate strength links are important for stability in the food web by reducing the size of oscillation cycles (McCann et al., 1998). In food webs dominated by generalist

species such as spiders, less variability in population dynamics would be expected. Lizard predation did not affect the population growth rate or variance of the spider populations analyzed. In the model projections, the reduction in variance with lizard predation, increased the potential for growth in the population. The similarity in carrying capacity with and without lizards, indicates that intraspecific competition, or parasitoids were a greater force than predation on population size. With the large population of *Metepeira* studied, intraspecific competition was the dominant issue, while with spider species with small populations, predation has a much larger effect.

## Conclusions

Spider populations were increased from surface mulch in association with crop plants in our small plots, and computer modelling affirmed that decreased predation from intraspecific competition could be increasing the population numbers. The specific species of spiders may be also be important in their potential for pest control, as linyphiidae have been found to increase to much greater numbers than lycosidae dominant in this study. It is possible that a small number of spiders may control populations of other species by reducing the size of pest population oscillations.

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## **Working with biodiversity in OA**

## Enhancing Biodiversity and Multifunctionality of an Organic Farmscape in California's Central Valley

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Key words: Multifunctionality, Biodiversity, Organic Farming, Ecosystem Function

### Abstract

*Organic farmers in the USA increasingly manage the margins of previously monocultured farmed landscapes to increase biodiversity, e.g. they restore and protect riparian corridors, plant hedgerows and construct vegetated tailwater ponds. This study attempts to link habitat enhancements, biodiversity and changes in ecosystem functions by: 1. inventorying the existing biodiversity and the associated belowground community structure and composition in the various habitats of an organic farm in California's Central Valley; and 2. monitoring key ecosystem functions of these habitats. Two years of inventories show greater native plant diversity in non-cropped areas. While nematode diversity did not differ between habitats, functional groups were clearly associated with particular habitats as were soil microbial communities (phospholipid fatty acid analysis). Earthworm diversity did not differ between habitats, but biomass was higher in non-cropped areas. Habitats with woody vegetation stored 20% of the farmscape's total carbon (C), despite their relatively small size (only 5% of the total farm). Two years of monitoring data of farmscape C and nitrogen (N) through emissions, run-off and leaching showed distinct tradeoffs in function associated with each habitat. Clearly habitat restoration in field margins will increase both landscape biodiversity and the multifunctionality of the farmscape as a whole.*

### Introduction

Deviations from the standard practice of monoculture food production through planned diversity could have a significant impact on associated biodiversity and ecosystem function (Vandermeer et al. 1998). Farmers manage habitat heterogeneity temporally with crop rotations or spatially through intercropping, or through "farmscaping". By farmscaping farmers retain or restore natural riparian tree corridors to protect waterways, plant hedgerows (shrubs and grasses along edges of farm fields) to attract beneficial organisms, establish tailwater ponds to reduce the nutrient content of

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irrigation water released into waterways and let previously denuded soil re-vegetate. Although these practices are increasingly being employed around the country there has been little scientific quantification of the effects of farmscaping on biodiversity or associated multifunctionality (Tschamtkke et al. 2005).

Although field margins may represent a relatively small area of the overall farmed landscape, alterations of their ecosystem function may be significant enough to impact the multifunctionality of the landscape as a whole. Not only does the vegetation in these margins provide habitat for pollinators and birds, and store nutrients such as C and N, but it provides habitat for organisms belowground. These belowground organisms in turn mediate ecosystem functions such as atmospheric gas exchange, soil C storage, and water quality dynamics.

This study provides an opportunity to establish linkages between nutrient cycling, greenhouse gas (GHG) emissions, aboveground biodiversity and belowground communities and quantify the relative contributions of farmscaping management options to the overall multifunctionality of the farm. Yolo County, California is an ideal region for a landscape study that examines the complex relationship between land use and ecological function. Located in the Sacramento Valley, which typifies intensive, diversity poor, industrial agriculture, Yolo County is the home of numerous growers involved in farmscaping as a means of land stewardship. The Rominger organic farm was selected for this study as it embodies several farmscaping management options on a single soil type within the context of a typical mid-sized organic processing tomato farm (Figure 1). This study attempts to link habitat enhancements, biodiversity and changes in ecosystem functions by: 1. inventorying the existing biodiversity and the associated belowground community structure and composition in the various habitats of an organic farm in California's Central Valley; and 2. monitoring key ecosystem functions of these habitats.

### Materials and methods

In the spring of 2005 and again in 2006, GIS (Arcview, ESRI 2005) was used to create a stratified random sample in each of the 6 habitat polygons (riparian corridor, hedgerow, north field, south field, drainage ditches, and tailwater pond) of the Rominger farm. Using each randomized point as the center, 16 m<sup>2</sup> plots were established which included four 50 x 50 cm<sup>2</sup> subplots (Figure 1).

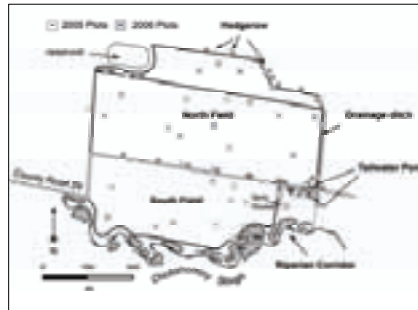


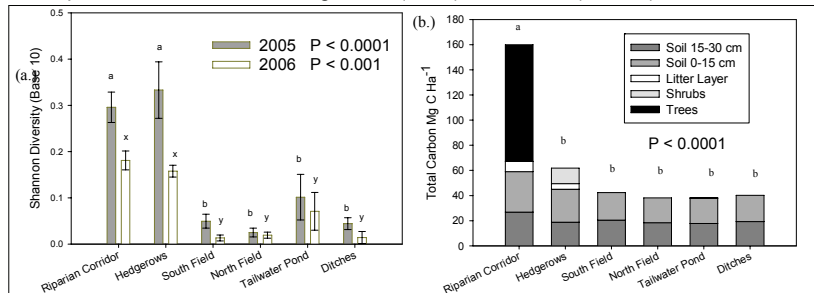
Figure 1: Map showing sampling points from 2005-06 in six farmscape habitats

**Biodiversity:** Vegetation cover (%) for each plot was recorded by species at each canopy layer. Soil microbial community structure was analyzed using phospholipid fatty acid (PLFA) analysis. Nematodes were extracted from 500g of sub-sampled soil, identified to family, and classified into functional groups. Adjacent to each of these 24 sampling points, a 30 cm<sup>3</sup> pit was excavated and sorted for earthworms which were identified to species and weighed in the laboratory.

**Ecosystem Functions:** We inventoried soil C and N pools, soil aggregation, and infiltration rates of each of the 24 points. Each habitat was monitored for both gaseous and aqueous C and N losses throughout the two year experiment. The GHG, CO<sub>2</sub> and



N<sub>2</sub>O, were sampled monthly using closed chambers and a continuous monitoring device (LiCOR 8100). Ceramic cup suction lysimeters were deployed at 30 and 60 cm depth to monitor dissolved organic C (DOC) and nitrate (NO<sub>3</sub><sup>-</sup>-N), while cumulative



**Figure 2: Inventories indicate greater (a.) native vegetation biodiversity and (b.) carbon storage in non-cropped areas of the farm**

NO<sub>3</sub><sup>-</sup>-N was assessed using anion exchange resin bags buried at 75 cm depth. Surface runoff from the north and south crop fields was monitored using automated collection samplers (ISCO units) during stormwater and irrigation events.

Soil cores were taken from each sub-plot at 0-15 and 15-30 cm depths, and analyzed for gravimetric moisture, KCl-extractable NO<sub>3</sub><sup>-</sup>-N and NH<sub>4</sub><sup>+</sup>-N, potentially mineralizable N, microbial biomass carbon (MBC), electrical conductivity (EC), and pH.

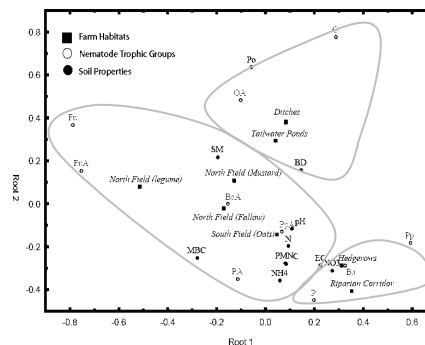
In the spring of 2005 and 2006, understory aboveground biomass was harvested from each subplot and shrubs were clipped. Crops were similarly harvested at the end of each summer. Ground, dry plant, fruit and soil sub-samples were sent to the UC DANR laboratory (<http://danranlab.ucdavis.edu>) and analyzed for total C, N, P and K (<http://danranlab.ucdavis.edu>). Shrub and tree C was estimated using measured heights and diameters and allometric biomass regression equations.

**Statistical Analysis:** Differences between habitats were analyzed using analysis of variance (ANOVA) followed by pair-wise comparisons using Tukey Honestly Significant Differences. Relationships between soil organisms and habitats were analyzed using Canonical Correspondence Analysis (CCA).

## Results

There were clear differences between the six habitats in terms of above- and belowground biodiversity and ecosystem functions. Plant inventories showed similar patterns of native diversity following the extremely wet winter of 2005 and the extremely dry winter of 2006 (Figure 2a). Non-native plant diversity, however, was much higher in the ditches and tailwater ponds particularly after the drier winter.

The PLFA analysis showed only small differences between microbial communities across habitats with the exception of the



**Figure 3: CCA biplot showing associations between nematode trophic groups, soil properties and farm habitats**

drainage ditches which harboured several distinct PLFA markers. Although there were no differences in the diversity of earthworms (over all only four species were found) more earthworms were found in the non-cropped habitats. Nematode inventories showed clear separation of species among habitats (Figure 3). The drainage ditches were an extremely "leaky" habitat in that both GHG emissions and  $\text{NO}_3^-$ -N leaching were high. Leaching losses in the ditches averaged  $17.9 \text{ g N m}^{-2}$ , higher than all other habitats except the tailwater pond, with the lowest mean loss of  $2.0 \text{ g N m}^{-2}$  in the riparian corridor. There were only small differences in total soil C among habitats, but when the contributions from woody vegetation were considered, large differences were observed (Figure 2b). Total C storage in the riparian corridor was estimated to be  $160 \text{ Mg C ha}^{-1}$  while the crop fields only stored  $40.1$  to  $42.4 \text{ Mg C ha}^{-1}$ . Together the riparian corridor and hedgerows account for 20% of the total estimated C stored on the farm despite being only 5% of the total area.

## Discussion

While the non-cropped habitats account for only a small fraction of the farmed landscape, they play a crucial role both in terms of habitat for above- and belowground organisms as well as locations of dynamic nutrient cycling (e.g. higher  $\text{CO}_2$  emissions in the riparian corridor as well as carbon production). There are numerous studies that have compared both the biodiversity and ecosystem function of organic vs. conventional production fields, but few have studied this in relation to managed edges of fields, and fewer still consider associations between the two. We have found that in some habitats, there may be functional tradeoffs (e.g. increased  $\text{NO}_3^-$ -N leaching associated with food production). While each habitat may provide many subtle functions and are best evaluated by the overall contribution to multifunctionality, some functions are quite pronounced. For example, the important role of C storage in the habitats with woody species overshadows soil C storage at the landscape level. While organic management typically stores more soil C than conventional, e.g. at a nearby research station, the highest soil C levels were in an organic tomato maize rotation ( $22.8 \text{ Mg C ha}^{-1}$  at 0-15 cm) compared to 9 other cropping systems (Kong et al. 2005), our study shows this can be further increased in at an organic farm by farmscaping. The soil C at the 0-15 cm depth at the Rominger farm's organic crop fields ranged between  $19.7$  and  $21.8 \text{ Mg C ha}^{-1}$ , increased to a mean of  $23.4 \text{ Mg C ha}^{-1}$ , when the total C storage for all the farm habitats was considered.

## Conclusions

Managing agricultural field margins can not only increase the biodiversity of organic farming systems but also significantly contribute to increased multifunctionality of the agricultural landscape, providing a variety of ecosystem services of human value.

## Acknowledgments

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## Diversity as a key concept for organic agriculture

Langer, V.<sup>1</sup> & Frederiksen, P.<sup>2</sup>

Key words: crop diversity, farm diversity, indicator, biodiversity, mixed farming

### Abstract

*Diversity is a key concept of organic agriculture and is intuitively perceived as having positive, but not always explicit, consequences for the internal functioning of the farm as well as for the impact on environment and farmland nature. In two groups of specialised organic farms (arable and dairy) and a group of mixed farms, links between production diversity and diversity at the scales above and below, as well as relations to potential farmland biodiversity, are examined. Results show that diversity in different scales are not consistently correlated, i.e. neither high diversity in farm household on-farm activities, nor diversity in agricultural production are linked to high crop and land use diversity. Furthermore, there are no simple relations between diversity measures and potential benefits for farmland biodiversity*

### Introduction

Diversity is a key concept of organic agriculture in a range of scales: within-field diversity (intercropping or mixed cropping is perceived as better than monoculture), diversity in crops and livestock (many crop and livestock types are perceived as better than few), production diversity (mixed farming is perceived as more harmonious than specialized farming) (Köbke, 2000) and organic farms with a diversity of activities (both agricultural and non-agricultural) are seen as desirable in connection with short market chains and rural development (Ploeg et al, 2002b). Diversity per se is in this way intuitively perceived as having positive, however not always explicit, consequences, not only for the internal functioning of the farm, but also for the impact on environment and farmland nature. The notion of improved internal function of the farm with higher diversity has been documented by e.g. more efficient nutrient cycling on farms with both crop and livestock production, improved resource efficiency by grazing with more types of animals (Sehested et al., 2004) and in the well known fact that rotations with many crop types decrease the risk of pests and diseases. The notion that a diversity of income generating activities beyond the agricultural production increases the stability of the farm by risk dispersion and contributes to rural development, is also well documented (Ploeg et al., 2002a). These activities include processing and marketing agricultural products (e.g. farm shops, box schemes), farm tourism, alternative energy production, hunting and fishing activities, and there are indications that organic farms more frequently than conventional engage in these activities. As the ongoing structural development within the organic farming sector in many regions takes the route of farm specialization and enlargement similar to the conventional sector (Langer et al., 2005; Levin, 2007), developing the concept of

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diversity and possibly adding facets to the picture of specialized organic farms and their counterparts, mixed farms, seems appropriate. Therefore, we ask the two questions illustrated in figure 1:

How is diversity in production linked to diversity at the scales above and below? In other words, do farms with specialized agricultural production exhibit less diversity on the scale above – the farm household – and below: crop and livestock diversity?

How is diversity on these different scales linked to potential farmland biodiversity, measured by land use and structure?

**Tab. 1: Diversity measures on different scales relevant for organic farming**

Scale	Diversity measure	Measures for potential biodiversity
Landscape	Crop diversity (number of crop types)	Degree of disturbance: <ul style="list-style-type: none"> <li>• % permanent grassland</li> <li>• % annual crops</li> <li>• % of annual crops mechanically weeded</li> </ul>
Agricultural production	Specialized versus mixed farms Diversity of production sectors Diversity in livestock types	Field size
Farm household	Diversity of economic activities on the farm in addition to agricultural production	Area of unfarmed habitats/ha Diversity of unfarmed habitats

### Materials and methods

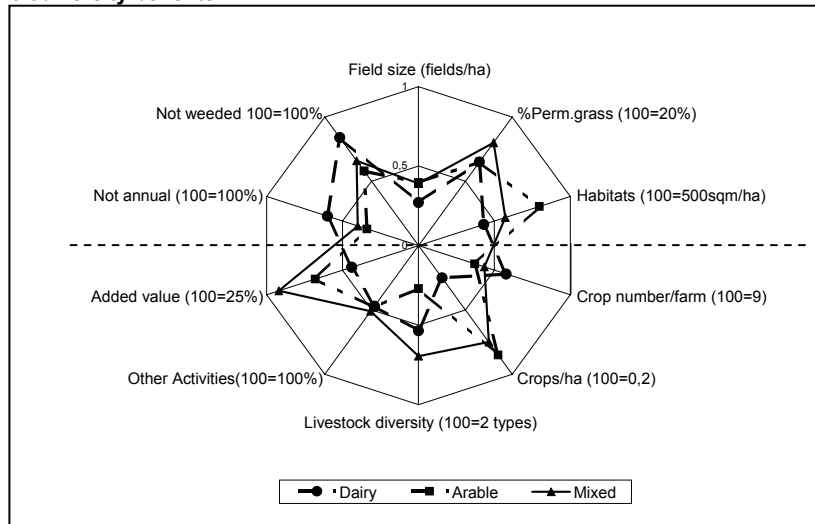
The links between diversity in three different scales as well as links between production diversity and characteristics relevant for farmland biodiversity were examined on three groups of organic farms, distinguished by being either specialized or mixed: Specialized dairy farms (N=80, mean 1,28 LU/ha, 109 ha), specialized arable farms (N=137, mean 0,14 LU/ha, 31 ha) and mixed farms (N=75, 1,03 LU/ha, 41 ha) were surveyed for land use and management, livestock production and household activities in 2001 (Frederiksen and Langer 2004) and classified into farm types based on their production structure. For crop diversity, the number of crop types out of nine possible (cereals, oilseed, legumes, crop for silage, row crops, seed crops, clover-grass ley, fallow, and permanent grassland) were calculated per farm and per ha farmed area. As a measure of on-farm economic activities beyond production two measures were used: whether the farm household was engaged in any other activities, and whether these included activities with the aim of adding value to agricultural products through processing or direct marketing. Measures of potential biodiversity were degree of disturbance (distribution on permanent, annual, weeded annual), which is known to affect weeds and below/above ground fauna in fields, and quantity/quality of unfarmed habitats, known to affect biodiversity on landscape level.

### Results

Diversity on different scales (lower half of diagram) and characteristics potentially favourable for farmland biodiversity (upper half of diagram) are shown for the three farm types in figure 1. Mixed farms are seen to have a larger number of commercially

produced livestock (Livestock diversity) as well as a higher frequency of engagement in activities with the aim of adding value to agricultural products (Added value) than the two specialized farm types. Crop diversity measured by number of crops per ha is similar on mixed farms and specialized arable farms, whereas it is considerable lower on specialized dairy farms (Crops/ha). Mixed farms have a larger proportion of permanent grassland than the two specialized farm types, whereas mean field size is similar to specialized arable farms but smaller than specialized dairy farms and a density of unfarmed habitats intermediate between the two specialized farm types. Specialized dairy farms exhibit considerably more undisturbed land area, measured by less annual crops and a smaller proportion of this under mechanical weeding.

**Figure 1: Measures of diversity in different scales in relation to potential biodiversity benefits**



## Discussion

The concept of mixed farming is often used when discussing diversity in production, but is an ill defined concept, often merely defined by its contrast, specialized farming. Quantitative definitions in the literature are few and not necessarily suited for organic farms. In EU statistics mixed farms are simply farms where no single production sector, e.g. dairy cows, contributes with more than 2/3 of the economic size. Crop diversity has been used as indicator of both management intensity (Herzog et al., 2006) and as a landscape heterogeneity measure. The results here show, that due to the correlations between farm size, field size and crop number, which are highly contextual, using number of crops per ha supplements the measure of crops per farm unit. The results confirm that mixed farms contribute to potential farmland biodiversity benefits by providing not only larger areas with permanent grassland than both arable and dairy farms, but also a high number of crops per ha, altogether securing a high heterogeneity for the benefit of biodiversity (Benton et al., 2003). On the other hand the large specialized dairy farms, in spite of having larger fields and less crops per ha, contribute positively to biodiversity benefits by providing a higher proportion of

perennial grassland as well as more annual crops, not mechanically weeded, and thus altogether a less disturbed environment than on the two other farm types.

## Conclusions

Diversity in different scales are not consistently correlated, i.e. neither high diversity in farm household on-farm activities, nor diversity in agricultural production are linked to high crop and land use diversity. Furthermore, there are no simple relations between diversity measures and potential benefits for farmland biodiversity. Crop diversity may be assessed on farm scale when discussing it as a measure of improving internal functions on the farm and spreading risk. However when used as a measure of potential benefit for farmland the close links between farm size and number of crops means that crop diversity should be discussed on an area scale. Whether crop diversity is beneficial for biodiversity, depends on the specific crop types. In the discussion of structural development within organic farming, concepts of specialisation and mixed farming should be expanded, and the links with other farm characteristics considered crucial for satisfying the organic principles should be explored.

## Acknowledgments

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# Testing and scaling-up agroecologically based organic conservation tillage systems for family farmers in southern Brazil

Altieri M.A.<sup>1</sup>, Lovato P.M.<sup>2</sup>, Lana M.<sup>2</sup> & Bittencourt H.<sup>2</sup>

Key words: agroecology, cover crops, weed suppression

## Abstract

*In southern Brazil several small farmers developed an innovative organic conservation tillage system (OCT) that does not depend on herbicides for weed control but relies instead on the use of cover crop mixtures (including various combinations of rye, vetch and raphanus) that leave a thick residue mulch layer on which traditional grain crops are directly planted, suffering very little weed interference during the growing season and reaching agronomically acceptable yield levels. Our research showed that the rye, fodder radish and vetch mixture effectively suppressed emergence of summer annual weeds in OCT systems. Because of the allelopathic effect of phytotoxins associated with the cover crops residues, farmers avoid toxic effects by placing crop seeds below the toxic layer (allelopathic zone) formed by the phytotoxins leached a short distance (5-10cm) from the mulch into the soil. In addition to weed suppression, residues also have positive effects on subsequent crops from increased soil quality parameters, improved crop nutrition, and in some cases suppression of soil-borne pathogens. Yields in most cases are 5-10% lower in OCT systems when compared to CT systems, but such differences are easily offset by the lower costs of production and the environmental benefits of OCT systems. In our trials the combination of grass and legumes enhanced biomass production and therefore mulch thickness, weed suppression, and organic matter inputs.*

## Introduction

In southern Brazil several small farmers developed an innovative organic conservation tillage system (OCT). Unlike conventional no-till systems, these novel OCT systems do not depend on herbicides for weed control but rely instead on the use of cover crop mixtures (including various combinations of oats, rye, pigeon pea, vetch, raphanus, etc) which leave a thick residue mulch layer on which traditional grain crops (corn, beans, wheat, etc) are directly planted, suffering very little weed interference during the growing season and reaching agronomically acceptable yield levels (Petersen et al 1999). Since very little research has been conducted to understand the ecological underpinnings of these systems, we initiated a research project aimed at assessing the processes involved in weed suppression that enhance soil fertility and crop productivity. Our hypothesis was that elucidating the mechanisms at play would provide principles and guidelines to hundreds of other farmers who, because of cost and/or herbicide dependence, want to transition towards OCT systems.

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From agroecological experience with similar systems, we knew that simply copying the cover crop mixtures used by successful farmers does not work for widely diffusing the technology. Agroecological performance is linked to processes optimized by OCT systems and not to specific techniques. Weed suppression and optimal soil fertility are emergent properties of the whole system.

The main objectives of this research were:

- to assess the agroecological performance (how do OCT systems function?) of a range of OCT systems currently used by small farmers in Santa Catarina.
- To elucidate the agroecological mechanisms explaining optimal levels of weed suppression (allelopathy) and crop productivity (soil fertility and moisture effects) in OCT farms
- To agronomically fine tune the best-bet OCT systems based on rye, fodder radish, and vetch mixtures
- To organize a participatory farmer-farmer research/extension initiative (field visits, cross visits, training sessions, on-farm experiments and demonstrations) aimed at explaining the agroecological principles underlying OCT performance, and translating such principles into practical OCT strategies to be used by hundreds of farmers in other areas

### **Materials and methods**

Cover crops are planted in early fall and produce sufficient biomass by early spring. The cover crops provide a layer of plant residue on the soil surface that can suppress weeds by exhibiting allelopathic effects, and/or enhance conditions unfavourable for weed germination and establishment (Monegat 1991). The cover crop biomass also enhances soil fertility. In order to understand such effects in the field, weed abundance and biomass as well as soil, crop growth and yield parameters were evaluated in five OCT systems in farmers' fields and in 5 neighbouring farms using conventional tillage (CT). We also established experimental plots to test several OCT designs to fine-tune the rye-fodder radish-vetch cover crop mixtures. In each plot we measured weed abundance and diversity, soil quality parameters (physical, chemical, and biological features), rates of mulch decomposition, and crop yields. Eighteen plots (6x6 m each) were assigned to the 6 treatments, replicated three times. After the cover crops were rolled over with a mechanical roller, soybeans were planted in September. Weed biomass samples were collected each 45 days from 0.5 m<sup>2</sup> in each plot, separating cover crops and weeds for later drying

### **Results and Discussion**

Comparing farmer-managed OCT systems with neighbouring CT systems allowed us to clarify the effects of cover crop mixtures on the emergence of summer annual weeds in an organic versus a conventional no-tillage onion system. Summer annual weeds in the OCT fields exhibited lower densities than in the CT fields. Broad-leaved weeds emerged more in tilled fields than in the no-tillage fields. The rye, fodder radish and vetch mixture effectively suppressed emergence of summer annual weeds in OCT systems. Crop yields were similar in both OCT and CT fields.

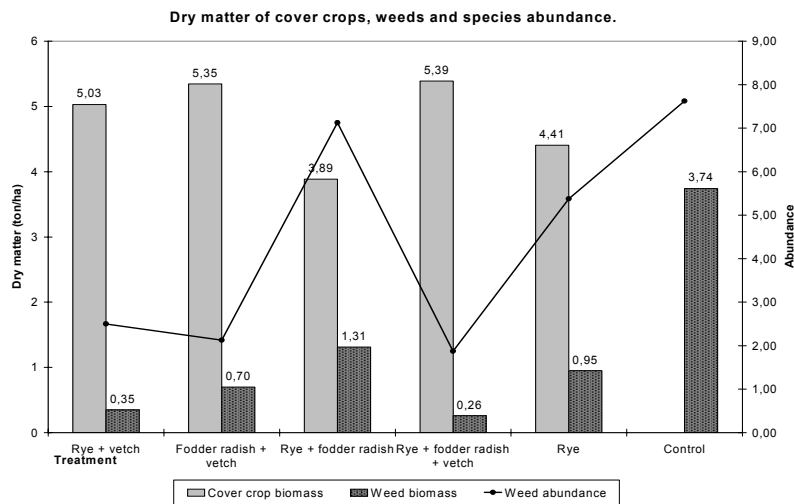
Our research suggests that a key effect of cover crops mixtures is the substantial suppression of weeds, thus reducing weed competition and eliminating the need for herbicides. Weed suppression in OCT systems is due to allelopathic effects of cover



crops, and rye and fodder radish play a key role in this regard (Boydston and Hang 1995). Rye releases toxins including B-phenyllactic acid and B-hydroxybutiric acid and various benzoxazolinone compounds (Barnes and Putnam 1987). Residues of fodder radish partially incorporated into the soil reduce weed density via release of glucosinolate compounds (Boydston and Hang 1995).

Cover crops residues also enhance soil cover and thus have positive effects on subsequent crops because of increased soil quality parameters, improved crop nutrition, and in some cases suppression of soil-borne pathogens. Yields of OCT systems may be equal to but in most cases are 5-10% lower than in CT systems, but such differences are easily offset by the lower costs of production and the environmental benefits of OCT systems.

Figure 1 summarizes the data on cover crop biomass, weed biomass, and number of weed species in each plot. Cover crop biomass was above 4 t/ha in all plots except in the control, which had no cover crops. The lowest production of weed biomass occurred in plots with the combination of rye, fodder radish and vetch (0.26 t/ha) and rye-vetch (0.35 t/ha), while all the other plots exhibited biomass values above 0.70 t/ha, and above 3,5 t/ha in the control without cover crops. The soil cover in the rye-vetch and rye-vetch-fodder radish plots was 92% at 60 days, which explains why these two cover crop mixtures exhibited higher weed suppressive potential. The vetch-rye-fodder radish and the rye-vetch mixtures had lower diversity of weed species (1.5 to 1.7 species), compared with 5.2 species in the control plots (fallow) which exhibited the highest number of species of all treatments followed by the rye- fodder radish plot.



**Figure 1: Cover crop and weed biomass and weed species diversity in experimental plots under various cover crop mixture treatments (Campos Novos, 2005)**

## Conclusions

Although phytotoxins associated with the cover crops residues can be toxic to the food crops grown after the cover crops are rolled, farmers avoid negative effects on crop emergence by waiting a few weeks between rolling the cover crop and seeding the crop, or more commonly by placing crop seeds below the toxic layer (allelopathic zone) formed by the phytotoxins leached a short distance (5-10 cm) from the mulch into the soil. In addition to weed suppression, residues also have positive effects on subsequent crops because of the increased soil quality parameters, improved crop nutrition, and in some cases suppression of soil-borne pathogens. Yields in most cases are 5-10% lower in OCT systems when compared to CT systems, but such differences are easily offset by the lower costs of production and the environmental benefits of OCT systems. In our trials the combination of grass and legumes enhanced biomass production and therefore mulch thickness, weed suppression, and organic matter inputs. The combination also offers a balanced carbon to nitrogen (C:N) ratio, which gives a gradual release of plant-available N, in contrast to the N-immobilization (tie-up) by an all-grass cover, or the rapid N release and potential leaching losses from an all-legume cover. Other nutrient effects seemed apparent: legumes tended to enhance availability of phosphorus (P), while grasses, especially rye, enhanced availability of potassium (K). By increasing cover crop diversity with fodder radish, the process of allelopathy was enhanced.

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# Organic farming and biodiversity – how to create a viable farm business including conservation issues

Stein-Bachinger, K.<sup>1</sup> & Fuchs, S.<sup>2</sup>

Key words: nature conservation, target species, arable farming systems, management plan, multidisciplinary approach

## Abstract

*The extension of organic farming (OF), the increasing recognition of the advantages for improving agro-biodiversity, and the fact that the protection of nature and natural species cannot be taken for granted, has resulted in several interdisciplinary activities. The first of these was the Brodowin Nature Conservation Farm project. Conflicts between nature conservation and modern, large-scale OF, focusing on arable land use systems, were identified, evaluated and solved. Suggestions for adequate financial reward for ecological performance were worked out. The tested optimisation strategies were implemented in a second project: preparing a whole farm management plan based on maps marked with fields having a high potential for specific target species. The aim was to achieve the highest benefit for nature conservation issues with the least expenditure by the farm. A manual is being produced as a third project, with a series of examples for the integration of nature conservation measures, based on the results of our own projects and data sourced in literature, along with different experts. The manual will allow the user to see immediately either how target species/groups can be directly promoted or how measures can be selected, and what effects these have on the business.*

## Introduction

Agri-environmental programmes as well as nature conservation by contract are expected to improve biodiversity and wildlife quality on farms on a voluntary basis. OF plays a central role in agri-environment policy (e.g. KULAP in the State of Brandenburg) due to the positive environmental effects it has demonstrated in a number of investigations in the past (e.g. Hole et al. 2005). However, it is also well-known and accepted that special requirements for the improvement of the habitat of specific target species cannot be taken for granted. Conserving biodiversity in arable farming systems requires specialist knowledge and money (e.g. Noe et al. 2005, Flade et al. 2006, Stein-Bachinger et al. 2005). In the future, the shortage of funds will lead to a concentration on valuable areas (Flade et al. 2006) and the effectiveness and efficiency of the agri-environmental programmes has to be improved on the road to more result-oriented schemes (e.g. Matzdorf et al. 2007). In organic farming systems three facts can be postulated: (i) the potential to improve biodiversity is often higher on organic farms (Flade et al. 2006), (ii) agri-environmental measures specifically designed for arable systems in OF have been in short supply and are not sufficiently aligned with OF-requirements (e.g. weed pressure versus enhancing segetal flora, internal fodder production versus promotion of ground-breeding birds in forage (Stein-

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Bachinger et al. 2005), (iii) there is a lack of well-structured materials which concentrate on proved and recommended nature conservation measures, taking the agronomic and economic consequences into account as well as offering alternatives and compromises. In order to work out solutions for these issues, three projects focusing on the optimisation of nature conservation in large-scale OF in North-East Germany were initiated and still are being operated.

### Materials and methods

Between 2001 and 2006, the Brodowin Nature Conservation Farm project focused on maintaining or creating habitat conditions for the flora and fauna of open and half-open agricultural areas, that guarantee a sufficient reproductive success to keep vital populations in the long-term (Stein-Bachinger et al. in prep.). Investigations were carried out in close cooperation with a large organic farm in North-East Germany (1200 ha). The recommended optimisation measures based on the effects on the target species and on agriculture were used in a second project. In 2007, we (biologists and agronomists) prepared a whole farm management plan for Brodowin, in cooperation with the farmer and the administration, based on maps marked with fields having a high potential for specific target species (arable measures as well as perennial or permanent structural measures). As a third project (2007-2008), a manual is being produced for the integration of nature conservation measures into organic farming systems, based on our own results and data sourced in literature, along with experts recruited among farmers, advisors, the administration, and scientists.

### Results and discussion

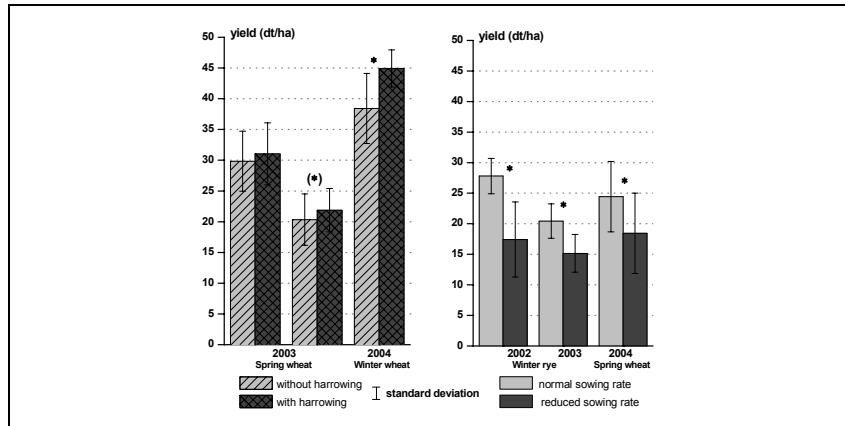
Within the framework of the Brodowin Nature Conservation Farm project, recommendations for the protection of farmland birds, brown hare, amphibians, insects and segetal flora were made concerning arable and structural measures. The effects of modified farming systems were investigated with regard to their agronomic and economic aspects. The interdisciplinary character allowed for a detailed evaluation and recommendation of more than 20 different production measures which promote biodiversity in legume-grass forage, cereals, pulses and field margins taking the whole farm organisation into account (Stein-Bachinger et al. in prep.). Table 1 shows selected measures in cereals and pulses and their efficiency for target species.

**Tab. 1: Modified production measures in cereals and pulses and their efficiency for nature conservation goals**

Measure	Description	Efficiency for nature conservation			
		Farm-land birds	Brown hare	Amphi-bians	Sege-tal flora
Reduce intensity of weed control	No harrowing/hoeing	+	+		+
Reduce sowing density	Half the sowing density, no harrowing/hoeing	+	+		++
Reduce soil tillage operations	Stubble breaking after mid-September		+	+	++

\* Efficiency: + = high, ++ = very high

Figure 1 shows that the reduction of weed control and sowing density leads to a decrease in yields of spring and winter cereals. These three years' data, along with results from literature and expert knowledge, were used for economic calculations (e.g. partial analysis, cross margins). The modified measures have to be awarded 50 to 150 €/ha/year to compensate for the reductions in yield and potential problems with undesirable weeds. For farmland birds and brown hare, the measures should be carried out upon the whole field; for amphibians and segetal flora, small-scale implementation, preferably on 'hot spots', is recommended. Further criteria have to be considered for a goal-oriented field selection e.g. for farmland birds: no or only a small area of forest around the fields (< 20 %) and a field size of 5 - 20 ha.



**Figure 1: Effects of a reduction in the intensity of weed control and sowing density on the yield of spring wheat, winter wheat and winter rye in Brodwin, significant differences with  $\alpha=5\%$  are marked \*, with  $\alpha=10\%$  (\*), Wilcoxon-Test)**

The proved optimisation strategies were used in a subsequent step to prepare a whole farm management plan. The farm consists of 85 arable fields. Fields with a high potential (e.g. high territory densities or reproductive success) for farmland birds, brown hare, segetal flora and amphibians were identified. For example, on 16 of these 85 fields the effects of nature conservation measures for farmland birds will be above average, and thus the implementation will concentrate on these locations. The aim is to achieve the highest benefit for nature conservation with the least expenditure of effort by the farm. In 2008, seven measures will be implemented; in subsequent years, the preparation of a catalogue of measures with selection and expansion possibilities is planned. The farm will promote itself with information boards for visitors as well as on the farms' website and with newsletters for 1700 subscribers of the vegetable box scheme.

According to our experience and that of other authors (Noe et al. 2005), a lot of farmers do not necessarily disagree with conservation criteria, but they often do not know what to look for and how to integrate modified production measures into their farm business. Therefore the compilation of all of the above-mentioned results and experience will lead in a third step to a manual that allows the user (farmers, advisors and the administration) to see immediately either how target species/groups can be promoted directly or how measures can be selected, and what consequences they

can have on the business. Experts recruited among the user group and scientists with different expertise are involved to discuss and evaluate the profiles of nature conservation-friendly production measures and target species in order to integrate a broad range of aspects and knowledge.

## Conclusions

The success of increasing biodiversity on the farm and landscape level depends essentially on the availability of suitable and proved information, as well as on practical examples which open the view for developing organic farming within the conservation movement and achieve a balance between the objectives of all stakeholders. The foundation of 'Nature Conservation Farms' can be a step towards reflecting one's own values in relation to the wild flora and fauna and to providing examples of multifunctional agriculture.

## Acknowledgments

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# Beneficial Invertebrate Activity in Organic and Conventional Vegetable Fields in Eastern England

Eyre, M.D.<sup>1</sup>, Labanowska-Bury, D.<sup>2</sup>, White, R.<sup>3</sup> & Leifert, C.<sup>4</sup>

Key words: Beneficial invertebrates; organic vegetables; field margins; farm management

## Abstract

*Beneficial invertebrate activity was assessed in 2005 and 2006 in three organic and one conventional vegetable field using pitfall and pan traps. Data was generated from a total of 208 trapping sites in cauliflower, leek, cabbage, purple sprouting broccoli and calabrese crops and 80 sites in planted field margins. More activity of epigeal invertebrates was found in Brassica fields compared with leek fields and there was more in organic than conventional Brassica fields. Activity of useful invertebrate groups in the field margins decreased with vegetation development and there appears to be a need for management of margins in order to optimise activity of the most appropriate beneficial groups for the crop planted.*

## Introduction

The increase in area of organically farmed agricultural land, brought about mainly as a result of concerns about food quality (Leifert et al., 2007), has necessitated an increased knowledge of the distribution of beneficial invertebrates because crop protection chemicals cannot be used on organic fields. This is especially needed in intensively cultivated vegetable fields because, for instance, some ground beetles are known to be potentially important predators of cabbage root fly eggs (Finch, 1996), a pest of all Brassica crops. Groups such as ladybirds (Coccinellidae) and lacewings (Neuroptera) predate aphids, which can be a problem on a number of crops. Recent work (Prasad & Snyder, 2006) has shown that small and medium-sized ground beetles are useful in vegetable crops but large ground beetles are more likely to predate smaller beetles than pests. Enhancements such as planted field margins and beetle banks have been used to try to increase beneficial invertebrate activity (Landis et al., 2005) and these are likely to be most important in organic systems.

The influence of crop type, management system and field margin on beneficial invertebrate activity in three organic and one conventional vegetable field in eastern England was assessed in 2005 and 2006. Three Carabidae (ground beetle) groups, based on size, and seven other groups were recorded in five crop types and in field margins differing in structure between fields and from year-to-year.

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## Materials and methods

Five pitfall traps (8.5 cm diameter, 10 cm deep), 0.5 m apart, part-filled with saturated salt (NaCl) solution containing a small amount of strong detergent as a preservative were used to sample epigeal invertebrates at each site and a yellow box (22 x 31 cm, 20 cm deep), containing 1 cm of salt preservative, was used to sample aerial invertebrates. Sites were 20m apart and in lines 15, 30 and 45 m from the field margins. There were 40 sites in two cauliflower (var marathon) fields in 2005 and again in the same fields with leeks (var roxton) in 2006. In 2006 another organic field with cabbage (var sunta) and purple sprouting broccoli (var bordeaux) had 24 sites, as did a conventional field with calabrese (var iron). The conventional field was sprayed with herbicides and pesticides, for the control of cabbage root fly, and there was the use of inorganic fertiliser. The 4 m field margins of the organic fields were sown with a wild flower mix in late 2004, whilst the margin of the conventional field was sown in June 2006. Four sites were sampled in the two margins of each organic field, with eight margin sites in the conventional field. Traps were set in the first week in May 2005 for the cauliflower fields, the last week of May 2006 for the leek fields and the first week of May 2006 for the other two fields. Four samples were taken, at between three and four-week intervals, to cover most of the period from planting to harvest.

Carabidae (ground beetles) from the pitfall traps were split into three groups; small (<5 mm in length), medium (5-10 mm) and large (>10 mm) and counted, as were total numbers of Linyphiidae and Lycosidae (money and wolf spiders) from pitfall traps and of Staphylinidae (rove beetles), Coccinellidae (ladybirds), Syrphidae (hoverflies), Neuroptera (lacewings), and Hymenoptera (parasitic wasps; Ichneumonidae, Proctotrupoidae, Braconidae, Pteromalidae) from both traps. The totals, transformed by  $\log_{10}n+1$ , were used in linear mixed-effects models in the R statistical environment (R Development Core Team, 2007). Models had crop as a fixed factor and field and year as random factors and field margin location (field) as a fixed factor and year as a random factor. Means were compared using the Tukey HSD test ( $P<0.05$ ).

## Results

There were significant differences in the activity of all invertebrate groups between crop types (Tab. 1) except Hymenoptera. Activity of small Carabidae was greatest in cabbage and least in calabrese whilst there were few medium-sized Carabidae in all crops other than cauliflower. There were more large Carabidae in cabbage and broccoli than in the other crops whilst Staphylinidae activity was least in leek and calabrese. Most Cantharidae were found in cauliflower whilst the cabbage and broccoli had considerably more Coccinellidae than the other crops. Linyphiidae were least active in calabrese with most of the few Lycosidae in cabbage. Leek fields had the most Syrphidae and by far the most Neuroptera. Most Hymenoptera were found in cauliflower, with the least in broccoli. In general, there was less activity of invertebrates in the conventional calabrese with more epigeal invertebrate activity in organic Brassica crops and more aerial activity in the leeks. There were significant differences in activity in the field margins (Tab. 2). There were considerably more small and medium-sized Carabidae, Linyphiidae and Hymenoptera and fewer Staphylinidae, Cantharidae, Coccinellidae and Syrphidae in the margins of the cauliflower fields compared with the same sites in 2006. There were few Neuroptera recorded and the least activity of small and large Carabidae, Coccinellidae, Linyphiidae and Hymenoptera in the margins of the cabbage and broccoli field, although this field's margins had the most Lycosidae.



**Tab. 1: Mean numbers of beneficial invertebrate groups recorded from sites in the five crop types (O = organic, C = conventional, Cauli = cauliflower, Cabb = cabbage, PSB = purple sprouting broccoli, Calab = calabrese).**

Group	Ocauli	Oleek	Ocabb	OPSB	Ccalab	
Small Carabidae	94 <sup>c</sup>	91 <sup>c</sup>	304 <sup>a</sup>	197 <sup>b</sup>	49 <sup>d</sup>	***
Medium Carabidae	35 <sup>a</sup>	4 <sup>b</sup>	14 <sup>a</sup>	9 <sup>b</sup>	10 <sup>a</sup>	**
Large Carabidae	36 <sup>c</sup>	120 <sup>b</sup>	325 <sup>a</sup>	297 <sup>a</sup>	88 <sup>b</sup>	***
Staphylinidae	167 <sup>a</sup>	76 <sup>b</sup>	159 <sup>a</sup>	142 <sup>a</sup>	84 <sup>b</sup>	**
Cantharidae	5 <sup>a</sup>	2 <sup>b</sup>	1 <sup>b</sup>	1 <sup>b</sup>	0 <sup>b</sup>	***
Coccinellidae	9 <sup>b</sup>	11 <sup>b</sup>	36 <sup>a</sup>	46 <sup>a</sup>	1 <sup>c</sup>	***
Linyphiidae	88 <sup>b</sup>	116 <sup>a</sup>	106 <sup>ab</sup>	83 <sup>ab</sup>	44 <sup>c</sup>	**
Lycosidae	1 <sup>c</sup>	3 <sup>ab</sup>	4 <sup>a</sup>	3 <sup>ab</sup>	2 <sup>bc</sup>	**
Syrphidae	1 <sup>b</sup>	13 <sup>a</sup>	10 <sup>a</sup>	4 <sup>b</sup>	2 <sup>b</sup>	***
Neuroptera	0 <sup>b</sup>	14 <sup>a</sup>	1 <sup>b</sup>	0 <sup>b</sup>	0 <sup>b</sup>	***
Hymenoptera	100 <sup>a</sup>	90 <sup>a</sup>	79 <sup>a</sup>	57 <sup>a</sup>	76 <sup>a</sup>	n.s.

n.s. not significant

\*\* significant for P<0.01

\*\*\* significant for P<0.001

Superscripts indicate significant differences between means (P<0.05)

**Tab. 2: Mean number of beneficial invertebrate groups recorded from sites in the field margins of the six fields in the two years (05, 06) of the survey**

Group	Org05	Org05	Org06	Org06	Org06	Con06	
	Caul1	Caul2	Leek1	Leek2	Cabb/PSB	Calab	
Small Carabidae	121 <sup>a</sup>	130 <sup>a</sup>	57 <sup>b</sup>	41 <sup>b</sup>	18 <sup>b</sup>	26 <sup>b</sup>	**
Medium Carabidae	260 <sup>a</sup>	249 <sup>a</sup>	68 <sup>b</sup>	90 <sup>b</sup>	92 <sup>b</sup>	83 <sup>b</sup>	*
Large Carabidae	220 <sup>ab</sup>	175 <sup>b</sup>	301 <sup>a</sup>	222 <sup>ab</sup>	70 <sup>c</sup>	173 <sup>b</sup>	***
Staphylinidae	99 <sup>b</sup>	133 <sup>b</sup>	251 <sup>a</sup>	154 <sup>ab</sup>	208 <sup>ab</sup>	107 <sup>b</sup>	*
Cantharidae	5 <sup>b</sup>	3 <sup>b</sup>	52 <sup>a</sup>	51 <sup>a</sup>	11 <sup>b</sup>	6 <sup>b</sup>	***
Coccinellidae	3 <sup>a</sup>	10 <sup>a</sup>	24 <sup>a</sup>	20 <sup>a</sup>	7 <sup>a</sup>	23 <sup>a</sup>	*
Linyphiidae	1004 <sup>a</sup>	646 <sup>a</sup>	217 <sup>b</sup>	108 <sup>b</sup>	32 <sup>b</sup>	79 <sup>b</sup>	***
Lycosidae	16 <sup>b</sup>	37 <sup>a</sup>	44 <sup>ab</sup>	22 <sup>b</sup>	74 <sup>a</sup>	5 <sup>b</sup>	***
Syrphidae	0 <sup>c</sup>	0 <sup>c</sup>	44 <sup>ab</sup>	56 <sup>a</sup>	21 <sup>bc</sup>	24 <sup>bc</sup>	***
Neuroptera	0 <sup>b</sup>	0 <sup>c</sup>	0 <sup>b</sup>	0 <sup>b</sup>	6 <sup>a</sup>	2 <sup>ab</sup>	***
Hymenoptera	496 <sup>a</sup>	316 <sup>b</sup>	183 <sup>c</sup>	159 <sup>c</sup>	78 <sup>c</sup>	99 <sup>c</sup>	***

\* significant for P<0.05

\*\* significant for P<0.01

\*\*\* significant for P<0.001

Superscripts indicate significant differences between means (P<0.05)

## Discussion

Less beneficial invertebrate activity was recorded from the conventionally managed calabrese field, with use of herbicide and insecticide. However, there was also far less activity of the soil-surface active invertebrate groups in the leek fields compared with the organic Brassica fields, although aerial invertebrate activity was generally higher. Ground beetle species distribution has been linked to the extremes of disturbance (Eyre, 2006) and the open leek fields are more disturbed and provide less cover than Brassicas. The planted field margins should provide a supply of appropriate beneficial invertebrates and the margins of the cauliflower fields in 2005 had high numbers of small and medium-sized Carabidae. These are predators of cabbage root fly eggs (Finch, 1996), but there was less activity in the field, especially of medium-sized Carabidae, indicating poor migration from the margins. This lack of immigration into crop fields has been observed with spiders (Sunderland & Samu, 2000) and most immigration from the margins appears to have by large Carabidae, of little use for egg predation (Prasad & Snyder, 2006). Vegetation density differed in the organic field margins between the two years and there was far more activity of the useful smaller Carabidae, as well as the Linyphiidae, in the more open margins of 2005 compared with the dense, total cover in 2006.

## Conclusions

Whilst there were considerable differences in beneficial invertebrate activity between leek and Brassica crops, differences in activity in field margins are likely to be more important. In order to optimise activity of specific beneficial invertebrates, properly planned management of field margins is likely to be necessary.

## Acknowledgments

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# Opportunities and Obstacles in Adoption of Biodiversity-Enhancing Features on California Farms

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Key words: biodiversity, ecosystem services, adoption, multifunctionality

## Abstract

*The USDA National Organic Program requires the conservation of biodiversity and the maintenance or improvement of natural resources on organic farms. On-farm biodiversity-enhancing features such as border plantings can provide many of these ecosystem services. However, which practices farmers currently use to manage non-cropped edges, why and how they use these practices, and how subsidies and technical assistance affect farmers' ability and willingness to manage farm edges for biodiversity are little studied topics. Our study set out to identify the range of practices currently used to manage non-cropped field edges, roadsides, pond edges, and banks of permanent watercourses (sloughs, canals, ditches) in a case study area in California. Secondary objectives were to gauge local farmers' awareness of planted hedgerows and vegetated waterways and to gather preliminary information about the range of incentives and constraints to installing such features.*

## Introduction

Border plantings enhance the multifunctionality of farms in that they provide numerous ecosystem services. They can provide habitat and dispersal corridors for wildlife (Ouin and Burel 2002), and alternative food sources and habitat for predator and pollinator insect populations (Kremen et al. 2002). They can lower pest populations, displace noxious weeds, and function as buffers to slow soil erosion and runoff and intercept airborne dust (Marshall and Moonen 2002). A diversity of perennial vegetation along watercourses may increase net accumulation of soil carbon and soil organic matter, improve retention of nutrients, and reduce greenhouse gas emissions due to greater plant uptake (Rowe et al. 2005). The USDA National Organic Program requires the conservation of biodiversity and the maintenance or improvement of natural resources on farms marketing products as organic. Therefore, adoption of practices that enhance biodiversity, such as border plantings, is of particular significance to organic farmers.

Several voluntary USDA conservation programs, including the Conservation Reserve Program and the Environmental Quality Incentives Program, give farmers technical

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and financial assistance in installing border features such as hedgerows, buffer strips, and grassed waterways, among others. However, little is known about why farmers do or do not adopt these multifunctional edge management practices, and inferences must be drawn from literature about related conservation practices. Stonehouse (1996) reviewed the literature on adoption of various in-field and field edge soil conservation practices in the U.S. and Canada and found that more and better technical information is needed about most conservation practices, but that often the available information about costs and benefits of such practices is inadequate. A 2001 USDA study (Lambert et al. 2006) found that percentage of off-farm income was negatively associated with participation in federal programs involving conservation structures, indicating the importance of an orientation to farming as a way of life. This study also found that the production of high-value crops was negatively associated with installation of conservation structures.

The above cited literature focuses on farmers as individual decision makers who manage individual farms, instead of a community of decision makers who manage contiguous pieces of a larger landscape. However, many of the ecosystem services potentially attributable to biodiverse farm edges occur at a larger landscape scale, suggesting that a landscape, with its collective of land managers, may be a more appropriate unit of analysis than an individual farm with individual decision makers. The general literature on adoption and diffusion of innovations demonstrates that the observability of innovations as well farmers' physical and social proximity to each other are important factors in the spread of practices across a community.

### **Materials and methods**

We chose the geographic area for this study to include farm and rangeland in western Yolo County, California, encompassing 7,114 ha, or roughly 72 square km. It includes both lowland, irrigated and intensively farmed cropland, as well as hilly, more extensively farmed, unirrigated rangeland. This area has a prevalence of public and private sector programs focused on increasing on-farm biodiversity and conservation. Yolo County has a very active Resource Conservation District (RCD) that works closely with the local office of the Natural Resources Conservation Service to connect local farmers with federal conservation cost-share programs. In the private sector, Audubon California's Landowner Stewardship Program has conducted farmer and landowner conservation projects in and near the study area.

We sought to interview all individuals who make day-to-day farm management decisions over the land in our study area in telephone interviews that were conducted in August-November, 2006. We succeeded in interviewing 22 out of 28 total farm managers, a response rate of 81%. The land managed by the interviewed farmers represents 71% of the total study area and produces over 20 different crops during different seasons, including field crops (tomatoes, alfalfa, vegetable seeds), orchard crops (almonds, walnuts, plums) and cattle. About 61% of the land area are owned by the farm operators, with the remaining 39% being rented. Twelve of the 22 respondents (55%) pursue farming as their sole occupation, while 10 farmers (45%) have off-farm employment. Four of the farms are either fully or partially in certified organic land, two in field crops and two in orchard crops.

## Results

Most farmers reported using a combination of two or more practices from a set of six active management practices (disc, apply herbicide, mow, hand hoe, burn, graze). Almost half use discing and herbicide applications in combination either with or without additional practices. In the sample as a whole, edges along natural watercourses tend to be less intensively-managed than other farm edges. Five farmers reported using no active management practices on watercourse edges while all farmers mentioned using at least one active practice on field and road edges. Half of the farmers reported leaving naturally occurring vegetation, including large trees, along waterways compared to only 18% for field and road edges. Thirteen farmers in the sample have planted hedgerows, windbreaks, individual trees, and/or native grasses and sedges, and one-third of these farmers (4) farm organically. Of the remaining farmers, all but one indicated that they had heard of these practices before. Nine of the farmers have installed tail water or rangeland ponds.

**Tab. 1: Numbers of farmers using designated practices on farm edges**

Practice	# of farmers in total sample using practice on waterway edges (N=22)	# of farmers in total sample using practice on field/road edges (N=22)	# of organic farmers using this practice on any edge (N=4)
Disc/scrape	6	11	1
Herbicide	9	14	2*
Hand hoe	2	3	1
Burn	2	3	1
Mow	6	12	4
Do nothing/ natural veg.	14	8	3
Grasses/ sedges	1	0	3
Hedgerows	4	4	4
Graze	2	0	0
Install pond	NA	9	3

\* These farmers have both certified organic and conventional fields.

## Discussion

One of the most frequently mentioned objectives in edge management is to keep undesirable elements out of crop fields, in almost all cases weeds but in some cases also rodents and other pests. While RCD materials suggest that filling edge areas with non-invasive native and introduced plants can suppress the growth of invasive weeds, only a minority of farmers in the study appear to consider this potential of hedgerows in their edge management decisions. Six individuals expressed a desire to attract beneficials and possibly even decrease pesticide use as a strong motivating factor, in keeping with the relatively larger number of research studies that have suggested important roles for hedgerows in pest management. Several of these farmers also indicated, however, that the direct impact of such plantings on pest populations is currently difficult for them to discern on their farms and is a topic that could benefit

from further research. This observation is consistent with research on conservation practices that technical and performance information about practices is inadequate. The benefits that were more visible to farmers who had edge plantings included increasing wildlife habitat, especially for birds such as quail and pheasants. Two farmers observed dust control as a benefit of hedgerows. Three fourths of the farmers explicitly mentioned awareness of cost-share and technical assistance programs for hedgerow and pond installation. All sampled farmers who have hedgerows and ponds have taken advantage of one of these programs. Despite the presence of and high familiarity with cost-share programs, however, the high cost of hedgerows and other planted features is still one of the most frequently noted constraints to installing such features. Absentee landlords whose main concerns are getting a rent check were also mentioned as potential blocks to conservation projects, consistent with previous research in other parts of the U.S. associating tenure with adoption of all types of conservation practices. Finally, most of the farmers with hedgerows are full-time farmers with no off-farm income and farm relatively larger acreages. These findings are also consistent with other research on adoption of on-farm conservation practices. Two organic farmers and one conventional farmer were mentioned by a majority of respondents for providing examples of border plantings for other farmers to see. All three farmers have played leadership roles in on-farm research and demonstration projects, and were regarded by others as influencing the unusually high adoption rate of border plantings in this area.

## Conclusions

This study demonstrates that organic farmers can provide a leadership role in installing multifunctional farm edge features across a landscape. It also, however, reveals critical gaps in information and understanding about the implementation as well as the benefits of such biodiversity features. Demand for relevant information will likely increase along with the continuing increase in organic farmland and the growing awareness of farmers, landowners, scientists, and government of the potential capacity for farm edge features to provide multifunctional ecosystem services.

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# Crop Type and Management Effects on Ground Beetle Species (Coleoptera, Carabidae) Activity in an Extensive Plot Trial

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Key words: Ground beetles, Carabidae, Fertiliser, Crop Protection, Organic farming

## Abstract

*The effects of crop type, and of fertility and crop protection management within crops, on ground beetle species activity were investigated using the Nafferton Factorial Systems Comparison Experiment, using pitfall traps in 2005. Thirteen species gave significant responses to crop type, with seven showing a preference for cereals and none for grass/clover. There were 22 significant responses to fertility and six to crop protection within crop types. Sixteen of the responses to fertility and four to crop protection resulted in more activity in organically managed plots. Fertility effects were found most in wheat, barley and grass/clover whilst crop protection effects were mainly in beans and vegetables. A better knowledge of the effects of fertility management is required following changes from conventional to organic farming.*

## Introduction

Ground beetles (Carabidae) are considered to be one of the more important beneficial invertebrate groups. Increased ground beetle activity in organic crops, compared with conventional, was reported by Pfiffner & Niggli (1996) but Purtauf et al. (2005) found no difference between organic and conventional wheat. Crop type was shown to have a greater effect on activity than management system. The effects of pesticides on beneficial invertebrates have been regularly reported (e.g. Sherratt & Jepson, 1993) but the effects of fertility management have not been rigorously investigated. The Nafferton Factorial Systems Comparison Experiment provides an opportunity to assess ground beetle species activity at the plot scale in a system with a number of organically and conventionally managed crop types. Eyre et al. (2007) found that fertility management had more effect on invertebrate activity than crop protection management. The effects of crop type and management systems on ground beetle species activity were investigated to provide better baseline information for use in the application of natural pest enemies in organic agriculture.

## Materials and methods

The Nafferton Factorial Systems Comparison Experiments consists of 128 plots (24 x 12 m) in an area converted to organic management in 2003. In 2005 the plots contained wheat, barley, beans, vegetables (potatoes, cabbage, onions, lettuce, carrots) and grass/clover. The 64 conventionally managed plots were treated with inorganic fertiliser and sprayed with herbicide, fungicide and pesticide where appropriate. The 64 organic plots were fertilised with compost and no sprays were

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used. Each plot was sampled for epigeic invertebrates using five pitfall traps with saturated salt solution and a small amount of detergent as a preservative, were set in the first week of May 2005 and five monthly samples were generated (see Eyre et al., 2007). Samples were sorted in the laboratory and ground beetles identified to species. The number of individuals of 30 of the 53 species recorded, transformed by  $\log_{10}n+1$ , was used in linear mixed-effects models in the R statistical environment (R Development Core Team, 2007). Analysis of variance was generated using models with fertility, crop protection and crop as fixed factors and the blocks of the trial as a random factor. Data from all plots were used to assess the effect of crop type whilst the effects of differing fertility and crop protection management were assessed within each crop type.

## Results

There were highly significant relationships between crop type and the activity of 13 ground beetle species (Tab. 1). Five species were most active in wheat, four in beans, two each in barley and vegetables and none in grass/clover. Five species had the least activity in the vegetable and grass/clover plots, two in beans and one in barley. Significant responses of ground beetle species activity to organic or conventional fertility or crop management in each of the crops are shown in Tab. 2, with plot means showing the preference for management type. Four species gave significant responses to fertility in grass/clover, three preferring organic and one conventional management. One species preferred conventional fertility in beans with the activity of three significantly related to crop protection, two preferring conventional plots. Eight species were affected significantly by fertility in wheat, with more of six in organic plots. One species was more active in organic crop protection wheat plots whilst all eight species giving significant responses in barley were affected by fertility, six more active in organic plots.

**Tab. 1: Ground beetle species giving a significant response to crop type and the mean number recorded from plots in the five crop types.**

Species	Grass/ clover	Beans	Wheat	Barley	Vegeta bles	
<i>Amara familiaris</i>	3	7	1	2	1	***
<i>Amara plebeja</i>	6	6	10	13	3	***
<i>Anchomenus dorsalis</i>	5	7	5	3	2	***
<i>Bembidion aeneum</i>	35	23	54	47	25	***
<i>Bembidion guttula</i>	9	31	22	12	10	***
<i>Bembidion lampros</i>	12	36	12	13	55	***
<i>Bembidion tetracolum</i>	12	49	8	6	31	***
<i>Loricera pilicornis</i>	20	20	19	31	3	***
<i>Nebria brevicollis</i>	35	74	132	107	122	***
<i>Notiophilus biguttatus</i>	4	5	6	6	7	***
<i>Pterostichus melanarius</i>	51	37	89	71	41	***
<i>Pterostichus strenuus</i>	13	10	11	24	4	***
<i>Trechus quadristriatus</i>	26	31	146	92	44	***

\*\*\* significant for  $P < 0.001$



Only one species preferred organically fertilised vegetable plots whilst two were more active in vegetable plots with organic crop protection.

**Tab. 2: Ground beetle species giving a significant response to either fertility or crop protection within each crop type, together with mean numbers recorded from plots with organic and conventional management.**

Crop and species	Factor	Organic	Conventional	
Grass/clover				
<i>Amara plebeja</i>	Fertility	8	4	*
<i>Nebria brevicollis</i>	Fertility	48	21	***
<i>Pterostichus melanarius</i>	Fertility	65	37	**
<i>Trechus quadristriatus</i>	Fertility	19	34	***
Beans				
<i>Amara familiaris</i>	Fertility	5	9	*
<i>Bembidion lampros</i>	Crop protection	29	44	*
<i>Bembidion quadrimaculatum</i>	Crop protection	1	4	*
<i>Trechus quadristriatus</i>	Crop protection	26	38	*
Wheat				
<i>Bembidion guttula</i>	Fertility	30	14	**
<i>Bembidion lampros</i>	Fertility	17	7	**
<i>Bembidion tetracolum</i>	Fertility	13	4	**
<i>Loricera pilicornis</i>	Fertility	11	26	**
<i>Nebria brevicollis</i>	Fertility	166	97	***
<i>Notiophilus biguttatus</i>	Fertility	4	7	*
<i>Pterostichus melanarius</i>	Fertility	126	53	**
<i>Pterostichus strenuus</i>	Crop protection	13	10	*
<i>Synuchus vivalis</i>	Fertility	7	2	***
Barley				
<i>Agonum muelleri</i>	Fertility	9	1	***
<i>Bembidion lampros</i>	Fertility	17	9	*
<i>Bembidion tetracolum</i>	Fertility	9	2	**
<i>Loricera pilicornis</i>	Fertility	19	43	***
<i>Nebria brevicollis</i>	Fertility	147	67	***
<i>Pterostichus melanarius</i>	Fertility	96	45	***
<i>Pterostichus strenuus</i>	Fertility	17	32	**
Vegetables				
<i>Bembidion aeneum</i>	Crop protection	29	22	*
<i>Bembidion tetracolum</i>	Crop protection	48	15	***
<i>Pterostichus strenuus</i>	Fertility	6	2	*

\* significant for  $P < 0.05$ , \*\* significant for  $P < 0.01$ , \*\*\* significant for  $P < 0.001$

## Discussion

Of the 13 ground beetle species providing significant responses to crop type, nine were most active in the tall wheat and beans whilst none were most active in grass/clover. Grass/clover provided the densest ground cover and it appears that all 13 species preferred some bare ground, with the smaller species most active in crops with the least ground cover. Eyre (2006) showed that ground beetle species differ in their reaction to disturbance and the less ground cover, the more disturbed and exposed the plot and Kromp (1999) postulated that inorganic fertiliser may have an effect on ground beetle activity in crops. Within crop types, fertility management had considerably more effect on species activity than crop protection management, especially in cereals. There was a marked preference for organically fertilised plots in wheat, barley and grass/clover. The two species with a preference for conventionally managed bean may have reacted to more bare soil and fewer weeds given the herbicide application.

## Conclusions

The results indicate that far more attention needs to be given to the effects of fertility management on invertebrate activity and distribution in crops. This will have an effect on the efficient use of beneficial invertebrates in pest control within organic agriculture.

## Acknowledgments

The authors gratefully acknowledge funding from the European Community financial participation under the Sixth Framework Programme for Research, Technological Development and Demonstration Activities for the Integrated Project QUALITYLOWINPUTFOOD, FP6-FOOD-CT-2003- 506358.

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# Spider (Araneae) Species Activity, Crop Type and Management Factors in an Extensive Plot Trial

Eyre, M.D.<sup>1</sup>, Shotton, P.N.<sup>2</sup> & Leifert, C.<sup>3</sup>

Key words: Spiders, Organic farming, Fertiliser, Crop protection

## Abstract

*Spider species activity in five crop types, with organic and conventional fertility and crop protection management, was assessed using pitfall traps in 2005. Significant differences in activity between crop types were seen with 16 species, with 14 most active in grass/clover and 12 least active in vegetable plots. Within crops there were 20 significant responses to fertility, with 16 more active in conventional plots. Crop protection management produced four significant models, with three preferences for organic management. Small linyphiid species showed a distinct preference for the densest vegetation on conventionally fertilised plots, whilst the larger lycosid species were more active on the more open organic plots. In general, there was more activity in conventionally managed crops, in contrast to other reports.*

## Introduction

Agricultural management has a considerable effect on the activity of spiders (Cole et al., 2005) and Fuller et al. (2005) found more spider activity in organic wheat than conventional. However, crop type had more effect on activity than management system. Eyre et al. (2007) found that fertility rather than crop protection management had considerably more influence on the activity of beneficial invertebrates and the Nafferton Factorial Systems Comparison Experiment provides an opportunity to assess spider species activity at the plot scale. A number of organically and conventionally managed crop types were surveyed.

## Materials and methods

The Nafferton Factorial Systems Comparison Experiments consists of 128 plots (24 x 12 m) in an area converted to organic management in 2003. In 2005 the plots contained wheat, barley, beans, vegetables (potatoes, cabbage, onions, lettuce, carrots) and grass/clover. The 64 conventionally managed plots were treated with inorganic fertiliser and sprayed with herbicide, fungicide and pesticide where appropriate. The 64 organic plots were fertilised with compost and no sprays were used. Each plot was sampled using five pitfall traps with saturated salt solution containing a small amount of strong detergent as preservative. The traps were set in the first week of May 2005 and five monthly samples were generated. Samples were sorted in the laboratory and spiders identified to species. Data analyses with 29 of the 57 species recorded were used in linear mixed-effects models in the R statistical environment (R Development Core Team, 2007), as in Eyre et al. (2007).

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## Results

Sixteen species produced significant responses with the crop models and the mean numbers recorded from each crop is shown in Tab. 1. The mean number of most species was low, with only four species having means of over 10 in a crop. Fourteen species were most active in grass/clover, with 12 having the least activity in the vegetable plots. There was more activity of the abundant species in the cereal crops than in beans.

The significant responses of species to fertility or crop protection within crop types and the means showing preferences for organic or convention plots are shown in Tab. 2. Two species produced significant responses in grass/clover with fertility, one preferred conventional plots, the other organic. *O. retusus* preferred bean plots with conventional fertility whilst two *Pardosa* species were more active in bean plots with organic crop protection. Four linyphiid species produced significant responses to fertility in wheat, all preferring conventional plots. Seven of the 10 species giving a significant response to fertility in barley liked conventional management with more of three species in organic plots. There was more activity of three linyphiid species in conventionally fertilised vegetable plots, with one species preferring conventional crop protection and another organic.

**Tab. 1: Spider species giving a significant response to crop type and the mean number recorded from plots in the five crop types.**

Species	Grass/ Clover	Beans	Wheat	Barley	Vegetables	
<i>Bathyphantes gracilis</i>	6	2	2	3	0	***
<i>Centromerita bicolor</i>	2	2	1	1	0	**
<i>Erigone atra</i>	152	60	87	84	25	***
<i>Erigone dentipalpis</i>	56	17	17	24	10	***
<i>Leptorhoptrum robustum</i>	2	2	1	1	0	**
<i>Lepthyphantes tenuis</i>	24	14	15	15	14	***
<i>Lepthyphantes zimmermanni</i>	3	1	1	1	2	***
<i>Milleriana inerrans</i>	4	2	3	4	2	**
<i>Oedothorax fuscus</i>	7	3	1	5	2	***
<i>Oedothorax retusus</i>	1	1	1	0	0	**
<i>Pardosa agricola</i>	3	3	2	3	1	**
<i>Pardosa amentata</i>	4	4	2	2	2	**
<i>Pardosa pullata</i>	2	0	0	1	0	***
<i>Pachygnatha clercki</i>	0	1	0	1	0	***
<i>Pachygnatha degeeri</i>	14	4	4	6	2	***
<i>Robertus neglectus</i>	1	2	1	1	0	**

\*\* significant for  $P < 0.01$

\*\*\* significant for  $P < 0.001$

**Tab. 2: Spider species giving a significant response to either fertility or crop protection within each crop type, together with mean numbers recorded from plots with organic and conventional management.**

Crop and species	Factor	Organic	Conventional	
Grass/clover				
<i>Erigone atra</i>	Fertility	145	168	*
<i>Pardosa agricola</i>	Fertility	4	3	***
Beans				
<i>Oedothorax retusus</i>	Fertility	0	1	*
<i>Pardosa agricola</i>	Crop protection	4	2	*
<i>Pardosa amentata</i>	Crop protection	5	3	*
Wheat				
<i>Dicymbium nigrum</i>	Fertility	0	1	***
<i>Erigone atra</i>	Fertility	59	117	**
<i>Leptorhoptrum robustum</i>	Fertility	0	2	**
<i>Milleriana inerrans</i>	Fertility	2	4	**
Barley				
<i>Bathypantes gracilis</i>	Fertility	2	4	**
<i>Erigone atra</i>	Fertility	60	107	***
<i>Erigone dentipalpis</i>	Fertility	20	27	*
<i>Leptorhoptrum robustum</i>	Fertility	0	1	*
<i>Lepthyphantes tenuis</i>	Fertility	12	18	***
<i>Milleriana inerrans</i>	Fertility	1	6	***
<i>Pardosa agricola</i>	Fertility	5	0	***
<i>Pardosa amentata</i>	Fertility	3	1	*
<i>Pachygnatha degeeri</i>	Fertility	7	5	**
<i>Robertus neglectus</i>	Fertility	1	2	*
Vegetables				
<i>Diplostyla concolor</i>	Crop protection	0	1	*
<i>Erigone atra</i>	Fertility	19	31	***
<i>Milleriana inerrans</i>	Fertility	1	3	*
<i>Ostearius melanopygius</i>	Fertility	0	2	*
<i>Robertus neglectus</i>	Crop protection	1	0	*

\* significant for  $P < 0.05$ , \*\* significant for  $P < 0.01$ , \*\*\* significant for  $P < 0.001$

## Discussion

One obvious observation from the results was that although 57 species were recorded, most were trapped at very low numbers. However, the two most abundant species, *E. atra* and *E. dentipalpis*, were the most abundant species on Scottish agricultural land and also on the plots sampled here. Weibull & Östman (2003) found differences in spider activity between cereal and grassland crops and there were considerably more activity in grass/clover plots for most species, with the least on the vegetable plots. Within crops there were 20 significant models with fertility, with more activity of 16 species in conventional plots. There appears to be a difference between small, linyphiid species, preferring denser vegetation on conventional plots, and larger lycosid species, favouring the more open organic plots. Of the four significant responses to crop protection, three showed preferences for organic management, possibly related to increased weed cover (Sunderland & Samu, 2000) with no herbicide application. However, in general most activity was in the conventionally managed crops, a contrast with other reports (Schmidt et al., 2005).

## Conclusions

Vegetation architecture is known to affect spider activity and fertility and crop protection management can change crop structure. In the plots surveyed there was more spider activity in the more densely vegetated conventionally managed crops.

## Acknowledgments

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# Weed species diversity and cover-abundance in organic and conventional winter cereal fields and 15 years ago

Kaar, B.<sup>1</sup> & Freyer, B.<sup>2</sup>

Key words: conventional / organic farming, diversity, weeds, winter cereals

## Abstract

*In this research, we compared the weed species development in conventional and organic winter cereals in Upper Austria. The investigations were done in 2003 in 15 paired conventional and organic farms. Following Braun-Blanquet procedure, a total of 105 weed species were found. 57 of them were found only in organic, four only in conventional fields and 48 in both. Therefore, there were 105 weed species in organic fields and 52 in conventional fields. More of the endangered species (Red List species) were found in organic fields. Low species diversity observed in 2003 compared to that in 1988 in the same field was attributed to higher temperature and low rainfall in the recent years. The question arises if under increasing temperature and dryness the diversity of species is regressing and endangered the biodiversity of weeds and linked with that also insects and other species as well as offers space for weeds with strong competition to cultivated crops.*

## Background and objectives

Several investigations have shown, that the diversity of flora and fauna is higher under organic in contrary to conventional farming (e.g. Rasmussen et al. 2006; Friebe 1998, 1988; Plakolm 1989, Callauch 1981). The abandonment of herbicides and pesticides as well as the diversified crop rotations are well known as most important factors influencing this development. Supporting conditions for a high species diversity are not only limited to the arable fields but reach also the environment of the cultivated land e.g. hedges or balks. Plakolm (1989) compared the weed populations in arable fields in organic and conventional fields in the years 1983, 1984, 1985 and 1988 in Upper Austria. In organic farms the weed diversity was higher (steadiness) as well as their dominance. The aim of this research was to study the long term development of weed species on these fields after 15 years.

## Material and methods

We analysed the weeds in the field border area (behind the first grain row) as well as in the centre of a field (minimum of 20m away from field border). Measurements were done by identification and estimation of abundance following Braun-Blanquet (1964) procedure. In addition to the field observations, we collected relevant data on arable techniques for the interpretation of weed data (effects not analysed).

In 2003, 15 organic and 15 conventional farms, with mainly two fields (total of 59) of winter cereals (triticale, winter rye or winter wheat) were analysed in four arable

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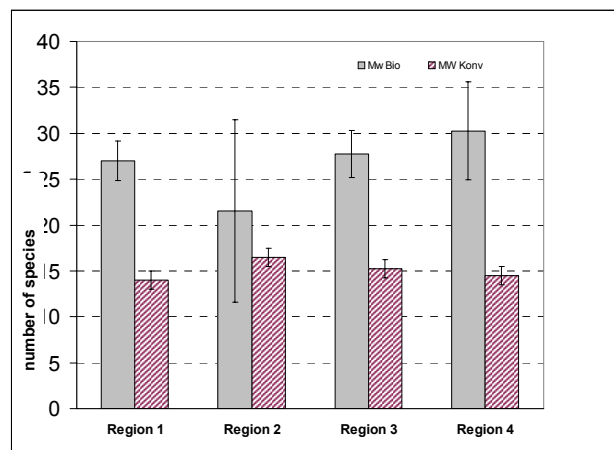
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regions of Austria in the same fields, which were already analysed by Plakolm (1989) 15 years earlier. Whereas the natural conditions of the neighbouring fields were similar, there were differences in the cereals, the varieties, the sowing intensities, as well as pre-crops. The size of analysed area was 50m x 2m along the field border and in the centre of the field following the methodology of Van Elsen (2000). The inventory method combined species abundance (number of individuals of one species) and the dominance (cover of one species in percentage) of the whole test field (cover-abundance) (see Dierschke 1994; Braun-Blanquet 1964). The analysis followed the methodology of Fischer (1994). For statistical analysis, we used SPSS. Furthermore we identified Red List (endangered) species of Austria (see Niklfeld 1999).

## Results and discussion

In total, we found 109 weed species, where 57 were only in organic and four only in conventional fields and 48 in both. Therefore, 105 species were found in organic fields and 52 in conventional fields, which translated to 100% more different species in organic than in conventional farms. This high species diversity in organic winter cereals compared to their conventional counterparts was significant at  $P < 0.05$ . In most cases the median of species frequency in organic fields was 21-25, whereas in conventional we found only 6-10 weed species. In three of four regions, the weed species in organic farms was considerably higher, while in one region the differences between organic and conventional farms were not clear. In the later case two organic farms has unusually low weed diversity, which we could not explain. Twenty-six species in the Austrian Red List were counted (Niklfeld 1999), where 18 were found in the organic, seven in the conventional fields and one only in one of the conventional fields.



**Figure 1: Average number of weed species in organic and conventional fields in four regions in Upper Austria.** (Anzahl der Arten means number of weed species; bars represent standard deviations)

Highest species diversity was found in the border section of the field, regardless of whether it was conventional or organic. The ratio between species diversity in the



border and in the centre of a field was 4:1, whereas in the organic farms the species diversity was twofold more in comparison to the conventional farms.

The comparison between investigations done 15 years earlier (see Plakolm 1989) and the current one (2003) showed a distinctively lower species diversity in the later. The tremendous dryness in 2003 and considerable higher temperatures can explain this decline. Temperatures in 2003 were 2.4°C higher in the first seven month in contrary to the period of 1960-1990. Further, the current rainfall was 395mm lower compared to the 1960-1990 period, amounting to only 125mm in seven months (ZAMG 2003). Even under these climatic conditions, the median of species diversity was two times higher in organic as in conventional winter cereals. Another reason for the lower species diversity in comparison to Plakolm (1989) was the applied methodology. Whereas Plakolm (ibid) collected weed data from an area ranging from 0.3 to 1.5 ha, we made our observations from an area of 2x100m<sup>2</sup> per field. Furthermore, he integrated the species outside the field along the field border.

The analysis of cover-abundance led to the following results: 56 of the 109 species were only found with a cover-abundance of "r" (1-5 individuals /m<sup>2</sup>). Most dominant endangered species in conventional plots was *Anthemis arvensis* ("2"; cover 16-25%), all other endangered species were in the rare category ("r"). Most dominant weeds in organic fields were *Anthemis arvensis* ("3"; cover 26-49%), *Centaurea cyanus* ("3"), *Galium aparine* ("+"; cover < 1%), *Myosotis arvensis* and *Sherardia arvensis* were mainly rare ("r"). *Apera spica-venti*, *Convolvulus arvensis* and *Veronica arvensis* were dominant in conventional fields (highest values "4"; cover 50-74%). *Fallopia convolvulus*, *Viola arvensis* were found in both organic and conventional fields with high dominance ("1; 1-4% cover /2"). *Gnaphalium uliginosum*, *Kickxia spuria*, *Stachys annua*, *Valerianella dentata* identified by Plakolm (ibid), were not found in the present study. Instead of that, we found *Geranium molle* („r"), *Holosteum umbellatum* ("r"), *Rumex stenophyllus* ("r"), *Trifolium campestre* ("r") and *Veronica opaca* ("r") in several organic fields. *Trifolium campestre* was only found in one conventional field ("r").

## Conclusions

In organic winter cereal fields, weed species diversity is higher than in conventional fields. The high weed diversity in the field borders is expected in any investigation on weed species. Higher survival rates of endangered species under organic farming conditions are not surprisingly, however in some cases we cannot explain, why some of these species were only found under conventional farming conditions. The lower weed species diversity in comparison with previous analysis seems to be an effect of dryness and higher temperature in 2003. Some species get lost, new ones emerged, but we cannot explain this development with this survey. Today it is of interest to know if further climatic differentiation lead to new weed societies with new competition to and interactions with the cultivated crops. Therefore, investigations over several years can only explain these developments.

## Acknowledgments

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# Invertebrate communities in soils of organic and conventional farming: conversion trial in the Czech Republic

Šarapatka, B., Laška, V. & Mikula, J.

Key words: soil, organic farming, conventional farming, epigeic fauna, edaphon

## Abstract

*This paper focuses on the evaluation of invertebrate communities at an experimental site in Prague – Uhřetěves (CZ) where an organic farming experiment (organic vs. conventional farming) started 13 years ago. The result of the research shows that strong effect to soil fauna during our evaluation had tillage and other disturbances of soil surface and also the amount of organic matter brought into soil. The research proved the complexity and integrity of agro-ecosystems in which individual actions considerably affect the biological activity of the soil and the occurrence of different groups of fauna, often without any relationship to a certain agricultural system. For these reasons, soil-protecting management practices are important to the soil inhabitants and must be established in the agronomy practices of organic farming.*

## Introduction

Intensification of agriculture within the last 50 years has remarkably affected biodiversity and the quality of soil. At present, there are intense discussions on the impact of agricultural systems on biodiversity (e.g. the effect of organic agriculture – Hole et al. 2005), as well as changes in agro-environmental measures aimed towards a more sustainable management of the landscape.

Arthropods are frequently used as bio indicators for the assessment of landscape and soil quality (Paoletti 1999). Soil organisms are assumed to be directly responsible for processes within the soil ecosystem, especially the decomposition of soil organic matter and the cycle of nutrients (Wardle and Giller 1997). Spiders are acceptable indicators of the biological quality of the habitat because they are dependent on the quality of potential prey. In organic farming some groups of invertebrates have higher diversity than in conventional farming – carabid beetles (Kromp, 1990), spiders (Feber et al. 1998), and earthworms (Brown 1999). There are considerable differences between the management of organic and conventional agriculture. Physical disturbance of soil, such as tillage is a detrimental factor for diversity of soil fauna. (Altieri 1999).

In this trial of the longest duration in the Czech Republic, we focused on soil biology evaluation of conventional and organic agricultural systems.

## Materials and methods

Evaluation of invertebrate communities was done at an experimental site in Prague – Uhřetěves (CZ) where conversion to organic farming started 13 years ago.

The research was carried out on the large study field, subdivided after the crops were planted and management established. We compared 4 sites, 2 with winter wheat and 2 with winter rape. In the conventional farming system both of these crops were grown

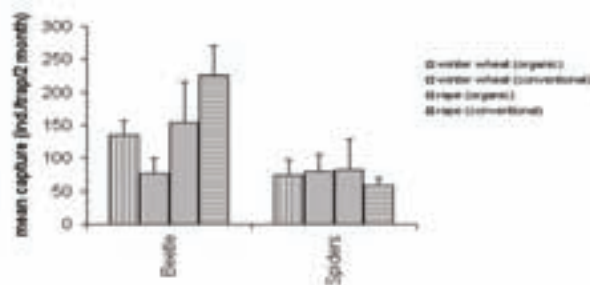
following a grain-leguminous mix crop. While in the organic farming system, the preceding crop was two-years of clover which were mulched and ploughed in.

In the spring and summer 2007, we sampled soil invertebrates at those sites. From epigeic fauna we evaluated beetles (Coleoptera), spiders (Araneae), flies (Diptera), harvestmen (Opiliones), centipedes (Chilopoda) and millipedes (Diplopoda). From the soil samples we evaluated beetles (Coleoptera), beetle larvae, mites (Acarina), springtails (Collembola), centipedes (Chilopoda), millipedes (Diplopoda) and earthworms (Lumbricidae). Epigeic fauna was obtained during the season by sets of pitfall traps (20 traps with 4% liquid of formaldehyde). Edaphon was heat-extracted by Tullgren funnels (Tuf, Tvardík 2005) from soil samples (28 samples, area 1/30 m<sup>2</sup>, 15 cm depth). Data was evaluated by ANOVA and t-test.

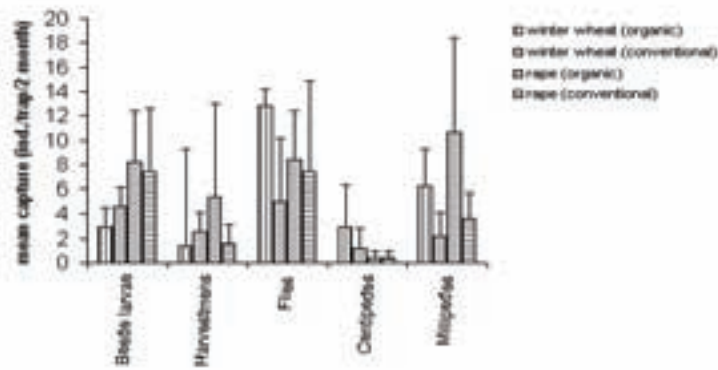
## Results

Results of the monitored epigeic fauna show (Figs. 1 and 2) that differences were significant for beetles ( $F=7.449$ ,  $p=0.002$ ) and millipedes ( $F=3.431$ ,  $p=0.042$ ) only. Beetles were the most plentiful group from the catch in the pitfall traps. In general, the growth of rape was more conducive regarding the occurrence of beetles, especially due to the microclimate provided by the growth. A correlating fact is that in the field of rape, with taller plants and denser coverage, the dominance of beetles was most pronounced. This variation was the only one where, regarding the number of beetles, a conventional field beat the organic one. The difference was significant ( $t=4.012$ ,  $p=0.008$ ). Spiders were captured in all cases in similar numbers. Millipedes clearly preferred the organic variety of both crops which probably relates to the preceding crop rotation. It brought a large amount of organic material into the soil and thus provided a rich supply of feed for these types of invertebrates. Preference for the organic system over the conventional system in rape fields was significant ( $t=2.248$ ,  $p=0.044$ ). Diptera were captured in higher numbers in the organic fields of both crops. The study shows that there are differences between communities in fields managed by conventional and organic systems but a stronger effect was noted among invertebrate groups in response to the given tillage.

**Figure 1: Average capture rate for more abundant taxa, with standard deviation, in pitfall traps**

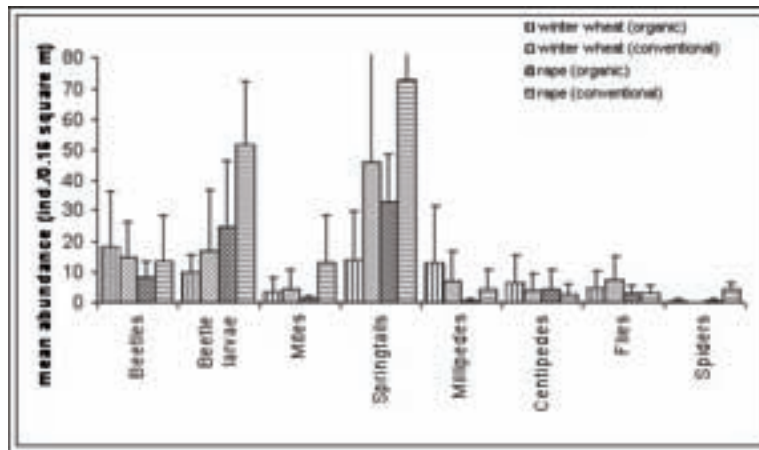


**Figure 2: Average capture rate for less abundant taxons, with standard deviation, in pitfall traps.**



The abundance of single taxons of edaphic invertebrates show (Fig. 3) that observed differences were evident, but not significant. In soil samples the most numerous group was that of springtails. Together with beetle larvae and mites they represent typical soil fauna which is strongly dependent on the chemical and mechanical properties of soil. Such dependence can explain their much denser occurrence in conventional fields which were not tilled as many times within a year. Centipedes, on the other hand, were more abundant in organic variants. The occurrence of beetles was quite balanced in all types of fields. Earthworms were not statistically evaluated because of their low occurrence in both systems.

**Figure 3: Mean abundance with standard deviation in soil samples (0,16 m<sup>2</sup>).**



## Conclusion

The result of the research shows that the amount of organic matter brought into the soil was an important factor in the occurrence of epigeic fauna, which complies with the results published e.g. by Hole et al. 2005, Mäder et al. 2002. This was shown by number of millipedes which process supplied vegetable material. Tillage and other disturbances of the soil surface had a strong effect on the soil fauna during our evaluation. Considerable disturbance of soil (e.g. when hoeing rape) resulted in the occurrence of edaphon in the soil. This brought better results for the conventional variant and was evident by the number of beetle larvae and springtails. The research proved the complexity and integrity of agro-ecosystems in which individual actions considerably affect biological activity in the soil and the occurrence of different groups of fauna, often even without any relationship to a certain agricultural system (organic vs. conventional). For these reasons, soil-protecting management practices are important for soil inhabitants and should be established in the agronomy practices of organic farming. A longer-term study of the whole crop rotation system in the future will provide a more comprehensive view of the entire agro-ecosystem. Its results can then be compared with this published data and the referred publications.

## Acknowledgement

The authors wish to thank the Czech Ministry of Education for supporting their research through grant No. 2B06101 and the Czech Ministry of the Environment for the grant they provided (VaV 1c/4/8/04).

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## **Multi criteria assessment of experiments**



## A pilot socio-economic analysis of QLIF dairy projects

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Key words: Dairy, milk quality, mastitis, calf rearing, financial cost-benefit

### Abstract

*A pilot socio-economic impact assessment was carried out on three dairy projects within QLIF to identify the business, consumer and policy issues likely to influence the adoption of the innovations resulting from QLIF. A socio-economic analysis is presented related to the key outcomes from the three projects which include: management systems to reduce mastitis and antibiotic use in organic dairy farms and how milk quality can be enhanced through high forage organic feeding systems. Due to a lack financial data costs had to be assumed based on other studies. The socio-economic analysis identified a significant number of potential economic and social implications of implementing strategies developed in the QLIF project that aim at increasing animal health welfare and milk quality.*

### Introduction

The integrated project QualityLowInputFood (QLIF) aims to improve quality and ensure safety and reduce cost along the European organic and “low input” food supply chains. Innovations developed within the project will have impacts on businesses operating within organic and “low-input” supply chains as well as on broader social and policy issues. Impact, assessment focused on dairy related WPs 2.1, 4.5.1 and 4.5.2 which had identified methods to improve milk quality and animal health and welfare. While these innovations are of relevance in their own right, they also need to be justified in terms of the financial impacts on businesses as well as the broader socio-economic impacts as these issues are likely to influence their adoption.

### Methods

The socio-economic impact assessment of the three selected dairy projects (details in Table 1) is intended to cover primarily economic aspects (value of non-market cost/benefits; financial returns/profitability; risk; producer/consumer welfare; public expenditure), but also social aspects (employment, labour incomes, working conditions, health & safety, culture/recreation, consumer incomes/affordability), policy/institutional implications and multi-functionality/sustainability issues. Quantitative analyses were only carried out where sufficient data was available and/or where costs could be estimated based on available data from previous dairy studies. Analyses are mainly based on physical data (supplemented with some financial data) supplied by the dairy project teams. The results of the analysis are presented in Table 1.

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**Tab. 1: Summary of socio-economic analysis of three dairy related projects within QLIF**

Title	1: Effect of dairy management on quality of milk	2: Effect of farm practices on udder health and milk quality	3: Suckling systems for organic calf rearing
Objective	Compare milk quality and cow health in organic, low-input and conventional systems with different feeding regimes in five countries.	Identify factors influencing udder health in CH organic dairy farms; identify therapeutic and preventive measures to avoid antibiotics in mastitis control	Impacts of alternative calf rearing systems: bucket fed (milk replacer or whole milk) and suckling (maternal suckling then nurse cow or nurse cow only)
Main outcomes	<ul style="list-style-type: none"> <li>▪ Proportion of grass or grass/clover forage higher in UK<sup>377</sup> than in IT, DK, SE</li> <li>▪ Maize silage and concentrate feeds major diet components in IT, DK, SE</li> <li>▪ Proportion of forage in organic diets higher in all countries</li> <li>▪ Organic milk tended to have higher <math>\alpha</math>-linoleic acid, conjugated linoleic acid and vaccenic acid levels and higher levels of fat soluble antioxidants (Vitamin E and carotenoids)</li> <li>▪ SCC higher on organic</li> <li>▪ No. of mastitis and other veterinary treatments higher on conventional</li> </ul>	<ul style="list-style-type: none"> <li>▪ Factors significantly affecting SCC are breed, alpine summer pasturing, calf milk feeding strategy, hard bedding and no post-milking procedure.</li> <li>▪ Advisory intervention did not reduce average herd SCC in the first year.</li> <li>▪ Herds with moderate udder health pre-drying off can avoid any treatment.</li> <li>▪ Use homeopathy as therapeutic measure against sub-clinical mastitis in herds with SCC&lt;200k/ml at drying off.</li> <li>▪ Use teat sealants where increased risk from environmental pathogens and cows have SCC&lt;200k/ml at drying off.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Consumption of maternal or nurse cow milk lead to higher weaning weights at 3 months of age</li> <li>▪ No immediate health problems linked to suckling systems</li> <li>▪ Increased natural behaviour (e.g. cow-calf bonding) in suckling systems</li> <li>▪ Loss of marketable milk in suckling systems compared to bucket fed</li> <li>▪ Increased stress after weaning in maternal single suckling systems - farmers changed to nurse cow only or maternal single suckling followed by nurse cow systems</li> </ul>
Wider impacts	<ul style="list-style-type: none"> <li>+ Consumer: nutritionally enhanced milk</li> <li>+ Animal welfare: forage a natural feed</li> <li>0 Adoption: reflects current practice</li> <li>- Processor: oxidation and off flavours</li> <li>- Environment: may be higher methane losses from high forage diets</li> </ul>	<ul style="list-style-type: none"> <li>+ Processor: lower SCC milk</li> <li>+ Consumer: reduced antibiotics</li> <li>+/- Adoption: reduced inputs but requires system changes</li> <li>+ Animal welfare: reduced mastitis</li> <li>+ Environment: reduced heavy metals from teat sealants</li> </ul>	<ul style="list-style-type: none"> <li>+ Consumer: integrity of organic product</li> <li>+ Animal welfare: mother/calf bonding</li> <li>+ Technical: improved growth rates</li> <li>0 Environmental: no impacts identified</li> <li>0 Processor: no impacts identified</li> </ul>

<sup>377</sup> CH: Switzerland; DK: Denmark; IT: Italy; SE: Sweden; UK: United Kingdom

Financial cost-benefit assessment	<p><b>COSTS 3,075 € per year for 100 cows</b></p> <p><u>Value of yield loss due to higher SCC</u><sup>378</sup></p> <p>Replacement rate O:20%<sup>379</sup>; C:30% SCC O:251, C:209 kcells/ml Net yield loss (O-C)<sup>380</sup> 0.23 kg/cow/day Annual cost for 100 cows 2400 €</p> <p><u>Milk price penalty due to higher SCC</u></p> <p>Organic yield (305d@22.2) 6771 kg/cow Price penalty 0.001 €/kg Annual cost for 100 cows 675 €</p> <p><b>BENEFITS 52,760 € per year/100 cows</b></p> <p><u>Veterinary cost decrease</u><sup>381</sup></p> <p>Vet. Costs<sup>9</sup> O:35, C65 €/cow Annual saving for 100 cows €3000</p> <p><u>Feed cost decrease less yield difference</u></p> <p>Milk yields O:22.43, C:27.7 kg/cow/day Concentrate use O:5.5, C:10 kg/cow/day Conserved forage O:0.36, C:0.35 kg/c/d Grazed forage O:5.5, C1.5 kg/cow/day Annual saving for 100 cows 2,360 €</p> <p><u>Value of organic milk</u></p> <p>Organic milk premium 0.07€/kg Annual benefit for 100 cows 47,400 €</p> <p><b>NET BENEFIT of organic production</b> <b>49,700 € per year for 100 cows</b></p>	<p><b>COSTS not estimated</b></p> <p><u>Cost of system changes</u></p> <p>Difficult to quantify costs of short and long term systems changes as very specific to the individual farm – higher costs associated with long terms changes (e.g. changes to breed, alpine pasturing and housing).</p> <p><u>Costs of inputs</u></p> <p>Cost of homeopathic and teat sealant treatments are small but also no significant impact on post parturition mastitis.</p> <p><b>BENEFITS from mastitis control best practice on organic farms</b> <b>21,000 € per year/100 cows</b></p> <p><u>Milk yield increase from best practice</u></p> <p>Top performing farms with best practice in 4 or 5 of key system mastitis factors: 22.3 kg/cow/day; other farms 20.4 kg Annual benefit for 100 cows 20,300 €</p> <p><u>Milk quality gain due to improved SCC</u></p> <p>Price penalty reduction 0.001 €/kg Annual benefit for 100 cows 700 €</p>	<p><b>COSTS of suckler system if saleable organic milk 105-185 €/calf</b></p> <p><u>Cost of organic milk consumed</u></p> <p>Milk price O:0.35; replacer: 0.40 €/kg Consumption bucket reared 540 kg/calf Value of tank milk: 189 €/calf Cost of organic milk replacer 216 €/calf Consumption nurse cow 840kg/calf Value of organic milk 294 €/calf Consumption maternal suckling (1m) and nurse cow (2m) 1065 kg/calf Value of organic milk 373 €/calf 'Unmarketable' milk from cull cows (not high SCC/antibiotic) prod. Cost 0.25 €/kg Cost of nurse cow system 210 €/calf</p> <p><u>Cost of other feeds</u> no data</p> <p><b>BENEFITS suckler LW gain 70 €/calf</b></p> <p>Live weight gain (kg/calf at 90/365 days) Maternal/nurse cow suckling 136/343 kg Tank milk bucket fed 101/316 kg Milk replacer bucket fed 95/288 kg Value of extra LW (2 €/kg) 70/54 €/calf</p> <p><u>Other benefits</u></p> <p>More research required to quantify long term health, longevity and productivity benefits of live weight differences.</p>
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<sup>378</sup> Abbreviations: SCC: Somatic cell count; O: organic; C: conventional; LW:

<sup>379</sup> Lampkin et al. (2006)

<sup>380</sup> Based on calculations by Reneau (1986) using the relationship between SCC and yield loss

<sup>381</sup> Costs derived from Jackson and Lampkin (2006), but proportions similar to treatment differences identified in this study.

## Discussion

Developing strategies to improve milk quality and reduce antibiotic use are the cross cutting themes in these projects and there appears to be little conflict between the objectives aimed for in the work packages.

In Project 1, systems with high forage diets resulted in milk with enhanced fatty acid and antioxidant profiles. Financial analysis of these systems shows reduced concentrate feed and veterinary costs, but also decreased milk yield per cow and increased somatic cell count (SCC), which largely balance each other out. However, the net benefit of the high forage diet systems was substantially increased by the organic premium reflecting in part the value placed by consumers on enhanced nutritional quality of the milk. In Project 2, management factors were identified as significantly influencing somatic cell counts in Swiss dairy herds. Some factors can be changed in the short term (e.g. post-milking management), but other factors are longer term strategies that are likely to be more costly (e.g. bedding system, breed, summer feeding system). It is difficult to put a cost on such changes as they are specific to individual farms. Dry cow therapies were found to be unnecessary in herds with moderate udder health resulting in saved vet costs (homeopathy, teat seal and/or antibiotics) without major milk losses.

In Project 3, using maternal single suckling and nurse cows to suckle calves, although costing more than bucket rearing, resulted in calves with higher weights at weaning and one year old. However, more milk was fed per kg liveweight gain, and the value of the milk used exceeded the financial benefit of the gain. More work is required to assess the impact of these rearing systems on first lactation performance, longevity and mastitis levels, as well as the impact on intakes of other feeds.

## Conclusions

In addition to the project results themselves, the analysis undertaken has identified significant associated economic impacts and highlighted where social impacts may occur. The methodology is limited by some of the assessed work packages being incomplete. Due to a lack of direct financial data, in many instances costs have had to be assumed based on other studies.

## Acknowledgments

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# Sustainability evaluation of long term organic farm systems

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Key words: Sustainability Indicators, LTE, Organic Agriculture

## Abstract

*The paper deals with the evaluation of sustainability at farm level in a long term experimental farm, organically managed since 1992 in Tuscany. The aim was to develop and implement a multi-objective organic agriculture, to establish new concepts of farming as result of long term research analysis and to provide a practical and easy understanding on what is necessary to change or improve in farming management. Soil fertility and biodiversity indicators are taken into consideration in the period 1992-2006: the weak points and the improvement obtained by the farm management are underlined. The values of indicators changed rapidly towards the desired ones in the first 6 years period. After 13 years, in 2006, the situation appears almost stable, P is still a problem, some little discrepancies for C/N ratio and KAR indicate the need to re-examine some of the production methods.*

## Introduction

In the context of the promotion of sustainable agricultural models many studies have been conducted to evaluate the degree of sustainability at different levels. Only limited information is available for the precise assessment of a single sustainable farming system able to provide adequate agronomical, economic, environmental and social benefits (Vazzana and Raso, 1997; Verejilken, 1997; Häni et al., 2003.). An European methodology developed since 1993 (Verejiken, 1997) adopted an holistic approach considering the farm as a complex unit in which any action has several or many effects. From this methodology an indicator-based conceptual framework has been derived and applied to many different farms in different social and pedoclimatic situations. A selection of specific indicators is used as a tool to evaluate farm sustainability. The framework is organised in a number of sub-systems: for each sub-system corresponding agro-environmental indicators and processing methods are identified. In this paper we present the results of the framework application to evaluate the sustainability of an organic long term experiment .

## Materials and methods

The experimental area is located in the farm of the University of Florence (Montepaldi) situated in the municipality of S. Casciano Val di Pesa, Tuscany. A sustainability evaluation has been applied to the Montepaldi Long Term Organic Experiment (MOLTE) active since 1991. MOLTE includes three micro agro-ecosystems (Migliorini and Vazzana, 2007) and we examine here the performances of the old organic microfarm, from 1992 to 2006. The micro farm covers an area of 5.2 ha, divided into 4

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fields; each field covers 1.3 hectares (260 m x 50 m). The agroecosystem is surrounded by ecological infrastructures such as natural and artificial hedges. Following the local farm management, a four-year crop rotation is adopted in the organic agro-ecosystem: green manure+corn – hard wheat+red clover – red clover – barley.

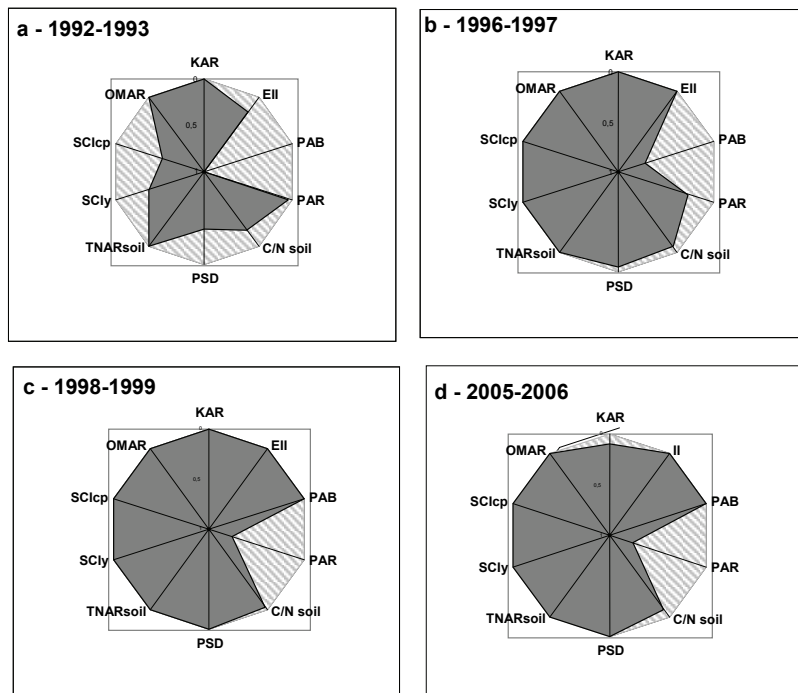
To measure sustainability different indicators were determined. For each single indicator, an optimal reference value was selected from the literature, considering the territorial and climatic context of the experimental area (Vereijken, 1997) and the threshold (minimal) level that is in compliance with the EU Regulations. The list of indicators is described in Table 1 (Vazzana et al., 1997).

**Tab. 1: List of indicators used to evaluate sustainability**

Acronym	Name	Description	m.u.	Desirable value
EII	Ecological Infrastructure Index	% of farm area managed as a linear and non linear habitat and corridors for wild flora and fauna	% area	$x > 5$
PSD	Plant Species Diversity in the farm	Number of species	number	$x > 40$
SCI <sub>y</sub>	Soil Cover Index year	months of the year when the soil is covered with crops /12 months	% month	$x > 50$
SCI <sub>c</sub>	Soil Cover Index critical period	months of the critical period for erosion when the soil is covered with crops /x months	% month	$x > 60$
OMAR <sub>s</sub>	Organic Matter Annual Reserve in the soil	OM in the cultivated soil layer	%	$x > 2,5$
TNAR	Total Nitrogen Available Reserve in the soil	N tot in the cultivated soil layer	‰	$x > 1,5$
PAR	Phosphate Available Reserve in the soil	P <sub>2</sub> O <sub>5</sub> in the cultivated soil layer	ppm	$35 < x < 25$
KAR	Potassium Available Reserve in the soil	K <sub>2</sub> O in the cultivated soil layer	10 ppm	$150 < x < 200$
C/N	C/N ratio in the soil	Ratio between the quantity of organic C and the quantity of total N of the soil	number	$9 < x < 12$
PAB	Phosphate Annual Balance	P input/P output	kg/kg	$> 1,20$

## Results

Taking into consideration the subsystems “biodiversity” and “soil fertility” at farm level we can follow the trend of the different indicators in the studied period (1992-2006). When the MOLTE started at Montepaldi farm after a long period of conventional management, soil characteristics were very poor. In fact, in 1992 low organic matter content in the soil, erosion problems, nitrogen and phosphorous imbalance, low C/N ratio were identified as major problems to be solved. Top priority was given to the improvement of these components. The implementation of ecological infrastructure and biodiversity were also taken into consideration. Fig.1a reports the discrepancies of each studied indicators from the reference values considered equal to 1, at the experiment starting time (1992-03). Fig.1b, Fig.1c and Fig.1d show the changing situation after four (1996-97), six (1998-99) and thirteen (2005-06) years.



**Figure 1: Evaluation of sustainability in an organic long term experimental farm: at starting point (a-1992-03) after four (b-1996-97), six (c-1998-99) and thirteen (d-2005-06) years since conversion.**

Before the starting of the experimental activity, the studied area was conventionally cultivated using chemical fertilizers. Soil cover was poor during the critical period of the year with risks of erosion. The farm area covered by natural vegetation was under the reference limits both for ecological infrastructures (5 % of total area) and for species diversity (>40). After the period of conversion to organic management (1996-97), a clear improvement resulted for many parameters ( $SCl_{cp}$ ,  $SCl_y$ , C/N soil) but others (PAB) gave a slow answer and PAR discrepancy increased. The indicator EII reached the optimal value later on, with the plantation of a new linear element (edge). The inclusion of herbaceous strips with natural vegetation between the fields increased the biodiversity as measured by PSD.

The situation was better for all the parameters, except for PAR after a period of 6 year of organic management (1998-99). The use of leguminous crops in the rotation increased the P availability in the soil. The planned agro-biodiversity (EII and PSD) reached stability and good levels. By changing the applied rotation soil was maintained covered by vegetation during most of the year and especially during the critical period. The parameters referring to soil fertility showed a positive trend towards the optimal reference values. At 13 years from the beginning of the experiment (2005-2006) the evaluation of sustainability of the studied microfarm confirmed the picture of

1998-1999, with some minor discrepancies (KAR, C/N soil). The problem of PAR (too high P availability) resulted still unsolved.

## Discussion

Soil fertility and agro-biodiversity indicators showed a rapid response time during the first period after conversion of the studied farm from conventional to organic practices. Some of the parameters concerning soil fertility are slow and the effect of changing management was significant only after 6 year. The P problem could be improved with a more critical estimation of farm needs, P input/output ratio, crop exportation and type of organic fertilizers in use. The agro-ecological indicators related to planned biodiversity respond very well to the changes realized in the farm (crop rotation, a new hedge and strips of spontaneous vegetation between the fields). After 13 years, in 2005-2006, the situation appeared almost stable, but some little discrepancies for C/N ratio and KAR indicate the need to re-examine some of the production methods.

## Conclusions

From the data available it is clear that agricultural practices connected to organic farming are able to significantly improve soil characteristics and farm biodiversity. A periodic evaluation of sustainability of farm management is an important tool to design and redesign the farming system. In our case the application of a set of indicators allowed to confirm the importance of long-term experiments (LTE) to evaluate and implement the management of organic farms. With the comparison of the indicator values, after 13 years since we began our research experience we can conclude that:

- a minimum period of 6 year after the farm conversion to organic is necessary to reach the equilibrium and the stability of the majority of involved processes.
- valid and applicable results from research can be obtained only if the experimental site is stable and its sustainability is monitored in continuum increasing the understanding of system attributes.

## Acknowledgments

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# Evaluation of Farm Biodiversity with Indicators in the Context of Sustainability

Siebrecht, N. & Hültsbergen, K.J.<sup>1</sup>

Key words: Biodiversity, Assessment, Indicators, Sustainability, Organic Farming

## Abstract

*Organic farming depends on the promotion of biodiversity and the corresponding functions. No tools are known for the obtention of farm-specific information explaining the influence of farm management on biodiversity. The paper describes an approach that allows estimating such effects. It has been applied in an experimental farm with an organic and a conventional farm section. The results distinguish between both sections. The investigations made so far allow concluding that multiple-structured low-input systems achieve better marks than specialized high-input systems. For further development and validation additional studies are required. It is planned to test the indicator model in numerous farms, in order to disclose bottlenecks and deficiencies.*

## Introduction

Conservation and promotion of biological diversity belong to the principles of organic farming. The guidelines of IFOAM include the demand to protect organisms, communities and ecosystems with the aim to safeguard the ecological balance. One of the targets defined in EC Regulation 834/2007 is the maintenance of a rich biodiversity by cautious farm management. The reason for this high esteem is the importance of biodiversity for the functioning of agro-ecosystems. Organic farming derives benefits from the natural regulation of harmful organisms and the support of mass cycles.

The influence of organic farming is mostly positive and only in rare cases indifferent or negative (e.g. Bengston et al. 2005, Hole et al. 2005). Divergent statements were sometimes caused by the choice of species or species groups. Such state indicators (e.g. target organism) are not suitable for integration into indicator models oriented on estimating the environmental impact by farm enterprises. What we need are methods rating the consequences for biodiversity on the basis of management data and derived pressure indicators. Such an approach, pursued in an experimental farm for years, is the focus of this paper.

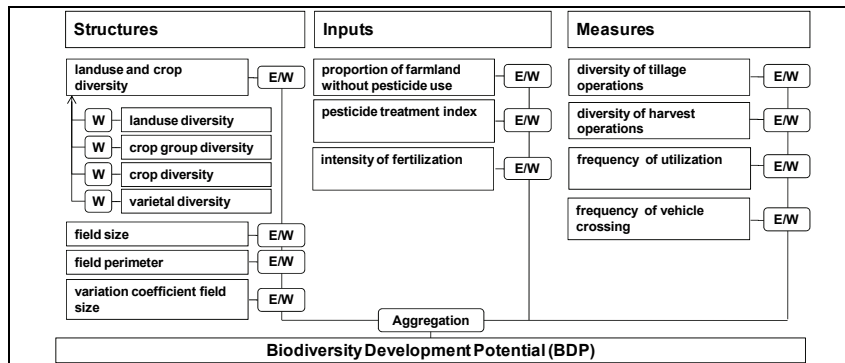
## Materials and Methods

The elaborated approach has been integrated into the indicator model REPRO (Hültsbergen 2003) following the existing conception: Potential environmental effects of farm enterprises are analyzed and estimated on the basis of management data and site specifics. In the past, relevant analyses were oriented on the abiotic environment; statements on the biodiversity were missing almost completely. The new approach considers the complex relationships of farm management in form of structural features (acreage and cropping structure), input parameters (fertilizer and pesticide input) as

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well as specifics of process design. For this purpose, partial indicators (PI) have been sampled, evaluated and finally aggregated to get the complex indicator Biodiversity Development Potential (BDP) (Fig. 1). The analysis of the PI is made using evaluation functions which convert the indicator value into a dimensionless figure. Value 1 stands for the best, 0 for the worst effect on the environment (see Fig 2).



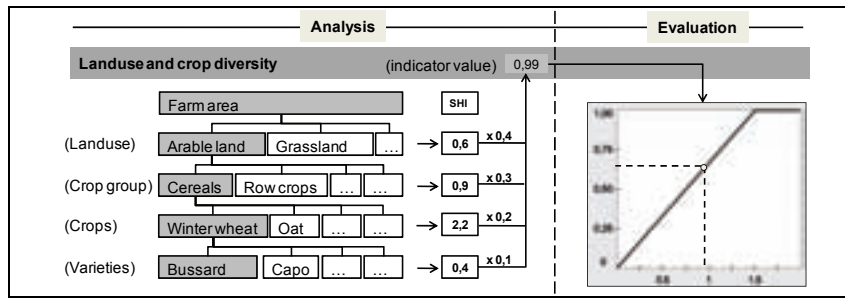
**Figure 1: Scheme of partial indicators and aggregation to the BDP; E/W = Evaluation and Weighting**

The principle of analysis and evaluation has been described on the example of land use and crop diversity. This PI is a derivative of the crop diversity: Land use and cropping structure are grouped on hierarchic levels. The first level describes types of land use (arable land, fallow areas, ..), which are then broken down to crop groups (cereals, root crops, ..), species and varieties. On each level, calculations of the Shannon Index (SHI) of the levels are aggregated with weighting factors and merge in an overall indicator which is then evaluated (Fig. 2).

The described method has been applied in commercial and experimental farms, followed by tests of its practicability. Below, results of its use in the Experimental Farm Scheyern in the south of Germany are given. The farm has concentrated on investigations in agro-ecosystems since 1990. In 1992, it was subdivided into an organically (OF) and a conventionally (CF) run section.

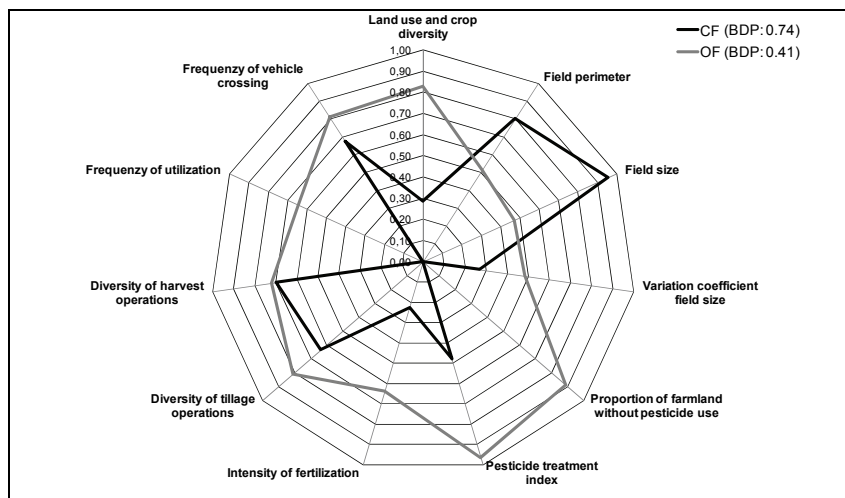
## Results and Discussion

The indicator approach allows differentiating between the two farm sections (Fig. 3). Considering the BDP overall index, OF was rated 0.74, CF 0.41. The result reflects the influence of higher land use and crop diversity (more differentiated cropping structure and catch crops) and the omission of mineral fertilizers and plant protection agents. With regard to the PIs, field size and field circumference, which serve the estimation of field structures, OF ranked slightly behind CF. This can be explained by the fact that, compared to CF areas, OF fields are smaller (1.3 ha on average) and of very compact shape (nearly square). The investigations made so far allow concluding that many-sided structured low-input systems, which often are under organic management, achieve better marks than specialized high-input systems. Due to its sensitivity to management measures, the indicator BDP permits a detailed differentiation between farm types. Intensively run or specialized ecofarms, marked by a closer crop rotation and higher intensity of fertilization, are rated lower.



**Figure 2: Scheme of the PI land use und crop diversity**

The farm-internal sensitivity of the indicator becomes evident when several years are compared (Fig. 4). Variations of the indicator value in CF go back to changes in the cropping structure and the intensity of fertilization and plant protection. OF shows a comparatively constant situation of the cropping structure throughout the reference period; variations are the result of changes in fertilization intensity and use frequency. Especially conspicuous is the pronounced differentiation of the two farm sections after the shift to organic management. The OF areas received clearly higher overall ratings due to the changes in management.

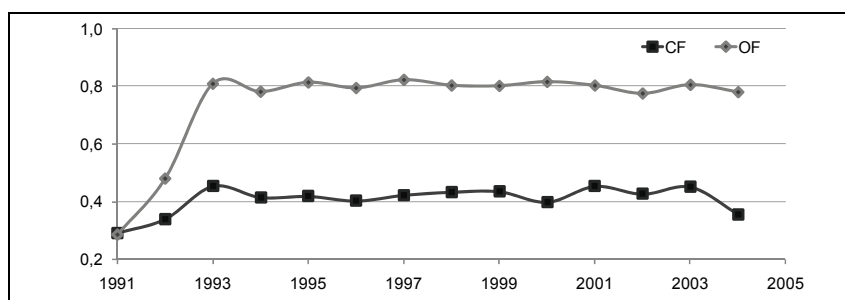


**Figure 3: Evaluation of PI compared between OF and CF**

### Conclusions

The approach produces farm-related analyses of the influence on the biodiversity without extensive surveying or mapping. The method is oriented on high transparency tracing back PIs, algorithms and evaluation functions. The required input data are available in commercial farms. The integration into an indicator model allows widespread applications and guarantees a high practicability. However, the indicator

cannot provide information on the occurrence of species because the development potential of biodiversity is only estimated. It may be fuzzy due to site conditions, temporal delay, deviating spatial consideration or the structure of the entire farmscape.



**Figure 4: Development of the BDP for CF and OF (1991 – 1994)**

The introduced indicator method has been coordinated and discussed in an expert commission. Additional studies are required for further development and validation, because the latter is not yet sufficiently documented. However, preliminary results obtained in the Experimental Farm Scheyern indicate that the development tendencies for groups of species (e.g. weed flora) coincide with those of the BDP (Osinski et al. 2005). It is planned to test the indicator model in numerous farms, in order to disclose any bottlenecks and deficiencies. It should be discussed whether further farm parameters and criteria have to be integrated as PI.

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# On the inherent instability of the monoculture

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Key words: Stability, Food webs, Network analysis, Agroecosystem architecture.

## Abstract

*In the last decades has been recognized that monoculture has harmful consequences: genetic erosion, soil loss, pollution, land concentration, increased poverty and so on. But, there is another aspect that has been underestimated, the instability that results of the oversimplification of monoculture's trophic structure. Here, using network analysis, we show why the trophic structure of monoculture is inherently instable. Considering an agroecosystem as a complex network, we propose that for the design of stable agroecosystems we must generate architectures with redundancy of relations and homogeneous connectivity, because this compensates and modulates perturbations.*

## Introduction

An ecosystem is a complex network, made of many interacting species (nodes). As result of these interaction emergent phenomena arises, being one of these, the system stability or homeostasis. With the goal of simplify production, conventional agriculture break up redundancy and trophic cycles which are present in natural ecosystems, transforming them in monocultures. Since stability is a phenomenon observed in natural ecosystems and not in monoculture, we need to study it in the first ones.

The network analysis of trophic webs can be used to study the interactions between the components of an ecosystem (Montoya *et al.*, 2006). One advantage of this analysis is its systemic approach, which allows to explore the whole system and find patterns. Recently has been suggested (Montoya & Solé, 2003) that the natural ecosystems trophic architectures can be divided in two classes according to their richness (S). Those that present low S, are called Poisson, whereas those with high S are called Scale Free (SF) or Power Law. Poisson nets have a similar number of trophic relations per species (connections or degrees) and Scale Free have a small number of species with many connections and most of the species with few connections. If the richness is related to ecosystem's architecture, and, if this influences the potential responses to perturbations (*i.e.*, its stability), this may offer clues on how to design agroecosystems.

## Materials and methods

We simulated Poisson and Powers Law networks, between  $S=20$  to  $S=150$ . These values were obtained from real ecosystem networks information (Montoya & Solé, 2003), and represent the interval on which the architectural change occurs. The simulations were settled to generate low average degree (*i.e.*, 13) networks according to empirical data (Montoya and Sole, 2002).

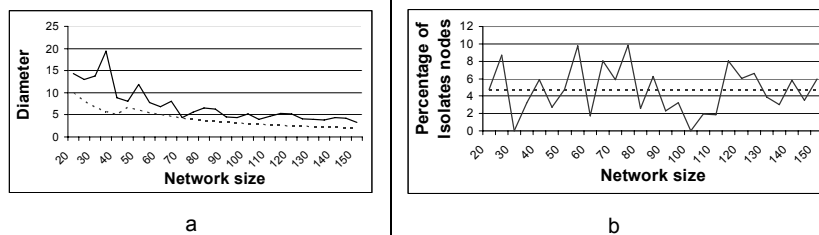
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In order to compare the architecture of the networks, we measured the diameter of the simulated networks. The diameter is a measurement of the cohesion of the food webs and represents the shortest distance (links number) between the two more distant species. The diameter was normalized according to the total network size. We also evaluated how the characteristics of the networks were affected with the removal of one of their nodes (*i.e.*, species). We removed the most connected node (directed attack), and the consequences of this perturbation was measured counting the number of isolated nodes (secondary extinctions). This perturbation simulates the effect of completely remove an element of the agroecosystem (*e.g.*, a plague, a weed, etc.).

## Results

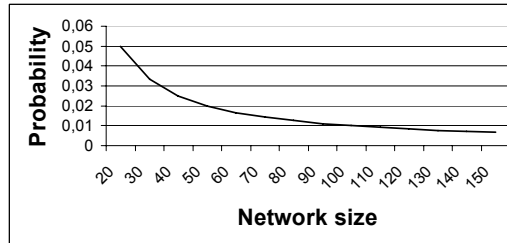
We found that the diameter diminishes as  $S$  increases in exponential fashion, independently of networks architecture. But, for values lower than eighty nodes the diameter of Poisson networks is considerably smaller than the SF diameter, therefore the Poisson net is more advantageous because the community is more integrated (Figure 1a). When perturbed, the number of isolated nodes was always zero for Poisson networks, whereas for Scale Free networks this number was variable, with an average of approximately five isolated species (Figure 1b).



**Figure 1 a): Changes in Networks Diameter as  $S$  increases. In small ecosystems the Poisson architecture is more advantageous than SF, because it has lower diameter (higher community cohesion). Continuous line: SF Networks, dashed line: Poisson Networks. b) Secondary extinction vulnerability for SF architecture as  $S$  increases. Continuous line: changes in the percentage of isolates nodes, dashed line: overall average of isolates nodes.**

## Discussion

Our results agree with and complement those of Albert *et al.*, (2000) and Solé & Montoya (2001). These authors show that Poisson networks are moderately sensible to random or directed removal, whereas SF networks are very robust to random removal, but highly sensitive to directed or specific removal. Which is the probability of randomly remove the most connected node (hub) in both types of nets?. If we consider the probability (Figure 2) of extracting the most connected node as richness increases (i.e.,  $p=1/S$ ), we found the following:



**Figure 2: Probability of randomly remove the most connected node**

The probability of remove the hub is higher for smaller nets.

The probability of remove the hub is lower for larger nets.

The smaller nets seen on nature have Poisson architecture, whereas in the largest nets, the architecture is SF (Montoya & Solé, 2003). Consequently, if we remove the hub from them we find:

- a.- Small Poisson networks: the nets do not disarticulate, and therefore, secondary extinction doesn't take place.
- b.- Large Poisson networks: the nets do not disarticulate, and therefore, secondary extinction doesn't take place.
- c.- Small SF networks: because (1) happens and the SF network is vulnerable to this perturbation, this architecture results instable.
- d.- Large SF networks: Because large SF nets have similar integrity levels as Poisson (Figure 1a), and because (2) happens, this architecture is as stable as Poisson. Nevertheless, extensive evidence (Albert & Barabási, 2002; Newman, 2003) shows that SF networks have in general more advantageous properties than Poisson ones. Therefore, if the larger SF nets are as stable as Poisson and more advantageous in terms of other properties, it is reasonable that natural ecosystem possess this architecture when the nets are large.

Let us extrapolate these results to the agricultural area. If we recognize that a monoculture is an ecosystem in which all the species are related by means of some type of ecological interaction (parasitism, predation, mutualism, competition, *etc*) to one species (i.e., the monoculture), we realize its trophic structure is a Star networks

(a net in which all nodes are directly connected to a common hub). The Star network is unstable when directed attack occurs, because the whole ecosystem cohesion relies on a single species (in this case, the monoculture). In this architecture, all the weaknesses of the SF networks in low richness ecosystems are taken to the maximum, because its centralization. In this context the Star net is the most inefficient architecture. In it any perturbation will reach the whole system in two ecological interactions in average. In this architecture any type of self-regulation is impossible. We think this is the fundamental reason of all imbalances inherent to the monoculture. If our goal is to design stable agroecosystems, we must copy the topologies found in nature. Our results indicate that the way to do so, in low diversity ecosystems (like agroecosystems) is generating architectures in which all the bets are not in a single species. Redundancy of relations and similar connectivity is the key of the stability, because these compensates and modulates perturbations in the network.

## Conclusions

Monocultures are ecosystem with an inherently imbalance architecture, in which all the weaknesses seen on low richness SF networks ecosystems are taken to the extreme. In this architecture any type of self-regulation is impossible and ecosystems functionality is loss.

If our goal is to design stable agroecosystems we must enforce redundancy of relations and similar connectivity for all system species, because this compensates and modulates disturbances in the trophic network.

## Acknowledgments

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## Methods in organic quality research

## Effect of organic and conventional feed on potential biomarkers of health in a chicken model

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Key words: Organic food, feeding experiment, chicken model, immunological parameters, biomarkers

### Abstract

*A feeding experiment was performed in two generations of chicken with feed from organic and conventional produce. The aim was to search for 'biomarkers', indicating different physiological effects from the feeds. Feed and chicken were extensively studied. Various differences in nutrient content were observed in the ingredients. Most consistent finding was a difference in protein content, resulting on average in a 10% higher protein content in the conventionally produced feeds. Although animals on both feeds were healthy, differences between the groups were found. The chicken, fed with conventional feed gained more weight, whereas the animals on the organic feed showed a stronger immune reactivity, a stronger reaction to a challenge to which they were exposed, as well as a slightly stronger recovery from this challenge, being a stronger 'catch-up-growth'. With these findings 'biomarkers' for future research are indicated. Interpretation towards 'health' appeared difficult, as the concept of 'health' is as yet scientifically not well defined.*

### Introduction

An important reason for many consumers to buy organic is the assumption that organic products are healthier than conventional products. However, until now, very little research has been performed to study the effect of organic food on health. Most studies on organic food are dealing with differences in nutrient contents of organic versus conventional products. Results from such studies can only speculatively be connected to health effects. Very little research has been performed studying actual effects of organic food on physiological processes in consuming organisms.

The present study was the first experimental study in the Netherlands in which the effects of feeds, derived from organic or conventional origin, are studied using animals as a model for humans. The aim was to search biomarkers that can show potential health effects of organic compared to conventional food. Based on results of this first explorative study an indication for 'biomarkers' was expected, which would need further confirmation in follow-up research and which eventually should be useful in research on health effects in humans.

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Based on a scientific discussion within FQH, experts concluded that possible feed effects would most likely show up in the immune system of young organisms, as it is known that through the gut (GALT), food induces the development of the immune system in the developing organism. However, a broader exploration of effects was concluded to be valuable. The present study was both searching for differences in available feed ingredients, as well as an explorative feeding experiment with animals, to identify possible biomarkers for a different effect from these feeds. The study was performed by a Dutch consortium of institutes and coordinated by the Louis Bolk Institute. Results have been presented in a report (Huber 2007).

## Materials and methods

The study comprised a blinded animal feeding experiment in two generations of chicken fed either conventional or organic feed. The animals were chicken from the Wageningen Selection Lines, laying hens that during 25 generations were divergently selected for their either high (H-line) or low (L-line) antibody response to SRBC (sheep red blood cells) (Parmentier et al. 1996). Next to these lines a random bred control group (C-line) of chicken was included. The main experimental group was the second generation, consisting out of six groups of 25 animals, 150 in total (3 lines, 2 types of feed). The chicken in the first generation were randomized for each line in 2 groups, received identically composed feeds from either organic or conventional products. The offspring of the resulting 6 line-feed combinations in the second generation received the same feed as their parents.

Three feeds for the different developing stages of the chicken (starter feed, grower feed, layer feed) were composed according to existing norms for organic chicken feed with six ingredients: wheat, barley, triticale, peas, maize and soy, that were produced organically or conventionally. As no products from controlled trials were available, ingredients were obtained from neighbouring 'farm pairs', with the same basic soil and climatic conditions, preferably known as 'best practice farms'. Before the ingredients were used for feed production, they were prescreened for residues of pesticides or mycotoxins. A contaminated ingredient was not used for the feed production, to prevent any adverse health effect due to these compounds. The ingredients used for feed production, as well as the composed feeds, were extensively analysed for macronutrients, micronutrients, trace elements, micro-organisms and bioactive ingredients. As complementary analyses, biophoton and protein ratio measurements and biocrystallizations were performed.

To prevent shortages in the nutritional needs of the chicken the feed was supplemented with potato protein, the amino acid methionine, chalk, grid, salt, NaCO<sub>3</sub> and a small dosage of a commercial mix of vitamins and minerals. The feed was presented as a composite flour. Feeds were coded either A or B.

The 1<sup>st</sup> generation of chicken was housed in individual cages; the 2<sup>nd</sup> generation in spacey and enriched indoor runs, in groups of 6 animals. The animals of the 1<sup>st</sup> generation were fed the experimental feeds from week 11 of their life. The 2<sup>nd</sup> generation received the experimental feeds from the first day on. Both generations could eat ad libitum. The 2<sup>nd</sup> generation lived till 13 weeks of age.

Physiological markers were sought in general health features, immunological response parameters, metabolite measurements in plasma and liver through metabolomics, gene activation in the gut through genomics, and in a post mortem evaluation through pathological anatomy. As both groups of animals received

balanced and sufficient feed, no large differences were expected. Therefore, a disturbance was provoked to evaluate the animals potential to react to, and recover from, an immunological 'challenge'. As a challenge the non-pathogenic, immune protein trigger KLH (Keyhole Limpet Hemocyanine) was injected at the age of 9 weeks in the 2<sup>nd</sup> generation.

General health effects were evaluated and a broad range of immunological measurements was performed, in both generations. Periods of feed changes were monitored, as well as the period before and after the challenge. Blood from before and after the challenge was also analysed by metabolomics. In week 13 the animals were sacrificed and section was performed. Tissue samples were analysed by metabolomics of the liver, by genomics of the gut and by pathological anatomy of the organs. The study was performed blinded. Only after all results were available and the conclusions were drawn, the codes of the feeds were broken.

## Results

Comparison of the nutritional content of the organic and conventional feeds showed most consistent differences in the amount of proteins, which was about 10% higher in the conventional feed, due to higher levels of proteins in conventional wheat, soy and barley. The organic feeds mostly contained higher levels of alpha-tocopherol, total folate and iodide, whereas lower levels of LPS endotoxins were found in organic feeds. Based on calculation it showed that the level of phytosterols, vitamin C and vitamin B5 was higher in conventional feeds and organic feeds were higher in vitamin K and isoflavones. In the period of the KLH challenge slight differences in fatty acids in the feeds occurred, with higher levels of unsaturated C18 in the organic feed.

With the complementary analyses the ingredients from the two agricultural systems could be differentiated and where experience with the ingredients was available, could correctly be identified as being the organic or conventional sample.

As the C-line animals represent the natural genetic variation of the population, the results of the 2<sup>nd</sup> generation of this group, were considered most informative. The results of the H- and L-line animals can be informative for understanding immunological mechanisms, though through the genetic selection this group has lost some potential to react on environmental changes. All animals were diagnosed as being perfectly healthy. However, the groups on the two different feeds showed clear differences in several aspects of their physiology. The animals on conventional feed showed a faster growth and were significantly heavier. After the KLH challenge a 20-30% decline in growth was observed in both groups for about two weeks; after this the animals on the organic diet showed a stronger 'catch-up-growth'. With respect to the immunological parameters, both the humoral and cellular and both the innate and adaptive components of the immune system showed differences between the animals on the two different feeds. The immunological results were not fully consistent, but were overall interpreted as indicating a higher potential for immunological reactivity of the animals fed the organic feed.

Metabolomics results of the blood showed a clear distinction between the animals on the two feeds, especially after the challenge. It was interpreted as that the animals on the organic feed showed after the challenge a stronger reaction and connected metabolism, indicating a stronger acute phase reaction than the animals on the conventional feed. Metabolomics results of the liver indicated an increased pentose phosphate pathway activity in the animals on the organic feed.

Genomics showed, in the animals on the conventional feed, a lower expression of genes connected with cholesterol biosynthesis. Pathological anatomy showed some differences in the weight of specific organs between the feed groups. More adipose tissue was observed with the conventionally fed animals, but this has not been objectivated.

## Discussion

An important outcome is that feed ingredients from different origins can have small but clear immunological and metabolic effects in healthy animals. Concerning the factors in the feed that could explain these differences, the higher protein content in the conventional feed is considered to be the factor that causes the stronger weight gain in the animals on this feed. There are indications in literature that an enhanced status of immune reactivity in animals (such as of those on the organic feed), may be related to a lower body weight. The factor(s) in the feeds that might cause the physiological differences in relation to the challenge are not yet clear. The present findings are in line with Lauridsen (2007) reported results of a feeding study in rats. Here the conventionally fed animals showed an increased body weight and fat tissue deposit, as well as an increased IgG-level of the immune system. However in this study the existing differences in feeds were compensated, resulting in iso-energetic and iso-nutrigeneous feeds with similar crude protein and essential amino acids content. This fact puts under stress our hypothesis of the protein being the cause of the differences in weight of the chicken. The implications of these different physiological reactions in the context of short term and long term 'health' of these animals, is still unclear. The concept of 'health', and its physiological and immunological parameters, currently lacks scientific identification and solid conventions.

## Conclusions

Weight gain and, especially after exposure to a challenge, 'catch-up-growth', immune responsiveness, metabolic parameters, gene regulation in the gut system and observations by pathological anatomy are suggested as 'biomarkers' for future studies of effects from the two different feeding regimes. However, before these 'biomarkers' can be used in a study in humans, confirmation of the mentioned results is necessary.

## Acknowledgments

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# The effect of medium term feeding with organic, low input and conventional diet on selected immune parameters in rat

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Key words: Organic, conventional, low input food, food quality and safety, immune system, rat

## Abstract

*There is currently limited evidence for differences in nutritional value and 'healthiness' between organic and conventional foods. While organic standards aim at minimizing antibiotic and/or pesticide residues they have been described as a potential source of high mycotoxin levels, and bacterial diseases or parasites. The aim of this study was to evaluate the effect of rat feeds based on the organic, low input and conventional crops on the rats' immune system function. Preliminary results obtained indicate a potential immunomodulatory effect of 'low input' foods that is not observed in rats fed conventional and organic diets.*

## Introduction

Conventionally produced crops may contain higher levels of pesticides and their metabolites, and significantly higher levels of nitrates and nitrites (Rembalkowska 2004). Also in vitro experiments have suggested that such contaminants may cause immunosuppression (Finamore et al. 2004) and pesticides were reported to perturb the homeostasis between pro- and anti-oxidant forces in the cell and this oxidative stress may be responsible for immune suppression (Olgun et al. 2004). On the other hand, organic crop production method, were described to result in higher mycotoxin loads, which may reduce growth rates and reproductive efficiency and increase mortality. However, consumption of low levels of fungal toxins may result in improved immunity (Bouhet et al. 2005). Despite the increasing interest in organic food production, there is a limited number of investigations which have studied the effect of organic food consumption on animal or human health or health related physiological factors (MacRae et al., 2005). The aim of this study was, therefore, to assess the effect of diets, based on crops grown in four different agronomical regimes on selected immune parameters of rats after twelve weeks of feeding.

## Materials and methods

Barley, potatoes, carrots and onions were produced in the Nafferton factorial systems comparison trials (NFSC) at the University of Newcastle's Nafferton Experimental Farm, Northumberland, UK in 2006. Conventional (pesticide based) crop protection protocols were applied according to the British Farm Assured standards, and organic

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(without pesticides) crop protection protocols were applied according to Soil Association organic farming standards. Under conventional fertility management mineral fertilizers are applied, and composted manure is used under organic fertility management. The combination of the two factors results in four factor combinations showed in experimental protocol (Table 1). Samples from all 4 production systems (four replicates, n=16) were dried at moderate temperature in order to keep their nutritive value. Rat compound feeds were produced based on these materials according to the nutritional recommendations for rat feeding trials. Analysis of the rat feed confirmed that there were significant composition differences in levels of key phytochemicals between treatments (see Wisniewska et al. 2008 in these proceedings). Rats used in this study were grown and reared as described previously (Baranska et al. 2006). Briefly, paternal males and females were fed experimental diets during the bred and pregnancy period (total 10 weeks). Six young males from each dietary group were left after weaning to be fed for subsequent 9 weeks (total 12 weeks) with one of four experimental diets and control standard feed for rodents (Labofeed, Andrzej Morawski Feed Production Plant, Kcynia near Bydgoszcz, Poland). Animals were kept under conditions of controlled light (12-h light/12-h dark cycle) and temperature (22–23 °C) with free access to water and food. After 12 weeks rats (F1) were anesthetized with Thiopental, blood was collected from heart and spleens isolated aseptically and used immediately for *in vitro* studies. All animal procedures were in accordance with the Guiding Principles for the Care and Use of Research Animals and had been approved by the First Warsaw Ethics Committee for Experiments on Animals.

**Tab. 1: Experimental protocol**

Exp. groups	Type of diet
OF-OP	organic fertility and crop protection management
OF-CP	organic fertility and conventional crop protection management
CF-OP	conventional fertility and organic crop protection management
CF-CP	conventional fertility and crop protection management
LF	control standard rodent's food – Labofeed

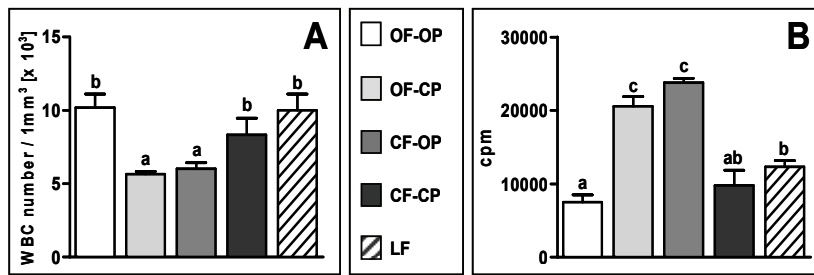
Hematological parameters (hematocrit value, RBC (red blood cells) number and hemoglobin content) and WBC (white blood cells) number were assayed using standard laboratory methods. Splenocyte cultures were prepared according to a method used previously in our laboratory for rat lymphocytes (Bik et al. 2006). Splenocyte proliferation *in vitro* was assessed by incorporation of 3H-thymidine in control (cells incubated with culture medium alone, spontaneous proliferation) and mitogen-stimulated cultures (Concanavalin A, ConA, for T-cells and Lipopolysaccharide, LPS, for B-cells) and expressed in counts per minute (cpm) as mean and as stimulation index (SI, ratio of cpm from stimulated to non-stimulated cultures  $\pm$  SEM). For statistical evaluation of differences between groups the one-way nonparametric ANOVA followed by the Student-Neuman-Keuls test was used. Results were considered statistically significant when  $p < 0.05$ .

## Results

In all hematological parameters of rats fed experimental diets were no significant differences (data not shown). The total white blood cell (WBC) number was significantly lower in animals raised on rat compound feeds made from crops produced in the two low-input systems (Fig. 1A). Spontaneous proliferation of

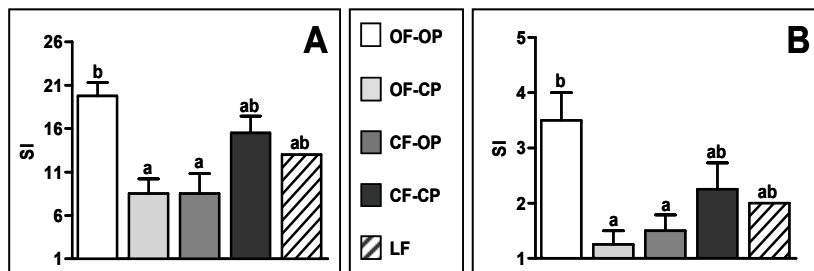


splenocytes in rats on the low-input (OF-CP and CF-OP) diets was much higher in comparison with rats in the other groups (Fig. 1B). The significant difference was found also between fully organic (OF-OP) and control (LF) dietary group (Fig. 1B).



**Figure 1: The effect of diet on WBC (A) and spontaneous splenocyte proliferation (B), expressed as mean  $\pm$ SEM, Different letters indicate a statistically significant difference at  $P < 0.05$  for a vs. b and  $P < 0.001$  for c vs. a and b in the Student-Neuman-Keuls tests**

Mitogen-stimulated proliferation of splenocytes was examined over wide concentration range of both T-cell (ConA) and B-cell (LPS) specific mitogens. The response was dose-dependent and the effect of only one concentration of particular mitogen is shown in Fig. 2. The ability of splenocytes to be stimulated by both T- and B- cell specific mitogens was diet-dependent and was significantly lower in splenocytes obtained from rats fed diets based on crops from 'low input' (OF-CP and CF-OP) systems compared to rats fed fully organic diet. The highest splenocyte proliferation was in OF-OP dietary group, but it did not differ significantly versus mitogen-stimulated proliferation neither from CF-CP nor the LF group (Fig. 2A and 2B). The pattern of mitogenic response in all dietary groups was similar after in vitro cell stimulation with LPS and ConA.



**Figure 2: The influence of diet on mitogen-stimulated (ConA 0.125 µg/well – A; LPS 2 µg/well – B) splenocyte proliferation expressed as the mean of Stimulation Index (SI). Different letters indicate a statistically significant difference at  $P < 0.01$  in the Student-Neuman-Keuls tests**

### Conclusions

This study was performed to detect potential effects of diets based on crops produced with or without synthetic pesticides and/or mineral fertilizers on the immune system of

rats. No effect of experimental diets on haematological parameters was found, thus confirming a previous study (Baranska et al. 2006). This suggests that there was no influence of feeds produced by different farming systems on the rats' basic health status after 12 weeks of feeding.

Changes in the WBC number, spontaneous and mitogen-stimulated proliferation appear to be induced by diets from products cultivated using one of two factors, i.e. low input cultivation systems. Both OF-CP and CF-OP diets increase spontaneous splenocyte proliferation in comparison to all other diet used, including organic diet. This might be induced by the over-stimulatory influence of these diets on immune cells. The suppression of stimulation by mitogens used might also suggest less efficient rat response to a possible immune challenge. In a previous study (Baranska et al. 2006) we found similar decreased response to mitogens only in OF-CP group, not seen in rats from the conventionally fed (CF-CP) group. We can conclude that different diets have the impact on the rat immunity, however the nature of these effects needs further investigation.

### Acknowledgments

This study was supported by the EU Commission under the FP6 Integrated project Quality Low Input Food (FOOD-CT-2003-506358).

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# Potential of X-Ray Spectrometry and Chemometrics to Discriminate Organic from Conventional Grown Agricultural Products

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Key words: food authenticity, principal component analysis, X-ray spectrometry.

## Abstract

*This work describes an innovative analytical method based on X-ray spectrometry combined with chemometrics which presents high potential to discriminate conventional from organic grown tomatoes and coffee beans. This novelty is based on the irradiation of samples in a bench-top EDXRF equipment provided with a Rh tube and further treatment of the spectral data using Principal Component Analysis (PCA). Multivariate analysis results showed a tendency in separating the samples according to the production mode (organic or conventional). Regarding the spectra obtained, the K-alpha peak of potassium showed to be the most responsible for discriminating different categories of samples. The chlorine K-alpha peak presented high capability in discriminating tomato and coffee samples from different origins. The method can be useful for food quality control to rapidly classify samples since the measurements can be done "in situ" with portable instruments. Nevertheless, it will be necessary to build robust classification models with a larger number of samples.*

## Introduction

The market of organic products increases every year. In 2005 it achieved a value of USD 37 billion, with most part of products consumed in North America and Europe (IFOAM, 2007). The consistent expansion of the organic agriculture results from the increasing concern among consumers about food quality attributes associated with the absence of chemical contaminants, negative environment impacts caused by the production system and use of bad labor practices (Fernandes et al., 2002; Fernandes et al., 2004). Considering that organic food reaches prices substantially higher than conventional food, unscrupulous producers and traders would feel encouraged to offer fake products in the market. On the other hand importers are facing several difficulties for the discrimination of organic and conventional products, mainly to detect and avoid frauds. Thus, it is clear the relevance of developing suitable analytical methods to classify samples (Santos et al., 2006).

In this study, coffee and tomato, two agricultural products highly dependent on synthetic fertilizers and pesticides when cultivated in the conventional system, were analysed by energy dispersive X-ray fluorescence (EDXRF) combined with chemometrics. EDXRF is a technique based on the photoelectric phenomenon that provides absorption/emission effects that generate energy spectra composed by specific energies, corresponding to elements present in the sample. The use of

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chemometrics allows analysing simultaneously all the energies detected as a variable of the model to be built.

The objective of this work was to evaluate the feasibility and potential of this analytical method and use of chemometrics for the discrimination of organic and conventional grown agricultural products.

## **Materials and methods**

### *Sampling and sample preparation*

Test samples were obtained directly in the crop fields. Coffee beans were collected in Santo Antonio do Amparo, Minas Gerais state, a pioneer region in the production of organic coffee in Brazil (Fernandes et al., 2002). Both conventional and organic plantations of the same variety were cultivated in similar soil and climate. The cherries were harvested and naturally dried in patios under sunlight and afterwards the outer skin and pulp were removed in a hulling machine. The coffee beans were then classified by size and sorted by density and color to remove defected ones. The resulting bulk material consisted of 4 batches: one conventional, one in transition from conventional to organic and two organics. For the tests, 5 samples of approximately 0.1 kg were taken from each batch and ground in a rotor mill reducing the particle sizes to < 0.5 mm.

Tomato samples of the hybrid AP 533 were collected in farms that adopt the organic and conventional cultivation systems, respectively located in Borborema and Novo Horizonte cities, São Paulo state, Brazil. The sampling was performed in areas of 2500 m<sup>2</sup> in both farms and twelve plants were randomly selected in each area. Four ripe fruits with average weight of 100 g were taken from each plant. The samples were transported to the Radioisotopes Laboratory (LRi/CENA/USP), Piracicaba, SP. The fruits were thoroughly washed with tap water followed by deionised water and cut in halves for removing seeds. They were frozen at minus 18°C for 24 hours and freeze-dried at minus 52°C and 0.1 atm for 5 days. Particle size was also reduced (< 0.5 mm) in a rotor mill.

Both organic coffee and tomato were produced in accordance with the guidelines from the Instituto Biodinâmico (IBD), an International Federation of Organic Agriculture Movements (IFOAM) accredited member, and the Associação de Agricultura Orgânica (AAO), a Brazilian affiliated of IFOAM.

### *EDXRF analysis*

For the trials, irradiation cells mounted with their bottoms having a 3 µm thick polymeric film (Mylar®) were completely filled with the ground samples. Two replicates for each sample were irradiated for 180 seconds under air atmosphere. Samples irradiations were performed using an EDXRF equipment, model EDX 700, Shimadzu (Kyoto, Japan), assembled with a rhodium X-ray tube and a Si(Li) detector, with resolution of 180 eV. The voltage in the tube was 50 kV, with an applied current of 100 mA and beam collimation of 10 mm.

### *Data Analysis*

To proceed with the chemometric analysis, matrices of independent variables were constructed in such a way that the columns refer to the spectrum energies with 2048 values (channels), whereas each line corresponds to one sample. The spectral data were mean centred and submitted to a moving average smoothing with a segment size equal 7. Afterwards the data were treated by Principal Component Analysis

(PCA), using The Unscrambler software, version 9.2, from Camo®. PCA results were validated by using the leave-one-out cross validation method, also named Full Cross validation method.

## Results

Figures 1 and 2 show the results obtained by applying PCA to coffee and tomato samples respectively. The score plots were constructed with the first and second principal components.

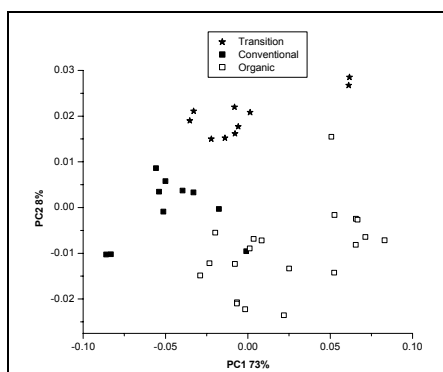


Figure 1: Scores plot obtained by applying PCA for all coffee X-ray spectra

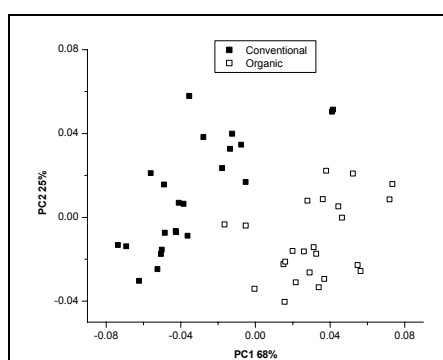


Figure 2: Scores plot obtained by applying PCA for organic and conventional tomato X-ray spectra

## Discussion

The PCA results in Figure 1 present a clear separation between the organic, conventional and in transition coffee samples. Regarding to PC1 axis it is possible to observe the separation tendency between organic and conventional coffee with 73% of total explained variance. The PC2 axis shows that the in transition samples are separated from the others with 8% of total explained variance. The results presented in Figure 2 show a clear separation between organic and conventional tomatoes. The PC1xPC2 scores plot accounted for 93% of total explained variance. Even though the tomatoes were produced in different farms and other factors may have contributed to the discrimination process, the method showed to be sensible to the variations resulting from different management systems. In both cases, analysing the loading results, it could be noted that the variables related to potassium K-peaks, element present in high concentrations in coffee and tomato samples, influenced strongly on sample grouping. Considering the tomato samples, the loadings results also indicated the strong influence of chlorine K-peaks on conventional and organic discrimination. This finding may be related to the regular use of KCl in the conventional crops, which adds substantial amounts of Cl in the system. For routine analyses, the proposed method is very promising to distinguish organic from conventional grown food. It is fast, non destructive and does not generate residues. As a further improvement, a larger number of samples must be analysed to provide a more robust classification model to be applied in routine quality control of organic/conventional grown food.

## Conclusions

EDXRF and multivariate statistical analysis indicated a good potential for the use of the method in discriminating organic from conventional grown food. The technique generates data in minutes, does not destroy the sample and can be carried out in portable equipments available on the market, allowing to analyse samples *in situ*. These advantages make it promising to be applied in routine quality control of organic products for the determination of authenticity. However, more studies are required in order to develop a robust model including a large number of samples from different locations.

## Acknowledgments

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# Authenticity tests of organic products (Golden Delicious and Elstar) applying sensory analysis

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Key words: sensory evaluation, quantitative descriptive analysis, apple quality

## Abstract

*In the governmental funded project BÖL-02OE170/F, apple samples from different farming systems (organic and conventional) were differentiated and classified by sensory evaluation. Samples from farm pairs derived from geographical neighbouring locations. Each farm pair consisted of one farm producing apples according to organic land use system and one producing conventionally. Factors of influence as growing conditions, climate, soil and harvest time were comparable within each pair. For sensory evaluation, a descriptive analysis panel was trained according ISO-standards of descriptive analysis. The quantitative descriptive analysis method (QDA) enables to show a complete product profile with all sensory characteristics of a product as well as their intensity. Over 2 crop periods (2004/2005), 18 apple samples (9 pairs) were evaluated by QDA method; 5 samples pairs of the variety "Golden Delicious" and 4 sample pairs of the variety "Elstar", each with 3 replicates and 6 apples per replicate. In the first crop year, descriptive analysis was done to develop product profiles of all samples. Based on these data, a classification model was developed to classify sensory characteristics of organic vs. conventional apple cultivation. According to this model, from 9 defined trial sample pairs, 8 sample pairs could be classified according to the farming system in the second year.*

## Introduction

Beside safety, freshness, general health benefits as well as nutritional value, one reason for consumers demanding organic foods is a tastier product. The results of the questionnaire conducted by Casutt and Guggenbuehl (2006) show that apples are consumed regularly (48% eat more than four apples a week) because consumers like them as a snack between meals and because they are refreshing. A number of studies comparing organic and conventional food have included sensory tests indicating that organic and conventional fruits and vegetables differ on a variety of sensory characteristics, but the findings are inconsistent (Roth et al, 2005, Homutova & Blazek 2006,). This is due to different sensory methods applied. The quantitative descriptive analysis method (QDA) is one of the most sophisticated tools in sensory science and allows - in opposition to preference or acceptance tests - objective descriptions of products in terms of the perceived sensory attributes. Depending on the specific technique used, the description shows a complete product profile with all sensory characteristics and their intensity in appearance, aroma, texture, mouthfeel and flavour attributes. Because without a classification model describing a quality profile with consistent product characteristics of organic versus conventional products, preference/ acceptability measures that reflect relative degrees of liking are difficult to

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interpret. Therefore the aim of the study is to develop a classification model for two different varieties of apples (Golden Delicious and Elstar) of different farming systems. The research project was funded by the German Government (Ministry of Food, Farming and Consumer protection BÖL-02OE170/F).

## Materials and Methods

Under the guidance of a panel leader, a panel group (10 – 12 persons) develops a scorecard with a list of attributes fully describing the product and developing definition for each attribute. At the same time a ranking of attributes of the product (apples) is done. At least the panellists learn to practice scoring along the intensity scale (0 to 9 resp. weak to strong). The panellists were trained to be able to communicate precisely without subjective descriptions and to work consistent and reproducible (Stone, Sidel 1993). Sensory evaluation was carried out during two consecutive years (from harvest 2004 and 2005). Two varieties of apple samples were tested, 5 sample pairs of variety "Golden Delicious" from defined field trial (FIBL Switzerland, F. Weibel) and 4 sample pairs of the variety "Elstar" (neighbouring farms, FAL Trenthorst). Each sample pair consisted of one sample derived from an organic producing system (according to Council Regulation [EEC] No. 834/2007 of the European Union) and one from a conventional farm. Harvest and climatic conditions were comparable. Training and evaluation were carried out according QDA-standards of Stone & Sidel (Stone, Sidel 1993).

The panellists were calibrated directly on the test samples. During data collection, panellists got at maximum of 6 product samples per session in a randomized design order (according to sensory evaluation software FIZZ, Biosystemes, France). The samples were served in booths, monadically (each panellists got the samples in different order). All data were quantified by ratings of perceived intensities, using an unstructured line scale with end-anchors and offset goal posts (e. g. from weak to strong). Experimental design was as follows:

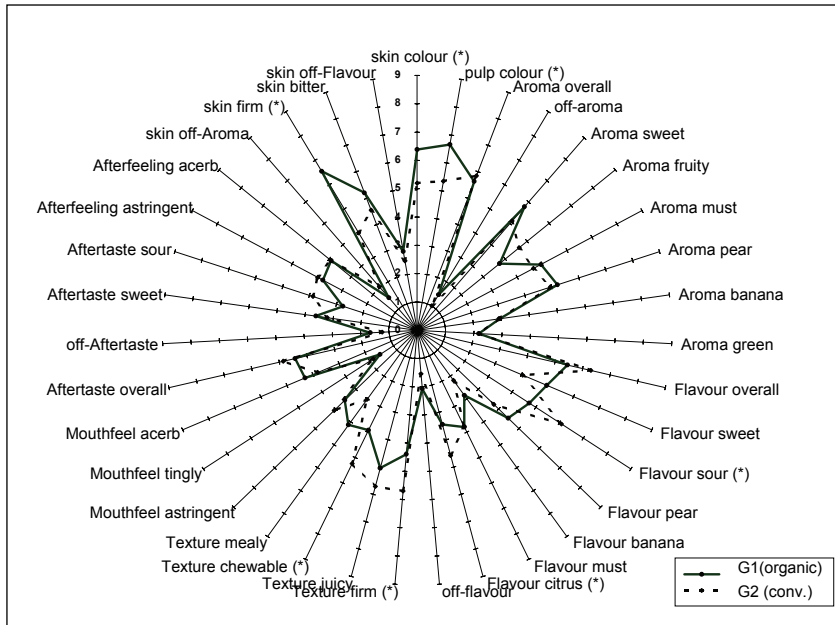
1. Factorial: each level of a factor is matched with each level of others,
2. Replicated: samples were evaluated 3 times,
3. Repeated measures: each panellist tasted each sample.

The experimental design yields a four-dimensional data matrix: panellist x attributes x samples x replicates. The data were analysed by "FIZZ" sensory software. Descriptive statistical measures were first calculated for all attributes using scores from panellists. Analysis of variance was performed on each attribute using a randomized block design for balanced data, with panellists as repeated measures. Where F-test indicated a significant difference between test treatments, differences was defined as  $P < 0,05$ . In addition, data of the quantitative descriptive analysis were also differentiated by classification and regression tree system (CART-system, Breimann et al 1984), which classified the sample pairs by statistic evaluation. This so called tree - system shows the relationship between one or more variables of influence (x variables) on a dependent variable (response variable =Y). The result of this statistical procedure is visualized as a tree (leafs are separated variables, branches are steps of differentiation. This tree can be used as a decision tree to look for key attributes or key parameters influencing the product quality.



## Results

Results of the descriptive quantitative analysis show a complete product profile of the evaluated apples (see figure 1 as an example). For multivariate variance analysis, the unstructured line scale is transferred into scores from 0 (no perceived intensity) to 9 (highest perceived intensity). The intensities given are results of all panellists and repetitions. By evaluating differences in the characteristic intensities, for classification into organic vs conventional samples, analogue differences in characteristic intensities were defined. Due to the comparison of both crop years for the variety Golden Delicious (from field trials in Switzerland), results show analogue characteristics of sweet and sour flavour in tendency, in year 2004 for 3 out of 5 sample pairs, in 2005 for 4 out of 5 sample pairs the organic sample was more sweet, the conventional had a more sour flavour. In crop year 2005 the conventional samples had a significantly higher intensity in firmness and juiciness of the pulp, which is seen only in tendency in crop year 2004. Most important for classification was the apple skin, which showed significant more firmness and thickness at all 5 organic samples in year 2005 and of 4 out of 5 samples in year 2004 (for Golden Delicious).



**Figure 1: Product profile of one sample pair (coded as organic/conventional), variety "Golden Delicious" (as an example)**

Also for the variety "Elstar" significant differences were found in firmness and thickness of the apple skin, the skin of the organic samples were more firm and thick in comparison of the conventional ones. The skin of the organic samples was also

more bitter in flavour. In other characteristics, no significant classification could be perceived, in tendency a higher intensity of firmness of the pulp in organic samples could be shown (see table 1). Results of classifying the sample pairs by CART-Systems confirm the differences of characteristics. Sample pairs could be separate clearly within the juice rate and firmness of apple skin.

**Tab. 1: Pulp and skin parameters of organic and conventional Elstar (2004, 2005)**

Year	2004				2005			
	conv.	organic	F-value	signif.	conv.	organic	F-value	sign.
Pulp colour	6,81	5,03	57,35	<0,0001	5,19	5,69	3,68	0,3841
Skin firmness	2,19	5,17	160,65	<0,0001	3,57	4,95	28,57	0,0081
Skin thickness	2,71	4,53	59,3	<0,0001	3	4,03	15,79	0,0365
Skin bitter	3,65	4,36	8,95	0,1665	3,67	4,81	19,6	0,0442

Results show that apple samples of organic vs. conventional farming systems and different varieties can be classified by quantitative descriptive analysis. The variety in this study was Macintosh. Our results show that a significantly higher firmness of the skin for organic samples can be observed in this controlled study for other varieties (Golden Delicious and Elstar), too. Beside that, the pulp of organic apples of both varieties was firmer compared to those of conventional ones. Homotova and Blazek (2006) state, that direct physical measurements and panellists' evaluation regarding the skin thickness show the same results. The bitterness of the skin, as observed in this investigation can be related to the higher amount of phenolic substances (Weibel et al, 1999). Furthermore, results of the CART-system support the differentiation between apples from organic and conventional farming systems. Measurements of human senses are able to evaluate precisely and reproducible results.

### Acknowledgements

The authors thank Dr. Nicolas Busscher (University of Kassel) and Statcom for providing the CART system as well as Prof. Dr. G. Rahmann (FAL-OEL) for coding and distributing the apple samples and the Ministry (BMELV) for financial support of the work (BÖL-02OE170/F).

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# Effect of wheat production system components on food preference in rats

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Key words: wheat, food preference, systems comparison

## Abstract

*In the study presented the effects of two major system components - fertility management and crop protection - were tested in a rat preference test for the first time. Wheat samples produced under 4 combinations of these management factors: - a) organic fertility and crop protection management, b) organic fertility management and conventional crop protection c) conventional fertility management and organic crop protection and d) conventional fertility management and crop protection - generated in the Nafferton factorial systems comparison (NFSC) trial at Newcastle University, were used as experimental diets. Results showed that the organically fertilised wheat was preferred by rats ( $P = 0.001$ ) while the organic crop protection resulted in reduced wheat consumption (not significant). This might indicate that the rats did not sense or did not select against possible traces of plant protection agents but responded more clearly to differences that were caused by the fertility management.*

## Introduction

There is extensive evidence that rats are able to sense toxicants and essential nutrients in their food and avoid foods that either contain toxins (Garcia et al., 1974) or are deficient in essential nutrients (e.g. Feurte et al., 2000; Rutkoski and Levenson, 2000). This ability was first employed by (Plochberger and Velimirov, 1992) to investigate nutritional differences between organically and conventionally produced foods. In several studies it was found that rats preferred organically produced foods (Mäder et al., 2007; Mäder et al., 1993; Plochberger and Velimirov, 1992; Velimirov, 2003, 2005). However, so far, it has been difficult to elucidate which components of these production systems (e.g. tillage, seed choice, fertility management, crop protection) or quality parameters in the food might influence this preference. In the present study we intend to elucidate the influence of two major management components, fertility management and crop protection, on the food preference in rats.

## Materials and methods

Wheat of the variety Malacca was produced in the Nafferton factorial systems comparison (NFSC) at the University of Newcastle's Nafferton Experimental Farm, Northumberland, UK. Conventional crop protection is applied according to the British Farm Assured standards, and organic crop protection according to Soil Association organic farming standards. Under conventional fertility management mineral fertilisers

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are applied, and composted manure is used under organic fertility management. The combination of the two factors results in four factor combinations: a) organic fertility and crop protection management, b) organic fertility management and conventional crop protection c) conventional fertility management and organic crop protection and d) conventional fertility management and crop protection. Wheat samples from these factor combinations were used in four replicates as experimental diets in the preference test (n=16). A total of 20 rats (male adults; Long Evans) were supplied standard rat food (conventional feed mixture T 779; Tagger Co., Graz, Austria) in order to prevent any deficiency symptoms. The feeding rack is divided by the water bottle into a right and left section, into which the two experimental diets were apportioned. The identity of the samples was unknown to the experimenter. The remaining feed was weighed every 24 hours. Position of the diet was swapped and new feed was supplied over a feeding period of four days. Each four-day-feeding period was carried out using 5 to 6 rats and was repeated four times. Between the different rats 6 possible pairs of the 4 different experimental diets (a-d) were compared four times in a fully randomised design. In addition, random replicates of pairs of the same experimental diet were included. The amount of experimental diet eaten from each of the two sections was analysed with a General Linear Model (GLM) and subsequent Tukey test using Minitab. The residuals were tested for normality and a transformation of the data was not found to be necessary.

## Results

When the consumption of individual samples was compared by GLM analysis it was shown that the organic fertility management significantly increased wheat consumption (Table 1) of individual samples ( $P=0.006$ ) while organic crop protection resulted in reduced wheat consumption (not significant,  $P= 0.286$ ). The interaction between fertility management and crop protection was significant ( $P=0.020$ ); consumption for both treatments under organic fertility management was similar but consumption of samples from conventional fertility management combined with organic crop protection was very low compared to the fully conventional treatment.

**Tab. 1: Effect of fertility management and crop protection on the amount of individual cereal samples consumed by rats ( $\text{g rat}^{-1} \text{day}^{-1}$ )**

Fertility Management	Health management		
	conventional	organic	mean
conventional	9.986	4.934	7.311
organic	10.634	12.545	11.590
mean	10.288	8.264	

The total amount of experimental diet consumed per day (sum of both samples in a comparison) increased with increasing proportion of cereal produced under organic fertility management (100%>50%>0%) in the feed offered to rats (Table 2). The intermediate combination with one of the foods organically fertilised is not significantly different from either both conventional or both organic. Total consumption was lower when one or both experimental diets were produced under organic crop protection. The GLM analysis comparing the total amount of cereal consumed (Table 2), showed that there was a nearly significant effect of the fertility management ( $P=0.051$ ) and the Tukey test confirmed significant differences, but the difference caused by the health management had no effect ( $P= 0.229$ ).

**Tab. 2: Effect of fertility management and crop protection on the total amount of cereal (both samples in a comparison) consumed by rats (g rat<sup>-1</sup> day<sup>-1</sup>)**

Fertility Management	Health management			mean
	both samples organic	one sample organic	no sample organic	
both samples organic	15.41	21.53	22.71	20.71a*
one sample organic	21.50	16.94	20.53	18.98ab
neither sample organic	11.03	18.38	19.30	16.13b
mean	16.81	18.45	20.49	

\* Significance in the Tukey test: different letters indicate a statistically significant difference, shared letter indicate no significant difference

A correlation analysis was carried out to relate the mean amount eaten from each of the 16 samples with a set of 14 quality parameters, 21 minerals, 12 indicators of wheat diseases and 16 defence related parameters. Significant correlations are summarized in Table 3. It seems that the rats preferred food with high P and K contents and low N and Cd contents. There was no correlation with different levels of contaminants such as chlormequat and mycotoxins. The experimental food uptake was also significantly correlated to a number of defence related compounds and disease severity indicators that were recorded prior to the harvest of the grain (correlations not shown).

**Tab. 3: Significant Pearson's product-moment correlations for the mean amount of rat feed eaten with wheat quality parameters of the grain**

Parameter	correlation coefficients	p-value
N (%)	-0.537	0.032
P (%)	0.576	0.020
K (%)	0.695	0.003
Ca (%)	-0.676	0.004
Cd (µg kg <sup>-1</sup> dry wt.)	-0.670	0.005

## Discussion

In general, previous food preference tests (Mäder et al., 2007; Mäder et al., 1993; Plochberger and Velimirov, 1992; Velimirov, 2003, 2005) comparing organic and conventional foods were confirmed. Consumption of the experimental diet was highest for the organically produced food. By considering the two management components it becomes clear that this was predominantly caused by the preference of the rat for organically fertilised wheat. This might indicate that the rats did not sense or did not select against possible traces of plant protection agents but responded more clearly to differences that were caused by the fertility management.

The high positive correlations with P and K and negative correlation with Cadmium suggest that the mineral composition might have contributed to the food preference in this experiment. This is possible because rats have been reported to select for food that contains needed minerals (e.g. Rutkoski and Levenson, 2000). However, it cannot be concluded that the mineral composition is responsible for the preference since the rat food varied in a multitude of (measured and unmeasured) parameters that might

have been co-correlated with the mineral composition and contributed to the preference.

The only indicator for plant health of wheat grain in the data set available, the content of *Fusarium* mycotoxins (all values were below MRL), was not correlated to food preference. However, strong, reproducible differences in the plant health between organic and conventional fertility management in the NFSC have been observed (Cooper et al., 2006). It seems possible that the health status of the plants caused a variation in the quality of the wheat grain that was detectable for the rats.

## Conclusions

Samples from the NFSC trial allowed the influence of fertility management and crop protection on preference of rats for organic food to be assessed. Findings emphasize the role of fertility management for producing food of a quality that was preferred by rats and in the organic production system in general. Based on these findings the test design has been improved and further quality parameters have been chosen for a repeat with samples of the 2007 harvest.

## Acknowledgments

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# Quality of organic feedstuffs grown in Trenthorst (Germany) – evaluated by Near Infrared Reflectance Spectroscopy

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Key words: feed quality, NIRS, chemical constituents, energy

## Abstract

*In the present study we address the development of a rapid technique –NIRS– for the evaluation of organically produced feedstuffs in Trenthorst (Germany). The exclusive use of organically produced animal feedstuffs is fixed in the EU-VO 2092/91 for the year 2011. The differences of the contents of crude nutrients between the data of conventionally and organically analysed feedstuffs, as well as the possible differences of the contents from year to year, point out that a satisfying calculation of feed rations needs an exact knowledge of the chemical constituents of the feed components used. Therefore, well-defined material from field trials of the experimental station of the Institute of Organic Farming in Trenthorst of the years 2002-2005 was used for the determination of the contents of crude nutrients and energy in different grain legumes and cereals. All samples were analysed by classical chemical methods and also scanned by NIRS. Predictions of crude protein, crude ash, ether extract, starch, sugar and energy contents for pigs and dairy cattle showed satisfactory accuracy. The correlation coefficients for crude protein, ether extract and starch were 0.98, respectively. Standard error of prediction was below 0.1 MJ ME (pig) kg<sup>-1</sup> DM and below 0.08 MJ NEL kg<sup>-1</sup> DM. The prediction accuracy for crude fiber, fiber fractions and AME<sub>N</sub> was poor. The prediction accuracy should be improved during further growing seasons.*

## Introduction

The exclusive use of organically produced animal feedstuffs is fixed in the EU-VO 2092/91 for the year 2011. But special approvals exist for the use of conventional feed components up to 2011. Nevertheless, all possibilities and resources should be used to evaluate feedstuffs for optimised feed rations to meet the recommendations of the German Society of Nutrition Physiology (GfE, 1999, 2001, 2006). The differences in the contents of crude nutrients from year to year, as well as the local differences of the contents, point out that a satisfying calculation of feed rations needs an exact knowledge of the contents of the feed compounds used.

Feed evaluation requires comprehensive and expensive analytical work. A strong demand for a fast and easy method to determine of the main ingredients exists. Therefore the potential of NIRS should be tested for predicting the chemical composition of organically grown grain legumes and cereals and also for predicting the energy values for dairy cattle, pig and poultry. In order to obtain robust NIRS calibrations, a large and variable set of samples is required with chemical composition determined by standardised methodologies.

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The present study addresses the development of calibration equations to predict the chemical constituents and energy values of organically grown feedstuffs at the experimental station of the Institute of Organic Farming in Trenthorst.

## Materials and methods

Over the past years (2002 to 2005), mixed cropping field trials with different grain legumes (blue and white lupines, peas, field beans) and cereals (barley, wheat, oat) were conducted at the experimental station of the Institute of Organic Farming in Trenthorst. In addition plot trials were carried out to test the cultivation ability of blue lupins. Samples from these trials were used for the investigations. At first samples were dried, purified and ground to 1mm. Afterwards the samples were analysed both by chemical analysis and by NIR-spectroscopy.

The chemical constituents of the feedstuffs were determined according to the methods of VDLUFA (1993). The energy values were calculated according to the formulas developed by the German Society of Nutrition Physiology as net-energy for lactation (NEL) for dairy cattle (GfE, 2001), as metabolizable energy for pigs (ME) (GfE, 2006) and as nitrogen-corrected apparent metabolizable energy ( $AME_N$ ) for poultry (GfE, 1999) using the data from chemical analysis.

NIRS analysis was carried out on the ground samples using the Fourier-Transform NIR spectrometer (NIRLab N-200, Fa. Büchi, Essen) in the spectral range from 1000 to 2500 nm with a step of 1 nm. Each sample was scanned three times and the spectra were averaged. Spectral data were exported to the NIRCal software (Fa. Büchi, Essen) and different mathematical pretreatments (derivation, smoothing) were performed. Calibration equations for crude nutrients and energy contents were calculated by partial least square regression (PLS) on about two-thirds of the samples ( $n=286$ ). The calibration equations were then validated on the remaining 125 samples. Calibration equations were evaluated in terms of standard error of calibration (SEE) and coefficient of determination ( $r_{cal}$ ), validation equations were evaluated in terms of standard error of prediction (SEP) and coefficient of determination ( $r_{val}$ ).

## Results and discussion

The statistics of NIRS calibration for chemical characteristics are listed in Table 1. The data set was split to predict the protein contents in a set containing the protein feedstuffs and another containing the cereals. The prediction accuracy for crude protein was satisfactory for both data sets, with SEP of 0.71 and 1.08 %, respectively. The coefficients of prediction were just as good for ether extract and crude ash. The strong absorption of fat in the NIR region is well known (Shenk et al., 1992). Therefore SEE and SEP for ether extract were low (0.32 and 0.34 %, respectively). Although the coefficient of determination for NIRS prediction of crude fiber was satisfactory, the SEE and SEP were high and the prediction accuracy was poor. The NDF and ADF prediction accuracy was fairly low, the SEE and SEP values were too high. To predict the starch content, the data set was split in the range of 30 %. NIRS prediction of starch showed high coefficients of determination in both data sets. The prediction accuracy of starch (SEP = 1.33 and 1.38 %, respectively) was very good and is comparable to results from Xiccato et al. (2003) with SEP of 1.6 %. The sugar calibration was satisfactory with a SEP of 0.74 %.

NIRS prediction of ME concentration showed satisfactory results, the SEE and SEP were low (0.09 and 0.1, respectively). NEL concentration in feedstuffs was very well



predicted (SEE = 0.08, SEP = 0.08 MJ kg<sup>-1</sup> DM). Simply the prediction accuracy for AME<sub>N</sub> was poor. The SEE and SEP were high with 0.69 and 0.65 MJ kg<sup>-1</sup> DM, respectively. Similarly poor results for AME<sub>N</sub> prediction were reported by Valdes and Lesson (1992) with SEE of 0.4 MJ kg<sup>-1</sup> DM. An explanation for the different prediction accuracy among the energy values could not currently be found. Amazingly, the prediction of energy values containing nutritive values (ME and NEL) were successful in contrast to AME<sub>N</sub> even though the prediction is more complex because animal response to feeding is involved.

**Tab. 1: Standard errors of calibration (SEE) and validation (SEP) and coefficients of determination in calibration (r<sub>cal</sub>) and validation (r<sub>val</sub>) obtained by PLS to predict the chemical composition and energy contents in organically grown feedstuffs**

Crude nutrients (% DM) and energy contents	Range (%)	Calibration		Validation	
		SEE	r <sub>cal</sub>	SEP	r <sub>val</sub>
Crude protein (low)	5.6-19.1	0.68	0.98	0.71	0.98
Crude protein (high)	19.4-46.7	1.09	0.98	1.08	0.98
Ether extract	1.4-13.7	0.32	0.99	0.34	0.99
Crude ash	1.7-10.8	0.47	0.94	0.50	0.94
Crude fiber	2.5-39.7	1.93	0.97	1.93	0.96
NDF	12.9-70.5	3.14	0.98	3.33	0.98
ADF	3.5-50.6	2.61	0.96	2.60	0.96
Starch (high)	29.5-70.3	1.18	0.99	1.33	0.98
Starch (low)	3.7-27.6	1.40	0.96	1.38	0.96
Sugar	1.8-15.2	0.68	0.96	0.74	0.95
ME (MJ kg <sup>-1</sup> DM)	15.26- 16.55	0.09	0.93	0.10	0.90
NEL (MJ kg <sup>-1</sup> DM)	8.16-9.66	0.08	0.95	0.08	0.95
AME <sub>N</sub> (MJ kg <sup>-1</sup> DM)	8.86-15.27	0.69	0.92	0.65	0.92

ADF = acid detergent fiber, NDF= neutral detergent fiber

## Conclusions

NIRS showed good reliability in the prediction of most chemical constituents and energy values of organically grown grain legumes and cereals in Trenthorst. This was particularly true for crude protein and ether extract, whereas the prediction of fiber and fiber fractions was less satisfying, partly due to the low reproducibility of the reference methods. NIRS analyses permitted the prediction of the energy concentrations of organically grown feedstuffs for pigs and dairy cattle. The prediction accuracy, especially for the fiber fractions and AME<sub>N</sub>, should be improved during further seasons. Further studies are necessary to validate the obtained calibration equations with independent samples from other locations.

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# Application of standardised biocrystallization on milk and butter samples

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Key words: organic food, biocrystallization, milk, butter

## Abstract

*Milk and butter samples from different feeding regimes were tested with standardised biocrystallization method. When computerized texture analysis is applied, milk and butter samples from different feeding regimes can be differentiated as statistical significant.*

## Introduction

The biocrystallization method has been used on animal products like milk (Merten et al., 1958). The sample is transferred to a watery phase and placed on a glass dish for crystallization with an inorganic salt ( $\text{CuCl}_2$ ). Patterns then emerge that can be evaluated with a texture analysis developed for this purpose (Andersen et al., 1999; Meelursarn, 2007). The method was able to differentiate successfully samples from different treatment (Busscher et al., 2007). The present study is intended to show that biocrystallization can also be used for milk and milk products. The samples are derived within EU-QLIF WP5.3.

## Materials and methods

**Samples:** For the pre-trials according the characterization of the biocrystallization, method milk and butter samples were purchased from the local market. Blinded milk and butter samples for the tests were from cow-herds with different feeding regimes and derived from Agroscope Liebefeld-Posieux Research Station ALP (Switzerland) directly via ground mail in spring and fall 2006. The milk samples were fresh, stabilized with Bronopol as well as frozen. The butter samples were produced at the pilot plant of ALP in May and September 2006. UFA/CLA enriched butter was obtained from Holstein cows (n=10) fed with pasture and sunflower seeds during 2 weeks. Control cows (n =10) were fed a conventional diet, composed of pasture and corn silage. The raw milk was collected separately from the two groups. The objectives of this part of the case study was the analysis of shelf life and the differentiation of milk and butter samples deriving from different diets of the cows within EU-QLIF-project. In fall 2006, the samples were stored with 4-6 °C as well as -18 °C for 8 weeks in addition and crystallized in week 1, 2, 4, 6 and 8. **Sample preparation milk:** After the sample tubes (200 mL) are moved gently in a circular, horizontal manner, 50 mL of the milk sample is transferred into a 100 mL Erlenmeyer-flask. The flask is left to stand for 30 min in a water bath (the frozen sample 90 min). After reaching 20 °C, milli-Q water and 10 %  $\text{CuCl}_2$  solution are added until the desired mixing ratio milk/ $\text{CuCl}_2$  is reached (30 min, Heidolph Unimax 2010, 100 rpm). Per dish 200 mg milk and 150 mg  $\text{CuCl}_2$  is used (volume 6 mL). 2 dishes were

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crystallized per each of the 2-3 sample repetitions in 2 chambers in parallel at 2 different days. For the evaluation all images from each sample were used.

Sample preparation butter: Because no biocrystallization procedure for butter samples existed, a method had to be developed. 100 g of a butter sample is transferred into a 250 mL Erlenmeyer-flask and 100 mL milli-Q water (Millipore) is added at 50 °C. The extraction takes place in a water bath at 50 °C on a Heidolph shaker (Unimax 2010, 175 rpm). The mixture is transferred into a separation funnel for separating the two phases. The watery phase is placed into a laboratory centrifuge (Universal 32R, supplier: Hettich/D) at 4.000 rpm for 10 min and after centrifugation a 10 % CuCl<sub>2</sub> solution is added until the desired mixing ratio butter/CuCl<sub>2</sub> is reached (30 min, 100 rpm, Heidolph UniMax 2010). Per dish 700 mg butter and 75 mg CuCl<sub>2</sub> is used (volume 6 mL). 6 dishes were crystallized per each sample repetition in 2 chambers in parallel at 2 different days. For the evaluation all images from each sample were used. Testing the influence of different mixing ratios on the pattern, commercial butter samples are crystallized with 16 different mixing ratios. For the test to determine the effect of different temperatures during extraction, butter samples from ALP were extracted at different temperatures (water bath). For every sample run a wheat standard is applied (Busscher et al., 2008). Construction and function of the crystallization chambers used here are documented in Busscher et al., (2008). To evaluate the patterns a texture analysis is applied. Here variables are applied by plotting them relative to circular regions of interest (ROIs) 20-100 %. This plotting is also done for the results of the statistical evaluation (F- and p-values). Only those variables are considered which show a monotonous course with ROI. The image analysis results are presented using one region of interest of the picture (ROI = 90 %), but they have also been calculated for interim stages. The variable *diagonal moment* was chosen, because of the best repeatability. The statistical evaluation has been carried out by means of a "linear-mixed-effects" model Programme R (Meelursam, 2007).

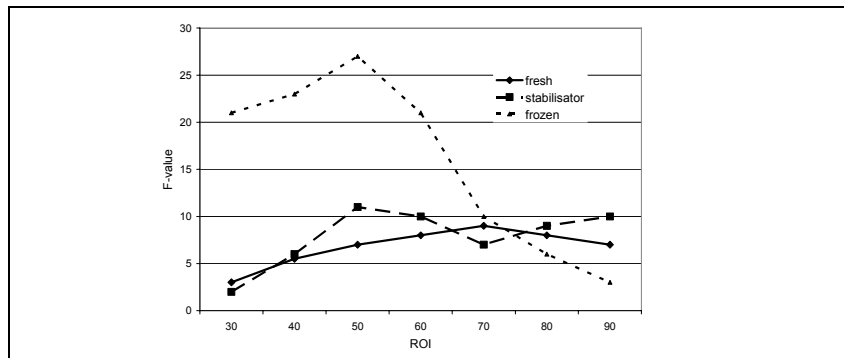
## Results

When the described procedures were applied, milk and butter samples could be crystallized (Figure 1). Freezing the milk samples influences the pattern, which can be evaluated by the texture variables as statistical significant (*diagonal moment*,  $p < 0.05$ ) in spring 2006. The effect depends on the ROI. The effect was still measurable but not significant when the samples were sent around in fall 2006. When the 2 milk samples (coded as A, B; B=control) from the different feeding regimes from spring 2006 were crystallized, the pattern show significant differences ( $p < 0.05$ ) for *diagonal moment* and ROI > 40 %, independent from the treatment. Because sample B was influenced stronger from the freezing process than A, the difference between both milk samples from different feeding regimes increases when the samples were frozen (Figure 2). When the 2 samples were sent around in fall, the texture analysis variables could not show a significant difference between the feeding regimes, except when the sample were stabilized with Bronopol. Here the difference is significant for ROI > 70% ( $p_{\text{diagonal moment}} < 0.05$ ). The butter patterns were influenced by different temperatures during extraction. *Diagonal moment* increases with higher temperatures. The increase depends on ROI and on the feeding regime. Furthermore the butter patterns are influenced by different amounts of sample per dish. *Diagonal moment* increases with higher amounts of sample. The increase does not depend on ROI. The differences between the samples is significant when comparing 600, 700 and 800 mg of the

sample per plate ( $p < 0.05$ , ROI 60). The influence of the mixing ratio on the patterns is stronger for the control than for the treatment in the range between 400-1600 mg



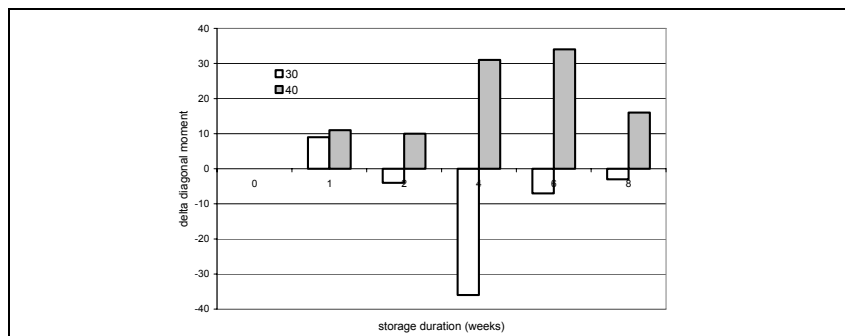
**Figure 1: Crystal pattern from milk sample (left) A fresh, sent in spring 2006 (5-B2006.05.22.K-J-05-2006.05.26 11.57.cut.tif and from butter sample (right) Nr. 12, sent in spring 2006 (11-B2006.06.27.K-Q-11-2006.07.04 10.12.cut.tif)**



**Figure 2: F-Values (I-me ANOVA) for the difference between milk samples A and B from spring 2006 according to different sample treatments during transport for variable *diagonal moment* and different ROIs**

When the two different butter samples were crystallized with 3 times sample preparation repetition and 3 dishes per sample preparation per chamber in two chambers in parallel on two different days (maximum variation), the difference between the two feeding regimes is significant ( $p_{\text{diagonal moment}} < 0.001$ ,  $30 < \text{ROI} < 70$ ). When the samples of the different feeding regimes were sent around in fall 2006, the difference is also significant ( $p_{\text{diagonal moment}} < 0.05$ ,  $30 < \text{ROI} < 70$ ). When the two butter samples from the different feeding regimes were stored for 8 weeks at 4-6 °C, a significant change in the patterns of both samples can be observed (Figure 3). When the frozen standard is taken as a reference, the storage influences the patterns from sample of milk of cows fed a conventional diet more compared to the other sample. After 8 weeks of storage the patterns from the control sample stored at 4-6°C showed a significant difference to those stored as reference material at -18 °C ( $p_{\text{diagonal moment}} <$

0,0001,  $30 < ROI < 70$ ). The difference between the samples can still be detected as significant ( $p_{\text{diagonal moment}} < 0.05$ ) independent from ROI.



**Figure 3: Difference between butter samples stored at 4-6 °C and -18 °C (as standard) for sample 30 (treatment) and 40 (control) (fall 2006, diagonal moment, ROI 60).**

### Conclusions

The standardised biocrystallization method can be applied on milk and butter samples. Samples from different feeding regimes as well as storage duration (shelf-life) can be differentiated as statistical significant.

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# Authentication of organic wheat samples from a long-term trial using biocrystallization

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Key words: authentication, organic food, biocrystallization, wheat

## Abstract

*Organic and conventional wheat grain samples from a long-term field trial were tested with standardised biocrystallization method. In 1999-2006 the organic samples can be separated from the conventional samples using computerized texture analysis and standardised visual evaluation of the crystallization patterns. Moreover the organic samples can be classified in 2005-2006 after training in 2003.*

## Introduction

The market for organic food is growing. The further growth of the market depends on whether the consumer still places a higher value on the quality of organic produce than on that of traditional produce. It is thus a question of the exposure given to these foodstuffs and how authentic they are. Studies indicate that holistic methods, such as biocrystallization, are especially suitable for authenticity tests of organic produce, hence a validation of the methods has been demanded (Siderer et al. 2005). Reproducible crystallization patterns emerge when a watery dihydrate cupric chloride (CuCl<sub>2</sub>) solution with plant extract is crystallized on a glass dish. The emerging patterns are characteristic of sample material. It is a two step process: first, the preparation of the samples in the laboratory with subsequent evaporation and crystallization in close climate chambers (Kahl, 2007); second, the evaluation of the patterns (Andersen et al., 1999). The process of pattern formation has so far not been elucidated. Earlier studies hitherto indicate that, in particular, physical-chemical processes affect the pattern formation during the evaporation. The validation process and scope have been described for biocrystallization (Kahl, 2007) and a suitable statistical model was developed (Meelursarn, 2007). The DOC-trial has been conducted continuously since 1978 (Mäder et al., 2007). The experiment uses a field plot design where different conventional and organic farming systems with identical crop varieties are run together in order to eliminate variation in climatic conditions and soil types. Wheat grain samples from this long-term field trial provide an excellent basis for authentication of organic crop samples.

## Materials and methods

Samples: Wheat grains (*Triticum aestivum* L., cv. 'Tamaro' (in 1999 and 2002), 'Titlis' (in 2003 and 2005), 'Runal' (in 2006)) were harvested in 1999, 2002, 2003, 2005, 2006 from the DOC field trial conducted near Basel, Switzerland (Mäder et al., 2007). Material was used from two organic farming systems defined as bio-dynamic (D2) and bio-organic (O2) and two conventional systems, one with mineral fertilizer plus

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farmyard manure (K2) and the other with mineral fertiliser only (M). Additionally, wheat grains from plots without fertilization (N) were included. Samples were taken from an independent source, divided, coded and delivered to the laboratory. The decoding took place after submission of the results.

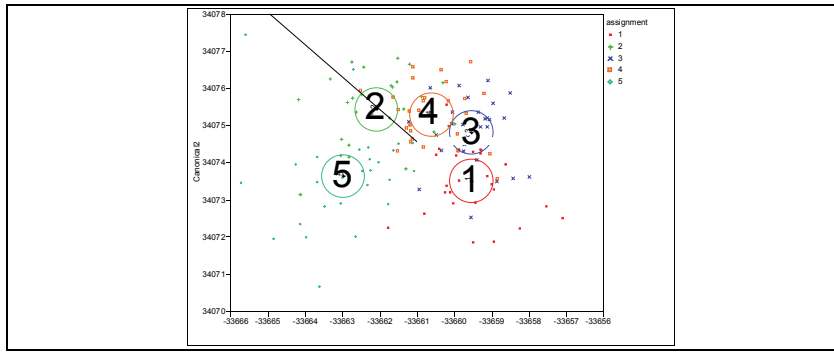
**Biocrystallization procedure:** In 1999-2003 bulk samples of the four field replicates were crystallized and 2005-2006 the four field replicates separately. The sample preparation was repeated 2-3 times per sample (sub-samples) and is described in Kahl (2007). For every chamber run a wheat standard is applied (Busscher et al. 2008). The crystallization solution is prepared by mixing the filtered wheat extract with a 10 % CuCl<sub>2</sub> solution to a final concentration of 90 mg CuCl<sub>2</sub> and 90 (70) mg extract (denoted as 90/90 and 70/90 respectively) per dish (volume is 6.0mL). Construction and function of the crystallization chambers used here are documented in Busscher et al. (2008). 3-6 dishes of each sample preparation (chamber solution) per chamber are crystallized in parallel. Because both chambers are used in parallel for all samples described here, the result is a dish repetition of 6-12 dishes per sample preparation and thus at least 12-24 dishes per sample. For the evaluation of the trials all dishes per sample are grouped together.

To evaluate the patterns the texture analysis developed by Andersen et al. (1999) is used. Only variables of a second order (because of histogram matching) on Scale 1 are considered. The variables are described in Carstensen (1992, ref. in Andersen et al. 1999). Here 15 variables are applied by plotting them relative to circular regions of interest (ROIs) 20-100 %. This plotting is also done for the results of the statistical evaluation (F- and p-values). Only those variables are considered which show a monotonous course with ROI. The image analysis results are presented using one region of interest of the picture (ROI = 90 %), but they have also been calculated for interim stages. For detailed description ref. Meelursarn, 2007. The Linear Discriminant Analysis (LDA) was performed in JMP applying all 15 different variables of the texture analysis. In addition to the texture analysis the patterns were visually evaluated in that all patterns from the samples prepared on one day and in one chamber were placed in parallel with increasing evaporation time (which is recorded with a camera during evaporation) on a light box and evaluated by trained people (for detailed description ref. Kretschmer, 2003, Kahl, 2007).

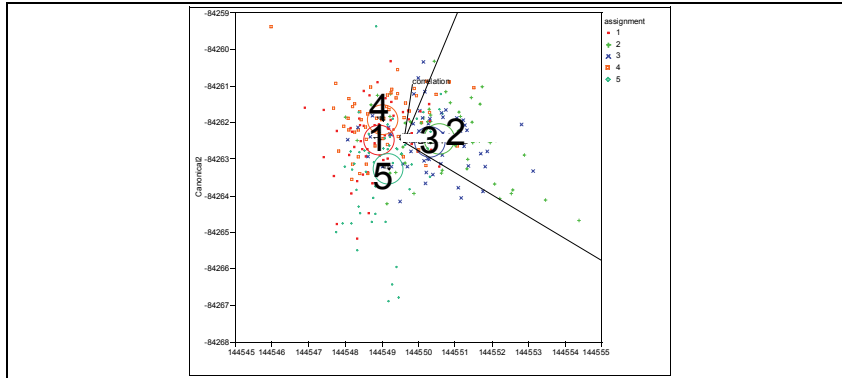
## Results

When the patterns from the harvest 1999 were analysed with texture analysis followed by LDA, all samples can be separated, while the two organic and the one conventional with mineral fertilizer plus farmyard manure (K2) are near together (Figure 1). The misclassification is 32%, when all five samples are taken separately. In 2002 the five samples can be grouped into three classes (results not shown). After decoding the three classes are the two organic and the two conventional, whereas the control represents its own class. The results of the statistical evaluation on the basis of the single variables show that there is a significant effect ( $p < 0.05$ ). In 2003 the two organic and the two conventional are grouped, whereas the control belongs to the samples grown conventionally (Figure 2). When the two conventional and the two organic were grouped, the misclassification is 21%. The results of the statistical evaluation on the basis of a single variable reflect the results derived with the LDA and show that there is a significant effect ( $p < 0.05$ ). The samples from harvest 2005 and 2006 were evaluated both with computerized texture analysis as well as visual evaluation. Based on single texture variable calculation the organic samples can be differentiated from the conventional samples as statistically significant ( $p < 0.05$ ).





**Figure 1: Canonical plot (LDA) using variables of the biocrystallization texture analysis for five blinded samples of the DOC-trial, harvest 1999 (1: O2; 2: M; 3: D2; 4: K2; 5: N). X- and y-axis are the canonicals 1 and 2 of the LDA.**



**Figure 2: Canonical plot (LDA) using variables of the biocrystallization texture analysis for five blinded samples of the DOC-trial, harvest 2003 (1: K2; 2: O2; 3: D2; 4: M; 5: N). X- and y-axis are the canonicals 1 and 2 of the LDA.**

When the visual evaluation was trained on the patterns received from the samples from 2003 and applied on the samples from 2005 and 2006 the classification of the organic samples where 100% correct in both years (Table 1).

**Tab. 1: Classification of the five samples from DOC-trial with visual evaluation of the biocrystallization patterns (field replicates tested)**

	N	D2	O2	K2	M
2005	N	D2	O2	K2	M
2006	N	D2	O2	M	K2

## Discussion

The organic and the conventional wheat samples from the DOC-trial can be differentiated using standardised biocrystallization with computerized texture analysis. Moreover the samples from 2005 and 2006 can be classified by visual evaluation. In 1999-2003 bulk samples were crystallized which allows to improve the method ability for differentiation of samples only. The results from the field replicate measurements in 2005 and 2006 show that the method is able to differentiate and classify samples according to the treatment (farming systems). To what degree each of the evaluation tools can be applied separately or in combination has to be tested in further investigations. The method variation is still too high for being applied in routine analysis, here the crystallization step has to be optimized.

## Conclusions

The standardised biocrystallization method can separate and classify defined organic wheat samples from conventional ones (long-term field trial). Texture analysis and visual evaluation of the patterns were applied in parallel. For routine analysis the method has to be optimised and samples from the praxis have to be tested.

## Acknowledgments

JK and NB thank B. Kulig, Statcon, Witzenhausen/D for the LDA calculation and Prof. Dr. G. Rahmann, FAL-OEL/D for the organisation of the samples and the Software AG Stiftung/D as well as the BMVEL/D for financial support. Machteld Huber and Paul Doesburg from LBI/NL and Jens-Otto Andersen from BRAD/DK for excellent cooperation within the Triangle-network (specially the development of the visual evaluation tools).

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# Organic wheat quality from a defined Italian field-trial

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Key words: organic wheat, quality, lutein, total protein, biocrystallization

## Abstract

*Organic and conventional wheat grain (Triticum aestivum and Triticum durum) samples coming from a defined field trial in Italy were measured in 2005 and 2006 for their total protein content and the contents of lutein and zeaxanthin. Additionally the samples were analyzed by means of the biocrystallization method. The grain samples could be differentiated by the total protein content, which was higher in the conventional samples. The organic samples contained a higher lutein content in Triticum aestivum but lower in Triticum durum. Biocrystallization differentiated Triticum durum from Triticum aestivum and organic from conventional grown samples when visual evaluation was applied. Differentiation of farming systems was possible for biocrystallization evaluated with computerized texture analysis but not significant for all samples and years.*

## Introduction

The growth of the organic food market is causing a growing interest in investigations on products deriving from differently managed farming systems. In such comparison studies it is of particular importance to use a possibly wide range of analysis methods, because the quality differences due to the farming system can appear in crops in various forms – in the contents of singular compounds, as well as in the structural features, which can be analyzed on the whole product only. In our research we have united therefore common chemical methods and holistic methods of analysis, so as to receive complementary information about the given samples. The aim of our experiment was to differentiate the organically and conventionally grown grain samples. The samples derived from the Mediterranean Arable System COmparison Trial (MASCOT) in Italian Toscana, a long-term experiment started in 2001 and carried out at the Interdepartmental Centre for Agri-environmental Research "E. Avanzi" (CIRAA) of the University of Pisa. The choice of the applied analysis methods was based on the findings in the available literature. The content of carotenoids, which belong to the secondary plant metabolites, was found to differ in organic and conventional crops because of the different growth conditions, like exposure to pests and diseases (Roose, 2008). Many studies were conducted on the antioxidants contents present in different wheat varieties (Roose, 2008). But to our knowledge there is still limited literature on the contents of antioxidants in wheat samples deriving from differently managed farming systems. Studies indicate that holistic methods, such as biocrystallization, are especially suitable for authenticity tests of organic produce, hence a validation of the methods has been demanded.

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## Materials and methods

Samples: Organic and conventional *Triticum aestivum* L. (variety 'Bolero') and *Triticum durum* L. (variety 'Claudio') wheat samples in three field replicates (in total 12 samples per year), harvest 2005 and 2006, coming from the MASCOT-trial (Bärberi et al., 2006) were analyzed by means of common chemical analysis for the content of total protein, secondary plant metabolites (lutein and zeaxanthin), and by means of the biocrystallization method for the picture forming properties. The aim of the experiment was the differentiation of the coded wheat samples. The experiment was performed in the laboratories of the University of Pisa and the University of Kassel. The fertilizer rates for the conventional system were the following ones: for *T. aestivum* 156 N, 92 P<sub>2</sub>O<sub>5</sub>, and 30 K<sub>2</sub>O kg ha<sup>-1</sup> and for *T. durum* 156 N, 92 P<sub>2</sub>O<sub>5</sub>, and 0 K<sub>2</sub>O kg ha<sup>-1</sup> on mineral basis and for the organic system: 30 N, 30 P<sub>2</sub>O<sub>5</sub>, and 30 K<sub>2</sub>O kg ha<sup>-1</sup> for both *T. durum* and *T. aestivum*. The fertilizer applied for the organic system was on organic basis, from dried manure; the amount of nitrogen available after clover was estimated 70 kg ha<sup>-1</sup>. Total protein: The total protein levels were determined using the procedure of Kjeldahl (EN ISO 3188, 1994). Factor 5.75 was applied to calculate protein content. The statistical analysis was the one way ANOVA for randomized blocks performed by use of the CoStat software (CoHort, 2006). Xanthophylls: Lutein and zeaxanthin were prepared as described in Roose (2008) by extraction with Methanol/THF followed by HPLC-separation and DAD-detection. Biocrystallization procedure: The sample material was crystallized in Italy and Germany in parallel. The experimental conditions at the University of Pisa are described in Mazzoncini (2005). The mixing ratio was 70mg substance based on 10% watery extract in combination with 90mg dihydrate CuCl<sub>2</sub> per plate. The resulting pictures were scanned and analyzed by means of the *Image J* computer software for the gray level distribution (Reinking, 2007). The mean values of the gray level distribution were measured within 10 ROI's (regions of interest) of circular shape, with the centers placed in the geometrical center of the picture, and diameters of different length. The diameter of ROI 10 was equal with the picture's diameter, whereas the diameters of ROI 9 to 1 were equal with 90 to 10% of ROI's 10 diameter. The visual evaluation of the patterns from harvest 2005 was carried out at the University of Kassel (Kahl, 2007). The sample preparation at the University of Kassel is described in Kahl (2007). For every sample run a wheat standard is applied (Kahl, 2007). Construction and function of the crystallization chambers used here are documented in Kahl (2007). To evaluate the patterns a texture analysis *acia* is used, where the variables of the second order are used (Kahl, 2007; in contrast to *Image J*). In addition to the texture analysis the patterns were visually evaluated in that all patterns from the samples prepared on one day and in one chamber were placed in parallel with increasing evaporation time (which was recorded by camera) on a light box and evaluated by trained people (Kahl, 2007).

## Results and discussion

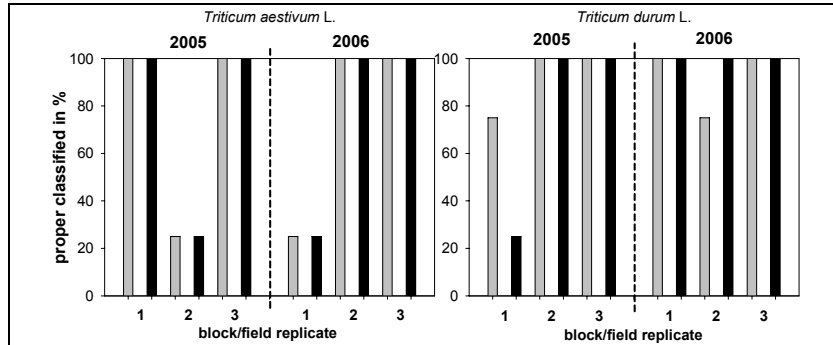
In both examined years the grains of both species differed significantly in their protein contents depending on the cultivation system (Table 1). The protein content of the organically grown grains was 2-3% lower than in conventionally grown grains. In year 2006 the protein contents of both varieties and cultivation systems were slightly higher, than in year 2005. The differences in lutein content were very small. For *Triticum aestivum* the lutein content of the organic grains was significantly higher in both years. For *Triticum durum* the lutein content was lower in the organic samples, but only for the samples of the year 2005.

In both years there was a significant higher content of zeaxanthin in the conventional varieties of *T. durum*, but no difference for *T. aestivum*.

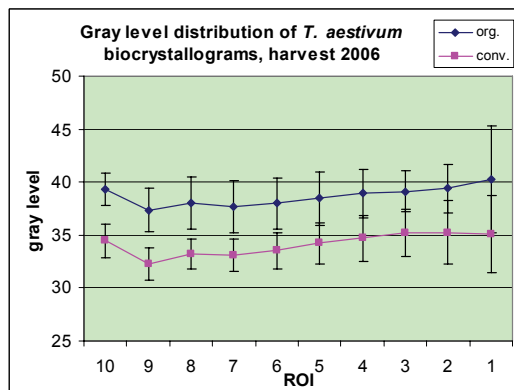
**Tab. 1: Protein content of the wheat samples from MASCOT-trial**

Protein content [%]				
	Harvest 2005		Harvest 2006	
	Organic	Conventional	Organic	Conventional
<i>T. aestivum</i>	8,54	11,84	10,10	12,28
significance	***		***	
<i>T. durum</i>	8,15	10,87	8,88	12,47
significance	***		***	

\* significance at  $\alpha=0,05$  based on one way ANOVA for randomized blocks.



**Figure 1: Classification of the MASCOT wheat samples according to the farming system (organic: gray/conventional: black). The bars are showing the percentage of proper classified sample replicates per field replicate/block.**



**Figure 2: Mean values of the gray levels calculated by Image J for the biocrystallization patterns measured at Pisa/I from MASCOT *Triticum aestivum* wheat samples (ROI: Region of Interest) in 2006 (3 patterns per field replicate).**

The variation of the lutein content in *T. durum* was higher for the conventional samples than for the organic. There was no consistent differentiation between the farming systems for both lutein and zeaxanthin. For *T. aestivum* 70% of the samples can be classified correctly, for *T. durum* 80% (Figure 1). When the biocrystallization patterns from the harvest 2005 were evaluated by applying an adapted triangular-test, the difference between org. and conv. samples was significant for both, *T. aestivum* and *T. durum*. With computerized texture analysis based on the gray level distribution (*Image J*) a significant differentiation was possible for all samples and years for ROI 8, 7 and 6 (Figure 2). With the texture analysis based on second order statistics, there was a significant difference between *T. durum* and *T. aestivum* but the difference between the farming systems was not significant over all samples and years. When the patterns of the biocrystallization at the University of Kassel were visually evaluated by trained people (descriptive test), the farming systems could be differentiated and correctly classified in both years for all samples.

## Conclusions

The introduction of holistic methods into our comparison study on organic and conventional wheat samples showed that differences due to different farming systems can be found applying both: common and holistic methods of analyse. The organic and the conventional wheat samples from the MASCOT-trial could be differentiated by total protein measurements and visual evaluation of standardised biocrystallization patterns. The difference could also be described applying different computerized image analysis programs on the biocrystallization patterns, although the difference was not always significant. Evaluation of lutein contents resulted in correct classification of the samples of 70-80%. The variation between the field replicates was higher than between the farming systems and moreover there seemed to be an opposite effect comparing lutein contents of *T. aestivum* and *T. durum*. The biocrystallization needs further development and validation when texture analysis with *Image J* and visual descriptive tests are applied.

## Acknowledgements

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# Organic beef production by Maremmana breed: qualitative meat characteristics

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Key words: Maremmana breed, Organic beef, meat quality

## Abstract

*Meat quality of Maremmana young bulls and steers was evaluated during three consecutive years, according to an extension service experimental program. Cooking loss values of meat samples were lower in meat from steers, whereas shear force values were higher. Meat from steers was darker than meat from young bulls, as a consequence of a low level of Lightness and a high level of Chroma. Meat chemical composition showed a higher content of intramuscular fat in steer meat, which showed also a lower level of saturated fatty acids and a higher level of unsaturated fatty acids. Conjugated linoleic acid content in meat fat either from young bulls or from steers was similar to that found in meat from confined cattle fed preserved forages and concentrates. However steer meat showed higher CLA content than young bull meat.*

## Introduction

As a consequence of the growing demand from consumers of foods with high quality standards (with particular emphasis to the interactions between human health and food nutritional properties), in the last years, research has been focused on the relationships between organic production system and quality traits of products. In beef production, EU organic rules may easier applied to some autochthonous cattle breeds (like Maremmana breed) that are characterized by extensive production systems. Aim of the work was to evaluate how modification in management and feeding regimen may affect meat quality and fatty acid composition of intramuscular fat from Maremmana young bulls and steers, reared in an organic farm located in the Tuscany Region (Italy).

## Materials and methods

The trial lasted three years. During these years, management and feeding regimen of calves were modified in order to optimize the growing rhythm and the slaughtering weight of the calves, according to an extension service experimental program, financed by the Regional Agency for Development and Innovation in Agriculture (ARSIA) of the Tuscany region. Each year, a group of Maremmana calves (eight, six and seven for the first, the second and the third year, respectively), born at the end of the winter, was weaned at the begin of the autumn and confined in feedlot. The weaning weight was  $164\pm 25$ ,  $215\pm 43$ , and  $165\pm 50$  kg, for the first, the second and the third year, respectively. During the first two years, calves were maintained in feedlot from weaning to slaughtering. In the third year, calves were castrated and managed

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on pasture until fattening, when they were confined in feedlot until slaughtering. During the three years, feeding regimen was based on oat hay and oat haylage *ad libitum* administered. Concentrate was daily administered on the basis of 0,8 kg/100 kg of live weight (LW) during the first year, and 1 kg/100 kg LW during the second and third year. Concentrate was composed by 75% of grounded barley and 25% of grounded bean during the first two years and by 80% of grounded barley and 20% of grounded bean during the third year. The slaughtering age and the slaughtering weight were 568±29, 562±71 days, and 494.2±44.3, 567.2±67.5 kg, for young bulls in the first and second year, respectively. In the third year, steers were slaughtered at 642±66 days and the slaughtering weight was 548±9 kg. After 14 days of ageing, the right half-carcass of all animals were dissected. Chemical and physical analysis (ASPA, 1996) were performed on samples of *Longissimus thoracis* muscle, taken from the 5<sup>th</sup> and 9<sup>th</sup> rib and stored at -20°C, after vacuum packaging. Fatty acid (FA) methyl esters of intramuscular fat were analysed by a gas-chromatograph apparatus, equipped with a 100 m. capillary silica column (Chrompack CP-Sil 88 Varian, Middelburg, the Netherlands). Atherogenic and thrombogenic indexes were calculated according to Ulbricht and Southgate (1991). All data were reported as means ± SD using the PROC MEANS of the SAS statistical package (1999).

## Results

Steer meat showed lower cooking loss and higher shear force values than meat from young bulls (tab. 1). Colorimetric parameters differed between young bull and steer meat: a\* values were higher in young bull meat, while L and b\* values were lower than those found in steer meat. Consequently, Chroma values resulted higher in the meat of steers. Meat chemical composition resulted similar for young bulls and steers with the exception of the lipid content, higher in steers (tab. 2). FA composition of steer meat resulted in a lower content of saturated and monounsaturated FA and in a higher content of polyunsaturated FA, including omega-6 (n-6), omega-3 (n-3) FA and conjugated linoleic acid (CLA) (tab. 2). As a consequence, the ratio saturated/unsaturated FA was lower in steer meat than in young bull one.

**Tab. 1: Meat physical characteristics (Mean±SD)**

		Years		
		First	Second	Third
		Young bulls	Young bulls	Steers
Cooking loss	%	30.37±2.61	28.42±3.72	24.10±2.04
Shear force	Kg/cm <sup>2</sup>	2.05±0.20	2.20±0.18	2.82±0.31
L*		40.80±0.83	39.75±0.76	38.90±1.02
a*		15.30±0.32	15.88±0.45	20.00±0.74
b*		8.70±1.21	9.20±0.82	6.50±1.23
Chroma		17.60±0.89	18.20±0.75	21.10±1.02
Hue		29.40±3.01	28.60±2.70	27.70±0.91

## Discussion

Meat from steers was darker than meat from young bulls as a consequence of the lower level of Lightness and the higher level of Chroma (tab.1). This results is probably due to the higher slaughtering age. Dry matter, crude protein, total lipids, ash



and sugars levels (tab. 2) are similar to those found by Sargentini et al. (2000) in Maremmana heifers and young bulls slaughtered at different ages. The higher level of fat found in the meat from steers could be considered an index of the level of fattening. FA composition of fat from steers is similar to that found by Monteiro et al. (2006). Some differences in FA composition between steers and young bulls could be due to the higher fat level in steers carcasses and to difference in the ratio between triglycerides and phospholipids (French et al., 2000).

**Tab. 2: Chemical composition of meat and fatty acid composition of intramuscular fat (Mean±SD)**

	Years		
	First	Second	Third
	Young bulls	Young bulls	Steers
Dry matter (%)	26.66±1.03	26.13±1.05	27.10±2.06
Crude protein (%)	21.33±0.54	20.70±0.63	22.21±0.61
Ash (%)	1.10±0.05	1.14±0.07	1.00±0.08
Total Lipids (%)	1.89±0.05 a	1.84±0.58 a	2.97±0.67 b
Sugars (%)	2.34±0.91	2.47±0.75.	2.23±0.63
Fatty acid composition of intramuscular fat (g/100 g FAME)			
Saturated FA (SFA)	52,50±8,20	50,44±7,89	45,26±1,14
Unsaturated FA (UFA)	49,09±0,32	48,12±0,27	54,73±1,14
Monounsaturated FA (MUFA)	41,53±8,23	40,70±4,87	35,30±2,37
Polyunsaturated FA n-3	1,05±0,32	1,03±0,20	2,96±0,25
Polyunsaturated FA n-6	6,28±2,46	6,16±2,04	17,89±2,90
n-6/n-3	6,06±1,45	5,94±1,21	6,08±1,12
SFA/UFA	1,07±0,02	1,05±0,02	0,83±0,04
Atherogenic Index	0.84±0.08	0.78±0.06	0.83±0.06
Thrombogenic Index	1.87±0.28	1.72±0.11	1.81±0.20
<i>Trans</i> - 11 C18:1	1,25±0,01	1,23±0,03	1,47±0,24
<i>Cis</i> -9, <i>trans</i> 11 CLA	0,14±0,02	0,14±0,03	0.19±0.04

The intramuscular fat showed a lower levels of saturated FA and monounsaturated FA respect those found by Sargentini et al. (2000), in young bulls and heifers slaughtered at 18 months of age. Nevertheless the levels of monounsaturated FA in steers are lower than that found in young bulls and similar to those found by Monteiro et al. (2006) in Mertolega breed steers, fed a diet composed by wheat straw and concentrates. Total n-3 and n-6 polyunsaturated FA and the n-6/n-3 ratio were lower than those found by Cosentino et al. (2005) in Podolica young bulls fattened at pasture. The saturated/unsaturated FA ratio resulted lower than that reported by Sargentini et al. (2000) in Maremmana heifer meat. The relatively high levels of unsaturated FA determined low values of atherogenic and thrombogenic indexes for both young bull and steer meat. The CLA content of meat fat was similar to that found in meat from cattle reared in non-organic systems (Pezzi et al. 2005) and lower than that found in meat obtained from cattle fattened at pasture (Cosentino et al., 2005). However, CLA content in steer meat was higher than that found in young bulls, in agreement with Sonon et al. (2004).

## Conclusions

Variation in management and feeding regimen weakly affected meat quality of Maremmana young bulls and steers, although some parameters as meat fat content and FA composition differed between meat from young bulls and steers.

## Acknowledgments

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## Organic vs. Conventional Field Trials: the Effect on Cauliflower Quality

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Key words: cauliflower, organic, conventional, rotation, phytochemicals

### Abstract

*Cauliflowers represent 10% of the vegetable production in EU and are rich sources of phytonutrients. Consumer's requests are for safe products, cultivated without massive chemical inputs. The aim of this work was to evaluate 6 years of organic (OR) and conventional (CO) field trials on 16 genotypes of cauliflower. Yield of production and quality-nutraceuticals characteristic were determined. Yield and florets weights significantly decreased in OR (about 25%) compared to CO. The differences in dry matter, soluble solids and pH between each OR and CO were negligible. The acidity and vitamin C was higher (14 and 18%) in OR respect to CO. Total polyphenol index, thiols and antioxidant indexes were slightly higher in OR compared to CO (not significant). With respect to sulphur-nitrogen volatile amounts, the total average difference between OR and CO was not significant, with however differences for single samplings. Some differences between single typologies were noted with respect to agronomical responses to different crop management. White typologies were positively influenced by CO, while green ones were more productive in OR fields.*

### Introduction

Cauliflower production in Italy (*Brassica oleracea*, L. var. botrytis) represented about 1% of the world production in year 2004 (Autori Vari, 2005). Spain, Italy and France are the main European countries producing cauliflower with 460, 438 and 336 thousands of tons in 2006 equalling nearly 10% of EU production (Autori Vari, 2007). Cauliflowers are rich sources of phytonutrients such as glucosinolates, vitamin C and polyphenols (John et al., 2002) and the consumer's need safe and healthy products. In a wider sense the "Inner Quality Concept", including crop management → food quality → health effects (Huber, 2006), is the more accredited. So, the main objective of the present work was to assess the suitability (18 genotypes, 3 typologies) of cauliflower for both organic (OR) and conventional (CON) systems over 6 years by analysing yield and quality parameters. Hence, organic (OR) cauliflowers (EU Rule 2092/91) and conventional (CO) fields were included in a crop rotation, in order to overcome the difficulties linked to the soil fertility and the control of biotic adversities (Caporali, 2003). Another aim of this work was to evaluate the effect of OR and CO field trials on the quality-nutraceuticals characteristics of cauliflower, justified by the lack of a specific literature.

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## Materials and Methods

### Plant material and yield analysis

Field trials were performed in the Research Unit for Horticulture (ORA) of National Council for Agricultural Research (CRA) located in Monsampolo del Tronto (Ascoli Piceno, Italy). The CRA-ORA is carrying on, from 2002, a research on an horticultural rotational system conducted both in OR and in CO. The two lands under crops for the trials (1584 m<sup>2</sup> each) were at a distance of 200m. Analyzed soils were of medium paste, and the chemical analyses were executed in the first 30 cm of depth, showing a good supply of phosphorous and potassium for OR and CON, but a low content of organic matter: 1.11% in OR and 1.21% in CO soils. Four horticultural species subjected to rotation were annually present, each one covering an area of 528 m<sup>2</sup> including tomato (*Lycopersicon esculentum*); cauliflower (*B. oleracea* var. botrytis), common bean (*Phaseolus vulgaris*) and muskmelon (*Cucumis melo*).

**Table 1.: N - application in the organic (OR) and conventional (CO) system.**

year	OR (U ha <sup>-1</sup> )		CO (U ha <sup>-1</sup> )
	pellet form	hydrosoluble	fertilizer
2002-03	150	10(1)*	190
2003-04	150	15(4)*	190
2004-05	150	1,8(5)**	190
2005-06	200	-	200
2006-07	190	7,5(1)*	200

\* number of distribution on soil, \*\* foliar manure

In OR a green manure of velvet vetch (*Vicia villosa*) and of barley (*Hordeum vulgare*) was cultivated prior to tomato and muskmelon. Cauliflower seedlings were transplanted at the end of Aug (except in 2004 = 5 Sept) at 3rd-4th leave stage and plants were 70×60cm spaced. The N manuring in OR was made by organic pellets and hydrosoluble matter, while for CO only fertilizers were employed, in successive amounts as showed in Tab 1. Four cauliflower genotypes were compared for each year on three times replicated plots (26.8 m<sup>2</sup> each) with the experimental scheme of a split-block design. In total sixteen genotypes were evaluated during the experiment: 8 of white typology (7 HF1 and 1 variety) in 2002-05; 4 of "violetto di Catania" tipology (1 commercial and 3 accessions selected in CRA-ORA) in 2005/06; 4 accessions of CRA-ORA belonging to the "verde di Macerata" green typology in 2006/07. Yield and average florets weight were calculated on 16 genotypes over 6 years of trials (Tab 2). The productivity was calculated by keeping in account the decreases in production due to lost plants for stress and diseases, considering the plants really present at harvest. All data were subjected to ANOVA.

Quality attributes were determined on 3 typologies (Tab 3). Dry matter, soluble solids (SS), pH and TA were measured according the official methods. Vit C was determined by HPLC (Lo Scalzo et al., 2007). The thiols were determined according to Hawrylak & Szymanska (2004). TPI index was measured by the Folin-Ciocalteu method. The antioxidant activity by the lipoxygenase-linoleic acid-crocin method (LIPOX) was carried out according to Lo Scalzo et al., (2007). FRAP assay was carried out according to Benzie & Strain (1996). The determination of S-N aroma compounds was made as described by Di Cesare et al (2003). Each experiment was conducted two times and all analysis were made in quadruplicate and the results were referred to dry weight units. Data were submitted to analysis of variance ANOVA and the averages were compared by Tukey test (p<0.05).

## Results and Discussion

Cauliflower productivity showed different patterns in the different years: this could be due both to environmental changes and to the genetic influence. The use of N fertilizers coupled with biostimulants enhanced productivity. The rotations had a visible effect on the soil organic matter: the values of 2002 were 1.11 and 1.21% in OR and CO, respectively, while in 2007 were 1.39 and 1.13%, with an increase for OR and a decrease for CO soils. The first three samplings (Tab 2) refer to common white genotypes. Yields were clearly higher in CO compared with CO plots.

Tab. 2: Average productivity parameters of 16 cauliflower genotypes over 6 years of production, using crop rotation in organic (OR) or conventional (CO) field management, Tukey test alpha = 0,05.

samplings		t ha <sup>-1</sup>		kg florets <sup>-1</sup>	
		OR	CO	OR	CO
Average 2002/03 (4 HF1)	white	15,64 b	29,24 a	0,706 b	1,255 a
Average 2003/04 (4 HF1)	white	20,55 b	26,59 a	1,106 b	1,254 a
Average 2004/05 (1 var 3 HF1)	white	9,35 b	14,49 a	0,528 b	0,728 a
Average 2005/06 (1 var 3 br. lines)	violet	3,82 a	4,64 a	0,336 a	0,380 a
Average 2006/07 (4 var)	green	12,63 a	11,04 b	0,639 b	0,707 a

In the second sampling, "Rafale" and "Triumphant" obtained good yields in OR, with similar OR and CO values for "Triumphant", assuming a significant adaptation under OR conditions for this variety. The third sampling, in particular cv "Palla di Neve", resulted in a general reduction of productivity, due to a late in plant set and to a drastic decrease in temperature (4-8°C lower than the seasonal average). Violet genotypes were assayed in 2005/06, showing a very low productivity, suggesting a low adaptability to both field conditions. In 2006/07, the assayed green genotypes resulted in lower productivity than white, but with a good response for OR, not so different from CO.

**Tab. 3: Quality parameters of OR and CO cauliflower (7 genotypes, 3 typologies, w=white, v=violet, g=green) over 6 years of trials, Tukey test alpha = 0,05.**

Cauliflower typologies	dm	% SS	pH	TA	Vit C	TPI	Thiols	LIPOX	FRAP
OR white (n=6)	8,0	5,8	6,4	36,8	465,6	411,9	20,4	46,3	129,5
OR violet (n=1)	9,0	7,1	6,5	50,0	1022,2	518,9	70,0	57,4	131,1
OR green (n=3)	9,8	6,7	6,6	41,1	526,9	511,9	19,5	44,1	94,8
OR average	8,6 a	6,2 a	6,5a	39,4 a	539,7 a	452,6 a	25,1 a	46,8 a	119,3 a
CO white (n=6)	7,9	5,6	6,5	33,2	402,2	424,6	18,2	48,5	118,5
CO violet (n=1)	10,0	7,9	6,7	39,0	690,0	591,0	64,0	60,8	163,0
CO green (n=3)	9,9	7,0	7,0	33,5	485,3	414,4	16,0	34,2	85,3
CO average	8,7 a	6,2 a	6,6a	33,8 b	455,9 b	438,2 a	22,1 a	45,4 a	113,0 a

\*Early harvested, \*\* Late harvested

dm: dry matter; SS: soluble solids (°Bx); TA: total acidity (mEq/100g dm); Vit C (mg/100g dw); TPI: Total Polyphenol Index (mg gallic acid/100 g dm); Thiols: total content of non-protein-SH groups (mg cystein eq./100g dm); LIPOX: antioxidant activity by the lipoxigenase-linoleic acid-crocin method (mg gallic acid/g dm); FRAP: ferric reducing antioxidant power (mg vitC/100g dm)

The primary quality characterization of the different cauliflower genotypes (Tab 3, dm, SS, pH and TA) affirmed that there were no differences between OR and CO, not showing a

quality loss in OR-grown cauliflowers. The only significant difference was noted for TA, which was higher in OR than in CO. The nutraceutical profile (Tab 3) shows the highest difference in vitamin C content. OR cauliflowers contained 18% more vit C than CO (significant). The TPI, thiols and antioxidant data resulted slightly higher in OR compared with CO (not significant). These trends were confirmed on other food plant species by other authors: recent studies pointed out that ascorbic acid content in OR-cultivated plants is from 5 to 90% higher than in CO ones (Heaton, 2001); polyphenols and carotenoids resulted higher or unchanged in OR plants, furtherly confirming our results (Lucarini et al., 1999). The characteristic volatile compounds of *Brassicaceae* were sulphur-nitrogen (S-N-) substances produced from the hydrolysis of glucosinolates that have relevant healthy-implications. The main classes of these compounds were sulphurs, isothiocyanates, nitriles and thionitriles.

**Tab. 4: Sulphur-Nitrogen volatiles (mg/100g dm) from organically (OR) and conventionally (CO) grown cauliflowers (5 genotypes over 4 samplings). Tukey test alpha = 0,05. Nd = not found.**

Cauliflower genotypes	Sulphurs		Isothiocyanates		Nitriles		Thionitriles	
	OR	CO	OR	CO	OR	CO	OR	CO
Nautilus 2004	392.2	1212.6	37.1 a	85.2 b	Nd	Nd	2,1	3,8
Medusa 2005	951.5	1198.2	369.2	489.6	Nd	Nd	0,9	2,9
Violetto di Sicilia	626.0	539.7	53.5 b	28.5 a	Nd	Nd	1,6	0,6
Noverde 2006	264.3	84.8 a	70.9 a	68.0 a	1.7	0,6 a	6.3	4,4
Velox 2007 E*	139.4	439.7	35.2 a	121.5	0,6	1,6 b	5,9	10,7
Velox 2007 L**	64.6	131.3	124.5	64.2 a	1,1	1,1 a	7,3	9,1
Average	406.3	609.4	115.1	142.8	1,1	1,1 a	4,0	5,2

\*Early harvested, \*\* Late harvested

Tab 4 shows a different situation in the different samplings. Specific variations have been shown for single genotypes, assuming that the influence of OR and CO could depend on both genetic and environmental factors. CO genotypes of Nautilus, Medusa, Velox 2007 E and L generally produced higher amounts of S-N-volatiles than OR ones. On the other hand, Violetto di Sicilia 2005 and Noverde 2006 resulted higher in OR trials. Other authors affirm that glucosinolates were higher in OR rather than in CO (Adam, 2002). The most important objective of OR is to prevent produce's quality reduction in comparison to CO. The present results confirm this objective, and except for the productivity of common white genotypes, the OR cauliflower did not differ from the CO samples. It's sure that further studies need to fully interpret environmental and genotypic quality characteristics of cauliflowers in OR and CO management, in order to better answer to consumers and producers demand for high product quality.

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The complete list of references can be found in: Eprints N°: 11758

Lo Scalzo R., Bianchi G., Genna A., Summa C., (2007). Antioxidant properties and lipidic profile as quality indexes of cauliflower (*Brassica oleracea* L.var. *botrytis*) in relation to harvest time". Food Chemistry, 100: 1019-1025.



## Health and Safety of organic products



# Feed composition and strategies to improve poly-unsaturated fatty acid levels in organic cow milk

De Wit, J. & de Vries, A.<sup>1</sup>

Key words: omega-3, CLA, grass pellets, roughage quality.

## Abstract

*Like in various other countries, organic milk in the Netherlands has higher levels of poly-unsaturated fatty acids, particularly CLA and omega-3, than conventional milk. Monitoring results from a total of 25 farms between 2004 till 2007 are presented. Regression analysis indicates a negative effect of maize silage and positive effects of feeding fresh grass, grass pellets, red clover and addition of oil on CLA levels in milk fat. Results with omega-3 are similar, but omega-3 levels in milk fat seem less related to feed characteristics: the model with feed composition, seasonal effects and farm effects as major parameters, explains a smaller part of the variation, while farm influence is much larger with omega-3 compared to CLA.*

*Farm influence might be caused by genetic differences and constant factors influencing roughage quality. Genetic influences are likely but could not be investigated as milk samples were not taken from individual cows. The influence of grass quality is suggested by the large effect of sampling date found in this study. Moreover, some high residual values and statistical estimates for individual farms seem often related to silage quality, botanically rich pastures and red clover feeding.*

## Introduction

Poly-unsaturated fatty acids (PUFA), particularly conjugated linoleic acid (CLA) and omega-3 fatty acids are increasingly recognized for their beneficial health impact. Similar to other countries (Butler et al, 2007), there are considerable differences in CLA and Omega-3 levels between organic and conventional milk the Netherlands. On average omega-3 and CLA levels were 60 and 38% respectively, higher in organic milk, with lowest levels during winter (Slaghuis & de Wit, 2007).

Variations in CLA and omega-3 levels, however, are high. Highest levels appear with fresh grass utilization and the addition of rumen protected oil, the latter technology now being used to produce conventional milk with higher levels of omega-3 fatty acids ([www.campina.com](http://www.campina.com)). This urges for organic dairy producers to improve the levels of beneficial fatty acids in organic milk, particularly during winter. To facilitate this, a participatory research programme concerning the relationship between feeding practices and fatty acid pattern at Dutch organic farms was started in 2004. In this paper, we present the results of this research that started as part of a product development project together with a Dutch cheese factory (Aurora), to produce organic cheese with distinct levels of CLA and omega-3. Later, it became part of the governmental supported research for organic agriculture in the Netherlands (see [www.biokennis.nl](http://www.biokennis.nl)).

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## Materials and methods

From June 2004 until September 2007, bulk milk samples were taken at variable intervals at a variable number of organic dairy farms, on average 15 farms. In total 415 samples were analysed from 25 farms. Samples were taken both at regular intervals as well as shortly before and two weeks after an interesting change in feeding ration, as un-replicated trials at farm level. Farms were selected to include as much variation as possible in feeding pattern, breeds, soil and farm type. Feed practices in the week before milk sampling were recorded by questionnaire. Feed ration composition was assessed based on farmers' estimations, combined with an assumed dry matter intake of 16 and 15 kg per day during summer and winter respectively, and a replacement rate of 0.5 resp. 0.4 kg DMI per kg concentrate in summer resp. winter. The tests were carried out from raw bulk milk by IGER (UK) on frozen samples till June 2005 and by COKZ (Netherlands) using fresh samples using the Kramer bimethylation method. In the analysis only rumen acid (C18:2 c9, t11) is taken as CLA, while omega-3 includes  $\alpha$ -linolenic acid (C18:3 c9,12,15), EPA (C20:5, c5,8,11,14,17) and DHA (C22:6 c7,10,13,16,19). Statistical analysis was performed with GenStat 9.1 (2006), using the stepwise multiple linear regression procedure.

## Results and discussion

Results are clustered according to season in table 1. CLA and omega-3 levels in this research are 1 resp. 1.5 - 2 mg per g milk fat higher compared with averages of Dutch organic milk (Slaghuis & de Wit, 2007), as a result of the farm selection process, which also resulted in relatively high levels of added oil (in the form of pure oil or included in oil rich residues). However, a comparison between seasons provides little information on the nature and importance of the different feed characteristic as several parameters change simultaneously.

**Tab. 1: Means of CLA and omega-3 samples and ration composition per season**

	Summer (n=208)	Autumn (n=78)	Winter (n=129)
CLA (mg/g milk fat)	9.51	8.86	5.60
Omega-3 (mg/g milk fat)	11.06	10.83	10.32
	Percentage in ration		
Concentrates	14	16	18
Grass pellets	1	2	3
Fresh grass	63	35	1
Grass silage	13	33	61
Maize silage	3	3	5
Whole grain silage	0	0	1
Red clover	2	7	10
Other roughages	2	3	2
Added oil (g/day)	38	50	78

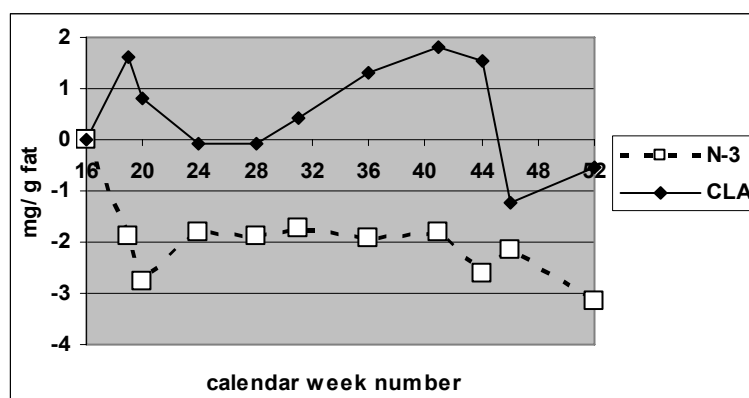
Statistical data analysis gave a feasible model including only significant factors ( $p < 0.05$ ), explaining 74.5 resp. 62.1% of the variance for CLA and omega-3. The model included a constant factor (estimated at 6.6 resp. 11.48 mg CLA and omega-3

per g fat), feed ration components (see table 2; contributing 12 resp. 15.1% to the explained variance of CLA and omega-3), an effect of sampling date expressed as calendar week number in the year (see figure 1, contributing 48.3 resp. 11.7%), a small effect of year, and a farm effect (contributing 38.2 resp. 68.9%).

**Tab. 2: Estimated contributions of feed components to CLA and omega-3 in milk fat (as mg per g milk fat per kg DM)**

	CLA (mg/g milk fat)	Omega-3 (mg/g milk fat)
Added oil	9.61	5.71
Grass pellets	0.29	0.74
Fresh grass	0.33	Not incl.
Maize silage	- 0.23	- 0.25
Red clover	0.24	0.21
Whole grain silage	Not incl.	- 0.70

Concerning the influence of feed components, the effects of red clover, maize silage, oil and fresh grass intake are consistent with literature (e.g. Chillard & Ferlay, 2004; Elgersma et al, 2006). The positive effect of red clover seems to be related to specific plants components and/or higher levels of PUFA's in clover. Both aspects of red clover seem highly variable (e.g. Vanhatalo et al, 2007), which is coherent with the variable effects of red clover in this research. The positive effect of feeding grass pellets might be related to increased rumen passage and thereby reduced bio hydrogenation (see e.g. Cabrita et al, 2007) as well as to higher levels of PUFA's in the grass as oxidation between harvesting and conservation is limited. The effects of grass pellets in this research are not constantly high, probably due to differences in original grass quality and time span between mowing and pelleting. The highly negative effect of whole grain silage might be an artefact, due to the low number of values (30) on which this estimate is based, but it might also be due to the high level of NDF inducing slow rumen passage and thus increased bio hydrogenation.



**Figure 1: Estimated influence of week on level of omega-3 and CLA**

The large effect of sampling date (see figure 1) indicates strong seasonal influences, probably related to grass quality. For omega-3, particularly week 16, when cows are

grazing very young grass, is high compared to the other periods, with smaller negative estimates for week 20, when grass is maturing, and winter (week "52" includes all winter values), when silage is fed with lower PUFA levels compared to fresh grass. For CLA, higher levels appear in spring and in autumn, mainly related to young leafy grass in spring and a growth flush of grass in autumn 2006 respectively.

Also, some unexplained high individual values and part of the large farm effect in the model seem related to feed quality factors such as the botanical composition of pastures, red clover feeding and silage conservation strategies (mowing at mature stages or ensiling with high dry matter content). In depth study in 2007, in which additional feed quality information of the grass silage and fresh grass was obtained, did not reveal a clear influence of feed quality on milk fatty acid composition. This disappointing result might be caused by the limited number of samples (n=37), as well as differences between sampling and ingested feed (due to selection or deterioration of the silage during feeding).

The large farm effect might also be caused by genetic influences. Important breed effects appear unlikely in this research, but differences between individual cows of the same breed haven proven to be large (Elgersma et al, 2006) and seem genetically based (van Arendonk, unpublished). This could not be proven in this research as no individual milk samples were analysed.

## Conclusions

Feed has a large influence on beneficial fatty acids levels in milk, even though feed components could explain only part of the variance in the bulk milk samples analysed in this research. Part of the large seasonal and farm effect, as well as some high individual residual values seem related to silage quality, red clover feeding and grazing botanically rich pastures. If organic dairy farms want to strengthen their distinguishable position, also vis-à-vis conventional milk with enhanced levels of beneficial fatty acids, they can best opt for using grass pellets as concentrate, red clover, maximum use of fresh grass and/or some oil supplements. The influence of other measures influencing roughage quality could not be convincingly proven.

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# Influence of cropping systems on the potential formation of acrylamide in different cultivars of wheat

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Key words: acrylamide, asparagine, production systems, cultivars, food products

## Abstract

*Acrylamide (AA) – probably carcinogen – is thermally created in carbohydrate-rich food (e. g. cereals) within the Maillard-Reaction by the reaction of asparagine and reducing sugars. First steps to decrease AA focused on changes in the technological food production process. However, these possibilities are limited due to occurring taste anomalies and consumer tolerance. Therefore, it might be an alternative to influence the precursors of AA. Up to now, multiple studies considering the influence of fertilisation, species, and cultivars on the content of asparagine (Asn) and reducing sugars have been carried out. But there is still a lack of information about the influence of the production system on the AA level. It can be expected that the amount of AA is different and might be lower in organic production systems, because of the difference in nitrogen management (amount and type). The aim of this study was to check organically and conventionally grown wheat samples of different cultivars for the level of the precursor Asn and the AA-formation-potential. The samples were obtained from locations in Switzerland and Germany. Partial significant differences in the amount of Asn and in the AA-formation-potential suggested an influence of the production system and thus a further chance to intervene.*

## Introduction

The health and safety of foodstuff nowadays is a very important aim even in industrialised countries (Nau et al. 2003). Normally the avoidance of food toxicants is quite well manageable. But for substances, created through food processing, like acrylamide (AA), it is problematical. Acrylamid, a so called “foodborne toxicant”, was first reported in 2002 by the Swedish National Food Administration in connection with food products. It is formed in carbohydrate-rich food stuffs like potatoes and cereals within the Maillard-Reaction (Mottram et al. 2002), where the amino acid asparagine (Asn) and reducing sugars (e. g. glucose) react by thermal processes to AA (Stadler et al. 2002). In this context, Asn is the limiting factor of the formation of AA in cereals (Weisshaar 2004). Furthermore, according to the IARC (International Agency for Research on Cancer 1994) it is a probably carcinogen substance. Consequently many efforts have been undertaken to understand the syntheses, the metabolism, the toxicology, the formation and, in the end, what can be done to minimize the amount of AA in foodstuffs. Up to now, a focal point was to find minimization strategies by changing technological food production steps. It has been successfully shown, that the amount of AA can be minimized by changing temperature, pH, time of heating,

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<sup>2</sup> As Above

<sup>3</sup> As Above

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backing agents and adding additives. However, the possibility to change technological process steps is limited, because of negative impacts on the quality of produced products. Modifications in technical food processing are linked to changes in taste, smell and texture and thus consumers' acceptance can be endangered. Therefore, additional strategies are needed to minimize AA. An alternative to reduce AA might be to limit the contents of precursors (e.g. free Asn) by using crop species and cultivars with lower levels. Furthermore, different amounts of N-fertilization can also increase the Asn level. Weber (2007) investigated different conventionally grown cereal species and cultivars of wheat, spelt and rye and found different levels of Asn. Weber et al. (2008) also found that conventional N-fertilization levels can increase the level of Asn. As organic farming uses different N-fertilization strategies e.g. crop rotation, enhancement of mineralization and organic N-fertilizer that lead to crude protein levels below 13 %, it can be expected that the amount of Asn in organic grain samples is lower. Thus it seems that organic products can contain a lower amount of AA and by this might have an advantage for consumers' health. Up to now only few studies have investigated the impact of organic production systems on levels of AA in foodstuffs, wherefore further research is necessary.

Hence the aim of these study was i) to evaluate differences in Asn content of organically and conventionally grown wheat cultivars, ii) to compare the content of Asn and AA-formation-potential between organically and conventionally grown wheat cultivars and iii) to evaluate the correlation between Asn and AA-formation-potential of organically and conventionally produced wheat cultivars.

### **Materials and methods**

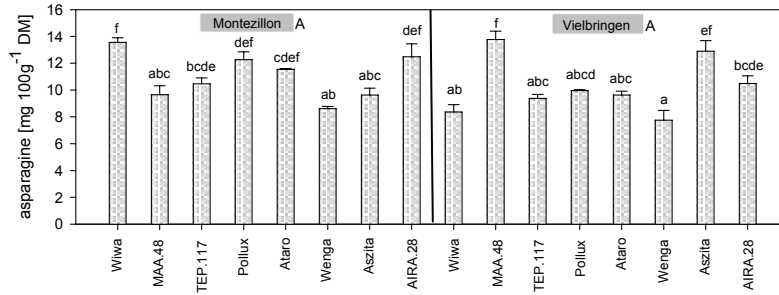
The organically produced 16 wheat samples (Wiwa, MAA 48, TEPP 117, Wenge, Pollux, Ataro, Aszita, AIRA 28) were obtained from field trials of two different locations (Vielbringen, Montezillon) in Switzerland from the seed breeder Peter Kunz in 2004/2005. The selected two locations were in the Regions Chaumont (Montezillon: 770 m above sea level) and Bern (Vielbringen: 560 m above sea level). The annual precipitation ranged about 800 – 1030 mm. Annual average temperature ranged from 6.2 to 9.9 °C. The field trials were arranged in a block design (randomised), with two replications on a sandy loamy soil. Liquid manure was applied as N-source, previous crops at both locations were grass-clover ley.

The conventionally produced 16 wheat samples (Enorm, Altos, Monopol, Batis, Elvis, Tiger, Cubus, Transit, Tommi, Natutastar, Magnus, Terrier, Dekan, Punch, Manhatten, Wasmo) were collected from the experimental station Ihinger Hof of the University of Hohenheim (south-west of Germany, 48° 44' N; 8° 56' E, mean annual precipitation 693 mm, mean temperature 8.1 °C). The samples were arranged in a block design (randomised) with three replications. The soil texture was classified as loamy clay. Sugar beet was cultivated as previous crop. N-fertilization was applied as KAS in accordance to the quality levels of wheat (quality level E, A, B, K) from 170 kg N ha<sup>-1</sup> to 200 kg N ha<sup>-1</sup>. The selected cultivars were used because of their relevance in the applied production system.

The lab analyses of Asn and the AA-formation-potential in the grain samples were done according to Weber et al. (2008). Asn- and AA-data were analyzed according to the experimental design with a linear mixed model. Analyses of variance (ANOVA) were performed using PROC GLM of the SAS 9.1 statistical software package (SAS Institute Inc., Cary, NC, USA). Tukey-Tests were carried out for comparison of means using the procedure PROC MIXED. All effects were set as fixed.

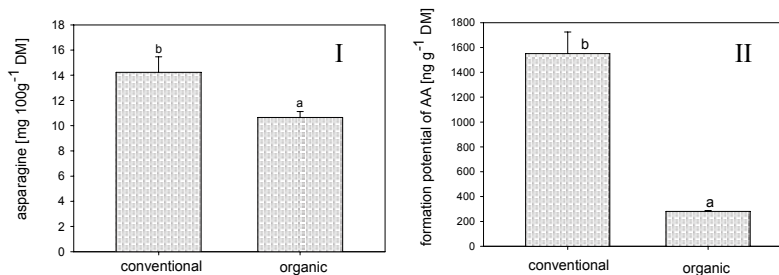
## Results and discussion

Figure 1 shows the results of Asn levels [ $\text{mg } 100 \text{ g}^{-1}$  in DM] in organically produced wheat. The content of Asn differed significantly between the chosen cultivars. Asn levels ranged from  $7.8 \text{ mg } 100 \text{ g}^{-1}$  DM as minimum to  $13.8 \text{ mg } 100 \text{ g}^{-1}$  as maximum with a mean of  $10.7 \text{ mg } 100 \text{ g}^{-1}$  DM. Against this the conventionally produced wheat cultivars (results not shown) had significant differences by a mean content of  $15.2 \text{ mg } 100 \text{ g}^{-1}$  DM, with a minimum of  $7 \text{ mg } 100 \text{ g}^{-1}$  DM and a maximum of  $21.2 \text{ mg } 100 \text{ g}^{-1}$  DM. The higher Asn contents in grain samples of conventional production systems might be the result of higher N-fertilization levels which can significantly enhance the amount of Asn (Weber et al. 2008). Means over two organic locations did not indicate significant differences in Asn level, but comparing the same cultivars a significant difference was given wherefore it is concluded that the location could have an effect.



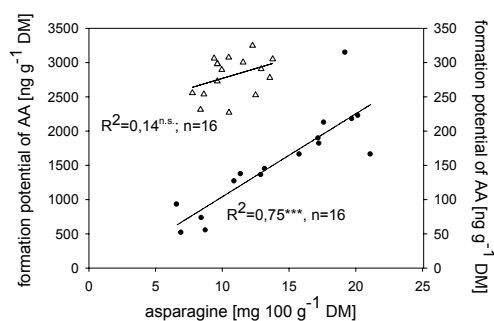
**Figure 1: Asparagine levels [ $\text{mg } 100 \text{ g}^{-1}$ ] of analysed organic wheat cultivars. Cultivars with the same letters did not differ significantly ( $\alpha < 0.05$ ).**

In a further step, the content of Asn and AA-formation-potential were analysed and compared between the two production systems (figure 2 I & 2 II). The results showed a statistically significant difference in the amount of Asn (figure 2 I) as well as in AA-formation-potential (figure 2 II) between the systems. Asn potential of organically grown cultivars was significantly lower than in conventionally grown cultivars. Further, the same effect was found for the amount of AA-formation-potential (Fig. 2 II). Wheat cultivars of organic production systems had a significant lower level (almost four times) than conventionally produced samples.



**Figure 2: Comparison of means of (I) asparagine [ $\text{mg } 100 \text{ g}^{-1}$ ] and (II) acrylamide (AA) formation potential levels [ $\text{ng } 100 \text{ g}^{-1}$ ] of analysed wheat cultivars. Production system with the same letters did not differ significantly ( $\alpha < 0.05$ ).**

The correlation between Asn and AA (figure 3) was only significant for the conventional samples. Due to a narrow range of Asn in organic samples, no correlation was obtained.



**Figure 3: Correlation between asparagine (Asn) and acrylamide (AA) formation potential of conventionally ( $R^2=0.75^{***}$ , black dots, left y-axis) and organically ( $R^2=0.14^{n.s.}$ , white triangles, right y-axis) grown wheat.**

## Conclusions

The results of the study indicated significant differences in the content of Asn and the final AA-formation-potential within organically produced wheat cultivars. A possible strategy to minimize AA in foodstuffs seems to be the selection of wheat cultivars low in free Asn. Further, the location might to have an impact on the content of free Asn when comparing single cultivars. The production system seems also to have an influence. However, no clear statement can be given because of different cultivars and locations. Further research on the overall influence of the production system is needed.

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# Effects of weed management strategies on quality and enteric pathogen contamination of organic lettuce

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Key words: food quality, weed control, vegetable production, microbiology, farm yard manure

## Abstract

*Quality requirements for raw edible produce like lettuces include nutritional value and hygienic quality. Organic lettuce is often considered to cause a potential health risk for immunocompromised individuals due to assumed pathogen transfer from organically manured soils into lettuce heads (*Lactuca sativa*, var. *capitata*). The effect of different weed management strategies (rotary tiller, mouldboard plough combined with flame weeding, plastic mulch and straw layer, resp.) on pathogen transfer from fresh and composted farm yard manure were assessed in four field experiments in 2006 and 2007. Results gave no hint on any pathogen transfer given by the assumed pathways (contaminated soil particles transported by mechanical tools and/or splash effect of rain drops). Nitrate contents in lettuce were low ranging from 269 mg/kg to 828 mg/kg in fresh matter respectively. A new method for measuring leaf tissue firmness is being developed by using an artificial denture. Substantial negative effects of manure on lettuce quality were not recorded.*

## Introduction

Hygienic harmlessness is an important quality trait especially for raw consumed vegetables that grow close to the soil surface. Due to the potential contamination with human pathogenic microorganisms, use of farmyard manure (FYM), a common practice not exclusive for Organic Farming only, may therefore be considered as a health risk. Pathogens capable of causing human health risks include *Salmonellae* or human pathogenic strains of *E. coli* that may occur in FYM under certain conditions. These pathogens may cause severe health problems such as gastrointestinal infections for immunocompromised individuals, babies, sick people and the elderly (Buchanan et al. 2000). The survival of these bacteria in the soil after FYM application can amount up to 100 days (Ingham et al. 2004). The transfer of pathogens might happen by splash effects caused by raindrops or overhead irrigation or via transport of soil particles into lettuce heads by mechanical weeding. Apart from hygienic aspects, the amount of beneficial and harmful compounds as well as tissue properties play a dominant role for lettuce quality. High contents of nitrate can decrease, secondary metabolites can increase the nutritional value of lettuce. Crispness of lettuce leaves is a criterion for freshness and constitutes a major factor of the consumer appraisal for product quality. This parameter is indirectly measured by determining the firmness of the leaf tissue. Due to high heterogeneity of the veined leaf tissue, measurements with an Instron penetrometer gave no satisfying results. Thus, we try to determine the firmness of leaves by simulating the consumer perception with an artificial denture.

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This paper highlights key results of field experiments with lettuce focussing on the impact of weed management practices and manuring on selected quality parameters.

## Materials and methods

Two field trials were carried out with lettuce (*Lactuca sativa*, var. *capitata*) in each summer season of 2006 and 2007 at the organic research farm Wiesengut in Hennef (Germany, 50°48' N, 7°17' E; 62 m a.s.l.; mean annual temperature 10.2°C; mean annual precipitation 846 mm) on a fluvisol. Since data of 2007 are still not fully exploited, only results of 2006 are presented here.

The experimental design was a Latin square with 6 treatments and 6 replications (Table 1). The treatments were selected based on results of Rattler et al. (2006) and included a high risk pathogen transfer treatment with fresh FYM (not incorporated to the soil). Weed management was carried out either by hoeing, flame weeding, plastic mulch or by covering the soil with a layer of straw. All treatments were adjusted to a target level of 170 kg plant available  $N_{min}$  ha<sup>-1</sup>. Thus, the amount of N applied was a function of the amount of mineral nitrogen ( $NO_3-N$  and  $NH_4^+$ , i.e.  $N_{min}$ ) in the soil solution in the 0-30 cm soil layer at the time of planting and an estimated mineralization rate of 5 kg N x ha<sup>-1</sup> and week. The amount of FYM was calculated by assuming 20% of total N applied becoming available during the vegetation time.

**Tab. 1: Treatments**

Weed control	Manure Incorporation	Manure Type
Mechanical 1	Rotary Tiller	fresh FYM
Mechanical 2	Plough	fresh FYM
Mechanical 3	} all Rotary Tiller	composted FYM
Flame weeding		fresh FYM
Plastic mulch		
Straw layer		

In 2006, lettuces were planted on 5 May and 18 July, respectively. Additional overhead irrigation was applied, if needed. In each trial, 16 lettuce heads per plot were harvested at optimal ripeness. Outer leaves either intensely soiled or having lesions were removed. All lettuce heads were weighted separately. Ten heads per plot were used for determining dry matter content, mineral composition, physiological and microbiological parameters (*Enterobacteriaceae*, Coliforms, *E. coli*, Salmonellae, Enterococci). Microbiological parameters were assessed directly after harvest with a pooled sample of 6 washed heads per plot according to German standard cultivation methods (LFGB, 2006). Nitrate content was determined in the dry matter (d.m.) according to Beutler et al. (1986). Results were statistically evaluated by ANOVA followed by Tukey's test using SAS (SAS version 9.1, SAS Institute, Cary, NC, USA).

In order to analyse whether different fertilizer and increased amount of fertilizer have an influence on crispness, an additional field trial was performed in spring 2007 and repeated in summer 2007. These 2007 trials were designed as a Latin rectangle with 12 treatments and 4 replications. Here fertilizers were applied either as FYM or

calcium ammonium nitrate. Nitrogen fertilization levels were adjusted to a mineral nitrogen content of the topsoil (0 - 30 cm) of 110, 130, 150, 170 and 190 kg N<sub>min</sub> ha<sup>-1</sup>, respectively. The new prototype for measuring leaf firmness uses an artificial denture and is called Degmatasimeter (DTM). The DTM measures the force that is spent for biting through a lettuce leaf and considered to refer to actual forces generated during human chewing. In contrast to this approach, the frequently used Instron penetrometer measures tissue firmness by punctual pressure on a tensed leaf until destruction. Occurring tensile and shear forces cannot be characterised and quantified by this method due to the heterogeneity of the leaf tissue. Consequently, a close correlation to crispness that is experienced by consumers is hardly possible. In the case of the DTM, occurring forces are expected to correspond with the perception of crispness.

## Results and discussion

Yields were relatively high (trial 1: 540 g/head, trial 2: 507 g/head) owing the high N - fertilization level. As expected, weed control treatments had no effect on yield. FYM contained *E. coli* in the range of 10<sup>3</sup>-10<sup>4</sup> CFU g<sup>-1</sup> in fresh matter (f.m.) in 2006. In composted FYM in spring 2006, *E. coli* counts were similar to FYM due to low temperatures during the composting process; in summer 2006 (composting temperature reached 60°C), *E. coli* was not detected. In 2006, no effects of the weed control treatments on total aerobic bacterial counts (overall average = 10<sup>6.25</sup> CFU g<sup>-1</sup>) and Enterobacteriaceae (overall average = 10<sup>5.44</sup> CFU g<sup>-1</sup>) were observed. A significant increase in the count of coliform bacteria was found following mulching with plastic mulch and with straw (p= 0.001) in spring 2006, but these were not confirmed by corresponding results for *E. coli*, which was detected in only some of the lettuce samples and in very low amounts slightly above the detection limit of 10<sup>2</sup> CFU g<sup>-1</sup>. These results indicate a minor relevance of soil particle transfer as hygienic contaminant. Coliform counts (10<sup>5</sup> CFU g<sup>-1</sup>) and counts of *E. coli* are in accordance with Pflieger's results (2006) for natural bacterial counts of heads of lettuce under field conditions without irrigation. *Salmonellae* were not detected in any of the samples. Although the treatments were designed to provoke a high transfer of potential pathogens, the initial results of 2006 do not indicate an enhanced health risk from the use of FYM as fertilizer for lettuces. These findings support the results published by Rattler et al. (2006) who observed similar bacterial counts in field-grown lettuce. Nevertheless, since the standard methods used are often not good enough for proper detection of human pathogenic strains more detailed investigations on the relationship of total *E. coli* counts and, e.g., *E. coli* O157:H7 are needed. Franz et al. (2005) did detect *E. coli* O157:H7 in lettuce roots but not in edible lettuce parts. While in 2006 few samples of lettuce contained *enterococci*, and only in low amounts, higher counts of *enterococci* were noted in 2007 and still require explanation. Nitrate values (average in spring 2006: 269 mg kg<sup>-1</sup> f.m., average in summer 2006: 828 mg kg<sup>-1</sup> f.m.) were considerably lower than the tolerable limits of 2500 mg kg<sup>-1</sup> f.m. (EC Directive N° 466/2001). These values are in the same range as those found in other surveys, with 495 - 1548 mg kg<sup>-1</sup> f.m. for organically produced lettuces (Samwel, 2000), but lower than those published by Souci et al. (1994), with 2190 mg kg<sup>-1</sup> f.m. Given the high nitrogen level of 170 N<sub>min</sub> ha<sup>-1</sup>, the nitrate values in the present experiment can be considered comparatively low. However, the nitrate content is generally lower in summer-grown than in winter-grown lettuces because nitrate reductase activity is higher at higher light intensities. In preliminary examinations, measurements of tissue firmness showed a significantly lower coefficient of variance for the DTM prototype (3%) than for the Instron penetrometer (10%). For other technical or chemical measurements, the maximum acceptable coefficient of variance is often 5%,

suggesting that the method has been improved by using the DTM. On average, mineral fertilization led to values of 570 g per bite, while organic fertilization resulted in slightly higher values (630 g per bite) in 2007 (trial 1). However, the DTM-values showed did not vary directly with the fertilization levels. Whether or not the DTM can be used to distinguish between different levels of crispness as a function of agronomic strategies is still unclear and requires further investigations.

## Conclusions

According to our results, the use of FYM, even when applied in a form that maximizes pathogen transfer risk, does not significantly affect the hygienic quality of lettuce. When good agricultural practice, i.e. no direct manuring of vegetables that are eaten raw, is also taken into account, the hygienic quality of organically grown lettuce cannot be considered a cause for concern. In terms of the nutritional value of lettuce, there are currently no indications that use of manure leads to a lower product quality.

## Acknowledgments

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# Pilot scale application of ozonated water wash – effect on microbiological and sensory quality parameters of processed iceberg lettuce during shelf-life

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Key words: ozone, iceberg lettuce, fresh-cut-vegetables, minimal processing

## Abstract

*The aim of the study was to assess the effect of ozonated water wash on the microbiological and sensory quality parameters of minimally processed iceberg lettuce in pilot scale in comparison to aqueous chlorine wash. Alternative solutions for chlorine are needed, since its use is prohibited in organic food processing. Iceberg lettuce samples were washed with three different ozone solutions and the water wash and the 100 ppm chlorine wash were used as control. Ozone generator based on corona discharge was used to produce ozone at level 7 ppm. The samples (150 g) packed in oriented polypropylene pouches were stored for 10 days at + 5°C and the microbiological and sensory quality was analysed on days 1, 6 and 10. There was no significant difference between chlorine wash samples and the samples washed 1 min in a machine with ozonated water concerning the microbiological quality. Compared with the chlorine with lower concentrations of ozone it is possible to control the microbial load. Concerning the sensory quality all samples endured all of the treatments well except the treatment with 7 ppm ozone for 5 min. As a conclusion the bubbling gaseous ozone in water can be as effective disinfection method as chlorine wash when the following processing parameters are taken into account: concentration of ozone during the whole process, exposure time, water temperature and the amount and type of the organic material.*

## Introduction

The disinfection of processed vegetables is one of the critical points along the processing line and has a definitive effect on the safety, quality and shelf-life of the product. Chlorine, which is the most widely used sanitizing agent for fresh cut vegetables, is forbidden in organic food production (EU 2092/91) due to the environmental and health risks (Wei et al., 1985). There is also a need for minimizing the water consumption and wastewater discharge rates in the industry. Therefore both the organic and the conventional processing sectors are now seeking alternatives to chlorine which assure the safety of the products, maintain the quality and enable a shelf-life as long as chlorine. Ozone has many characteristics that make it attractive for use as a sanitizer in food processing. High reactivity, penetrability and spontaneous decomposition to a non-toxic product (O<sub>2</sub>) make ozone a viable disinfectant (Kim et al. 1999). It does not remain in water or on the surface of the product for a significantly long period of time, thus its use may be considered as a processing method rather than a food additive. There is also no need for storage of toxic chemicals as ozone is produced on demand and it is possible to re-use the

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process water and the ozone treatment is accepted as an environmentally friendly process (Khadre et al., 2001). Many studies show that bubbling gaseous ozone in water is the most effective ozonation method for vegetables and can be effective even in lower concentrations (Kim et al., 1999; Singh et al., 2002; Beltran et al., 2005; Ölmez et al. 2007). However higher levels of ozone might be needed for a large manufacturing plant because of the amount of organic, dissolved solids and ozone-demanding material in the water (Garcia et al., 2003). Therefore pilot trials should be always conducted before implementing ozone applications in industry.

The aim of the study was to assess the effect of ozonated water wash on the microbiological and sensory quality parameters of minimally processed iceberg lettuce in pilot scale in comparison to aqueous chlorine wash during the shelf-life of the products. Based on the laboratory scale tests and pre-tests (Ölmez et al., 2007) a pilot test was executed in order to find out the optimized ozone treatment (dose, exposure time and temperature) and in order to develop a process applicable in industrial scale.

## Materials and methods

Conventional industrial iceberg lettuce heads (*Lactuca sativa L.*) were transported and stored under refrigerated conditions until processing day. The wrapper leaves of the lettuce head were stripped away and the lettuce head was split in four pieces. The pieces were shredded with Hällde RG-200 vegetable cutter in 3 cm pieces (10 mm blade). The shredded iceberg lettuces were washed with five different solutions: 1) 7 ppm of ozone for 1 min. in Meiko GK60 washing machine 2) 7 ppm of ozone for 5 min, washing in a tub (volume 70 l) 3) 7 ppm of ozone for 1 min, washing in a tub (volume 70 l) 4) water wash for 1 min, in Meiko GK60 washing machine 5) chlorine wash for 1 min, 100 ppm active chlorine, prepared from sodium hypochlorite adjusted at pH 6,5 with 1M citric acid. The water wash and chlorine wash were used as control. For each wash 4 kg:s of lettuce was shredded. All samples were centrifuged in JMD drying drum (500 r/min). Tap water was used in washing treatments (pH 7.0, temp. +8.5 °C).

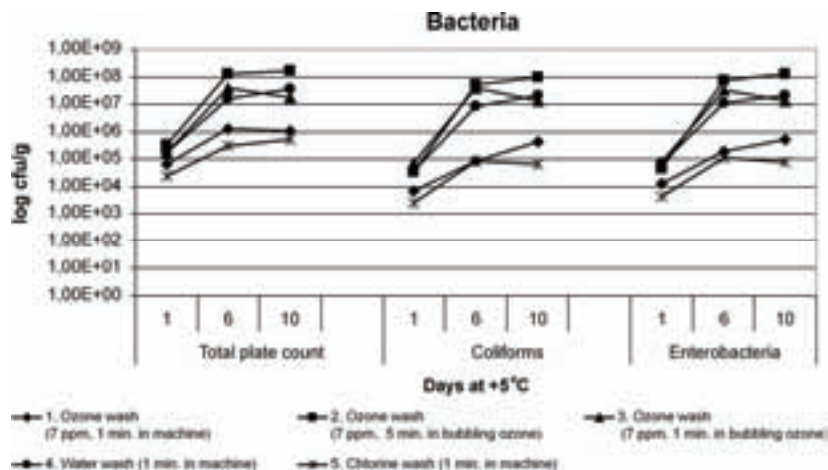
Ozone generator based on corona discharge was used to produce ozone. The ozone productive capacity was ca. 10 g/h when pure oxygen was used as a feed gas. A flow of ozone was dissolved in the tap water by an inverse mixer (+ mixing nozzles) in 70 l tub. The 7 ppm ozone dose for the treatments 1, 2 and 3 means the concentration in the beginning of the process. Gaseous ozone production was measured using on-line measurement system (ATI Dissolved Ozone Monitor, Model A15/64). The samples (150 g) were packed in commercial packaging material (oriented polypropylene pouch, oxygen permeability 900 cm<sup>3</sup>/m<sup>2</sup>\*d) in ambient atmosphere. The size of the pouch was 12.5 cm x 17.5 cm. All samples were stored for up to 10 days at +5 °C and evaluated on day 1, 6 and 10.

The microbial analysis included the aerobic plate count (ISO 48333, 3 days at 30 °C), total coliforms (ISO 4832, 1 day at 37 °C) and *Enterobacteriaceae* (Nordic Committee of Food analysis, No 144, 1 day at 37 °C). Each microbial count expressed as log cfu/g of tissue, is the mean of four samples. The sensory quality of the samples was evaluated by five-membered expert panel. Qualitative describing method using semi-structured 100 mm scale was used to evaluate the sensory quality of the samples. The evaluated character was anchored with reference lettuce sample which was prepared the same day just before the evaluation. The organoleptic characteristics included freshness of the smell and off-flavour straight after opening the package, off-flavour on the plate, crispiness, watery taste, freshness of the taste and off-taste. The visual quality evaluation included moisture of the surface, browning of the cut surface

and other colour defects. One sample t-test ( $p < 0.05$ ) for the significance of the differences of the means compared to the reference was performed using SPSS (Windows 2000, version 12.0). One-way analysis of variance and Tukey's test was used to compare the differences between the samples.

## Results and discussion

Concerning the effectiveness of the control of the bacteria there was no significant difference between chlorine wash and the treatment 1 where the samples were washed 1 min. in a Meiko washing machine with ozonated water (Fig. 1). The concentration of ozone was 7 ppm in the beginning of the process and the level of the ozone in the water declined very rapidly during the process being in the end of the process between 0.7-1.0 ppm. As a conclusion, if the level of ozone is high enough in the beginning of the process 1 min as a treatment time is adequate. The chlorine treatment was more effective washing method ( $p < 0.05$ ) than treatment no. 2. It can be concluded that 5 minutes ozone treatment is too long and possibly degrades the microbiological quality of the samples by providing excess oxygen to the microbes during the process. This conclusion is supported by the fact that even the water wash (treatment no. 4) gained lower microbe load than the treatment no. 2.



**Figure 1: The effect of different washing treatments on the growth of bacteria during 10 days of storage at +5°C.**

Concerning the sensory quality all samples endured all of the treatments well except the treatment no. 2 (7 ppm ozone dose for 5 min.). The samples were less fresh concerning the smell and taste ( $p < 0.05$ ), had more moisture on the surface ( $p < 0.05$ ) and had colour defects like greyish appearance after the treatment. The taste was also described more watery than the other samples. Because any severe discoloration did not occur in case of the other ozonated samples it can be concluded that discoloration is caused rather by the treatment time than the high level of the ozone dissolved in the water.

## Conclusion

As a conclusion it can be stated that bubbling gaseous ozone in water can be as effective disinfection method as chlorine wash when the following processing parameters are taken into account: concentration of ozone during the whole process, exposure time, water temperature and the amount and type of the organic material. In order to develop an ozone water wash process applicable in industrial scale, proper testing at the plant must be conducted before applying the method in vegetable disinfection processing. Furthermore a better understanding of the mechanism involved in bacterial attachment on the surface of the fresh vegetable produce is necessary to improve the technology.

## Acknowledgments

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# Protein quality and content of nitrite, nitrate and metals in commercial samples of organic and conventional cold meats.

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Key words: organic cold meat, protein, additives, heavy metals

## Abstract

*Twenty-six organic and conventional samples of cold meats were analysed and compared with respect to: meat protein quality, nitrite, nitrate and metal content to verify if organic products have any health advantage that may be attractive to consumers.*

*Proteins quality was assessed by sodium dodecyl sulphate-polyacrilamide gel electrophoresis (SDS-PAGE) and two-dimensional electrophoresis (2D EF). Nitrite and nitrate content were measured by the Griess reaction. Metals were detected by atomic absorption spectroscopy.*

*Electrophoretic data show differences in the quality of water-soluble proteins in uncooked products, in contrast to thermal treatment results, which revealed no differences between the organic and conventional products, although it is difficult to interpret these data.*

*Metal analyses show significantly higher levels of Fe, Zn, Ca, Se, and Cu in organic meat.*

*There was no significant difference detected in nitrite content, while nitrate was lower in organic compared to conventional salami. These results suggest that cooked organic meat products do not have any nutritional advantage over conventional ones, and that only seasoned products preserve the original quality of organic meat.*

## Introduction

In recent years both consumer demand and the scientific work carried out on organic meat products have increased. However, most studies have been conducted on fat profile (Hansen et al., 2006) of raw meat or on the effect on growth performance (Millet et al., 2005), with little attention paid to the protein quality of cold meats. Yet we know that the content of metals (Jemeljanovs et al., 2004), nitrite and nitrate (*The EFSA Journal*, 2003) are important with respect to food safety. Consumers are thought to be attracted to organic meat by the perception of a superior nutritional profile in comparison with conventional food. This work is the beginning of a project to investigate the composition of cold meats such as salami and cooked and seasoned ham, and to identify differences that could justify the consumers' ideological motivation to choose organic over conventional products.

## Materials and methods

Twenty-six samples of organic and conventional meat products were purchased on the local market or obtained from Italian producers. The comparison was made among six salamis, three dry cured hams, and four cooked hams for each class (organic and conventional), choosing products as similar as possible regarding formulation and

processing technology. Three replications were made for metals, nitrite, and nitrate analysis, while each electrophoretic sample was performed twice.

Edible parts of the meat samples were ground and proteins were extracted for SDS-PAGE and 2D EF analysis. Water-soluble proteins were extracted in phosphate buffer (pH 7.4) at low ionic strength, while myofibrillar proteins were extracted by a high ionic strength solution (KI 0.75M). The electrophoretic run was performed on ExcelGel 8-18 (GE Healthcare).

Two-dimensional EF protein samples were taken by extraction with urea and nonionic detergent solutions. Immobiline strips (pH 6-11 NL and 4-7) were used to carry out the first dimension.

Gels were stained with Coomassie Blue Brilliant. Electrophoresis patterns were evaluated with Quantity one and PD Quest software (BioRad).

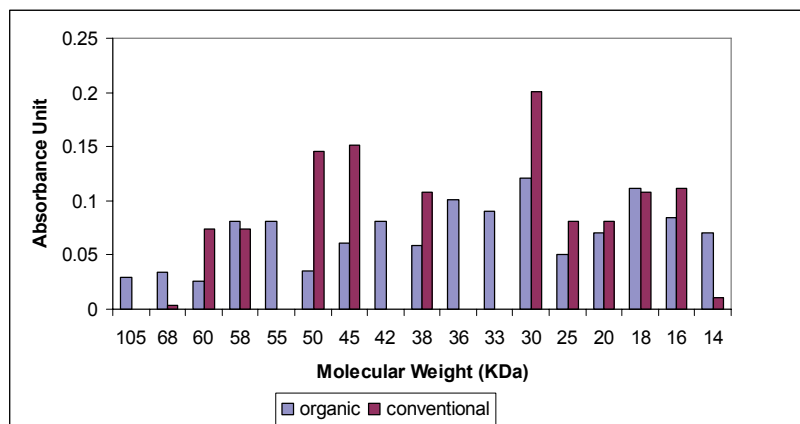
Metal analyses were performed by atomic absorption spectroscopy (Al, As, Ba, Ca, Cd, Cr, Cu, Fe, Hg, Li, Mn, Ni, Pb, Se, Zn).

Nitrite and nitrate were detected by cadmium reduction-Griess reaction.

Statistical analysis: independent t-tests were performed with the SPSS 10.0 software package, comparing two classes (conventional and organic) for each meat product.

## Results

The electrophoretic pattern of organic seasoned products shows more peaks, although they are often weaker than in conventional products. In Figure 1, the main peaks of water-soluble proteins detected in SDS-PAGE of salami are shown. No difference was detected in the salt-soluble protein fraction.



**Figure 1: Main peaks of water-soluble protein of salami identified by SDS-PAGE (average value).**

The 2D electrophoresis pattern presents more and stronger spots in the region of enzymatic proteins (pI 6-9) in organic meat samples. In contrast, the structural

components (actin, light chain of myosin and tropomyosin) do not differ much (data not shown).

The samples obtained from cooked products reveal no significant differences.

Metal analysis data are illustrated in Table 1. Table 2 reports the nitrite and nitrate content per 100 g of edible portion.

**Tab. 1: Metal content expressed as mg per 100 g of edible portion.**

		Ca	Cu	Fe	Se	Zn
<b>Cooked ham</b>	Conventional	7.3 <sup>a</sup>	0.05 <sup>a</sup>	0.5 <sup>a</sup>	0.03 <sup>a</sup>	1.6 <sup>a</sup>
	Organic	6.2 <sup>a</sup>	0.05 <sup>a</sup>	0.6 <sup>a</sup>	0.02 <sup>a</sup>	2.1 <sup>b</sup>
<b>dry ham</b>	Conventional	10.8 <sup>a</sup>	0.2 <sup>a</sup>	1.5 <sup>a</sup>	0.03 <sup>a</sup>	3.2 <sup>a</sup>
	Organic	12.1 <sup>b</sup>	0.1 <sup>a</sup>	1.8 <sup>b</sup>	0.04 <sup>a</sup>	3.2 <sup>a</sup>
<b>salami</b>	Conventional	2.9 <sup>a</sup>	0.03 <sup>a</sup>	0.3 <sup>a</sup>	0.03 <sup>a</sup>	2.9 <sup>a</sup>
	Organic	5.0 <sup>b</sup>	0.06 <sup>b</sup>	0.8 <sup>b</sup>	0.04 <sup>b</sup>	4.1 <sup>b</sup>

<sup>a,b</sup>Means in a column of the same product without a common superscript differ significantly (P< .05)

**Tab. 2: Nitrite and nitrate content expressed as mg per 100 g of edible portion.**

		nitrite	nitrate
<b>Cooked ham</b>	Conventional	2.0 <sup>a</sup>	3.0 <sup>a</sup>
	Organic	1.6 <sup>a</sup>	2.3 <sup>a</sup>
<b>dry cured ham</b>	Conventional	0.05 <sup>a</sup>	0.2 <sup>a</sup>
	Organic	0.03 <sup>a</sup>	0.1 <sup>a</sup>
<b>salami</b>	Conventional	0.4 <sup>a</sup>	5.2 <sup>a</sup>
	Organic	0.3 <sup>a</sup>	1.3 <sup>b</sup>

<sup>a,b</sup>Means in a column of the same product without a common superscript differ significantly (P< .05)

## Discussion

In organic cold meats, the proteins seem to cover a wider range of molecular weights than in conventional ones. A large number of fragments are observed in SDS-PAGE of water-soluble extracts and especially in the enzymatic region of the 2D EF map. Heat treatment levels out the differences, so that the patterns of cooked meats are very similar between the two types. The presence of new fragments has been highlighted by Hajos et al. (1995), but their meaning is not clear. A strong enzymatic

activity could explain the development of a great number of soluble protein fragments. Further research is needed to understand it.

The content of nitrite and nitrate is similar between the two classes. A significant difference was detected in salami for the final value of nitrate. A small difference was found in nitrite content of cooked ham because residual nitrite is very low even in products where it was added.

A more important difference was detected in metal content. Fe, Ca, and Se were significantly higher in the organic meats only in uncooked products, but Zn was higher in cooked organic products also. The Cu content was higher in the organic salami. All other metals analysed did not show any difference between the classes.

The data reported in the literature about the metal content of conventional meat products are roughly similar to those found in our test (6).

## Conclusions

For seasoned cold meats, organic products showed a wider range of protein fragments, although these are difficult to translate into a positive marketing message. More interesting is the higher level of some beneficial trace elements in organic meat, probably the result of the pigs' nutrition. Nitrate residue in meats was higher following its addition during processing, as in conventional salami, which is significantly higher than the organic salami. Generally, cooked cold meats showed little difference between conventional and organic products in the variables studied, since processing technology has a stronger impact on the final product than the origins of raw meat.

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# Survey of acaricide residues in Italian organic and conventional beeswax

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Key words: beeswax / organic / coumaphos / fluvalinate / acaricide

## Abstract

*According to EU Regulation 1804/99, beekeepers converting to organic production methods must replace old combs, which contain residues of lipophilic acaricides used to control infestation of Varroa destructor, with residue-free wax. This poses problems due to difficulty in obtaining organic wax, passage of residues from old wax to new residue-free foundations and the risk of contamination of foundations in the wax transforming firms. To monitor the residue levels of Italian beeswax, samples produced between 1990 and 2006 were analysed for residues of most commonly used acaricides. The samples analysed for the two most commonly used active ingredients, coumaphos and fluvalinate, were classified according to the production method (organic, conventional or converting) and according to the kind of wax (melted or foundation). For all the considered a.i. the average levels of residues in all kinds of samples (organic and conventional) grouped by year, decreased during the considered time period. Classification according to production method showed that organic beekeeping practices have definitely reduced levels of residues, although these persist in wax for a long time. Average levels of acaricide residues in organic melted cap beeswax were used by most Italian Control Bodies for fixing thresholds levels for use of wax in organic beekeeping (200ppb for coumaphos and 100ppb for fluvalinate).*

## Introduction

In the middle of the 90s, after several years of regular use of chemical treatments to save honey bees from the parasitic mite *Varroa destructor* Anderson & Trueman, samples of beeswax started being collected to evaluate the effects of these treatments in the beehive in terms of residues. At the turn of the century organic farming passed from being relegated to a niche market to providing an economically attractive alternative way of farming: in Italy organic hives increased by 40% between 2001 and 2002 (data from Ministry of Agricultural and Forestry Policies). Organic beekeeping is included in Reg.CE 1804/99, which requires, among other things, that hives should be treated against the Varroa mite only with substances of natural origin, such as thymol and organic acids. During conversion of their hives beekeepers must replace the old combs, which contain residues from treatments with lipophilic acaricides, with residue-free wax. This represents the initial obstacle faced by converting beekeepers: problems are due to difficulty in obtaining organic wax, passage of residues from old wax to new residue-free foundations and risk of contamination of foundations in the wax transforming firms.

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## Materials and methods

The reported data is derived from specifically collected samples between 1990-1999 and from service analyses (for beekeepers, control bodies, associations, etc.) carried out by the CRA-API (ex Istituto Nazionale di Apicoltura) UNI CEI EN ISO/IEC 17025 certified laboratory from year 2000 to 2006. For each sample, information concerning the kind of production system (conventional, converting, organic) and the kind of wax (melted combs or foundation sheets) was obtained. The latter classification was carried out to monitor the problem of accumulation of residues in foundation sheets during transformation. This phenomenon occurs due to contamination in the melting chambers (where different lots of beeswax with different residue levels) are processed and due to the affinity between the fat-soluble molecules and wax (Bogdanov et al., 2005). 733 samples (356 organic, 275 conventional and 109 converting) were analysed for presence of at least one of the active ingredients (a.i.) of registered and unregistered acaricides most commonly used by Italian beekeepers: coumaphos, fluvalinate, chlorfenvinphos and cymiazole. Analyses were conducted with gaschromatography connected to selective revealers (nitrogen-phosphorous for coumaphos and chlorfenvinphos; mass spectrometry for fluvalinate and cymiazole). Data is reported as means  $\pm$  SE and results are interpreted in relation to time, production system, kind of wax.

## Results

The pesticide with the highest levels of mean residues over time is coumaphos (Fig.1), confirming that formulated products containing this a.i. have been the most commonly used acaricides in Italy in the last 10-15 years. Fortunately residue levels have decreased progressively from the 1990-1997 samples ( $2490\text{ppb} \pm 1153\text{SE}$   $n=20$ ) to the 2006 samples ( $125\text{ppb} \pm 257\text{SE}$   $n=99$ ).

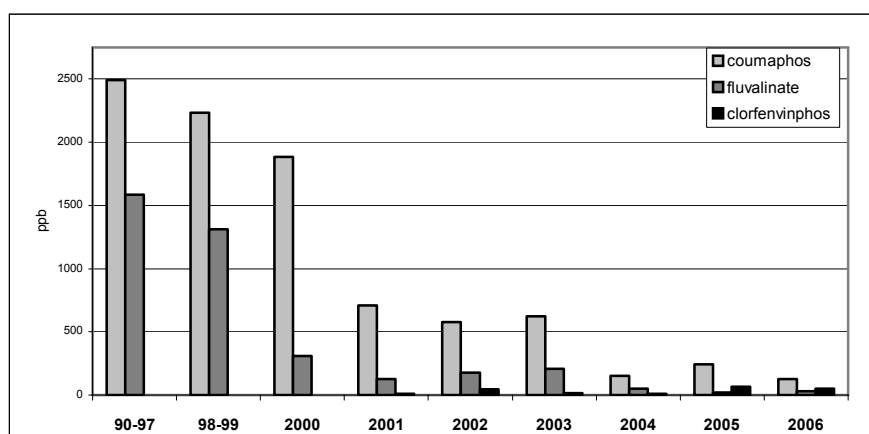
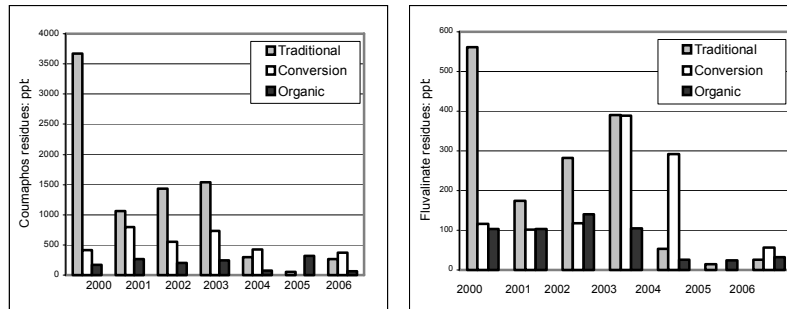


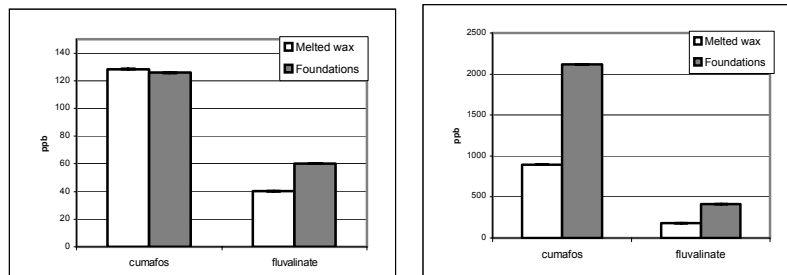
Figure 1: Residues of acaricides in samples of Italian beeswax from the 1990s to 2006 (pooled data from organic, conventional and converting samples).

Residues of clorfenvinphos were also detected in an increasing number of samples (from 0% in year 2000 to 22% in 2005), which, although low ( $67\text{ppb} \pm 54\text{SE}$  in 2005, probably indicating a limited residuality in wax), in 2005 and 2006 were higher than average levels of fluvalinate. In comparisons between conventional and organic wax only coumaphos and fluvalinate were considered. Residues levels for both a.i. decrease passing from conventional to organic wax (-88% and -61% in organic compared to conventional, respectively), while the samples of converting wax have intermediate levels of residues (Fig.2-3). The percentage of positive samples in 2006 is still quite high for both coumaphos (75%) and fluvalinate (40%) but the proportion of positive organic wax samples with residue levels higher than 200ppb for coumaphos and 100 ppb for fluvalinate were relatively low (5% and 6% respectively).



**Figure 2 and Figure 3: Residues of coumaphos (left) and fluvalinate (right) in beeswax from different kinds of honey farms (conventional, converting and organic).**

Comparisons according to the kind of wax showed that, in the case of fluvalinate, residues levels in foundations were higher in both kinds of production method (Fig.4-5). For coumaphos, however, a different situation was observed: while foundations from conventional farming contained more than double the residues of conventional melted combs (Fig.5), in the samples from organic farming the mean levels of residues of the two kinds of wax were almost equal (Fig.4).



**Figure 4 and Figure 5: Residues of coumaphos and fluvalinate in organic (left) and conventional (right) melted wax (from caps) and foundation sheets.**

## Discussion

The decrease in residues of most acaricides over the years indicates the beekeepers' tendency to shift to alternative products, although it must be considered that most of the analyses carried out from the year 2000 concern wax belonging to beekeepers who were personally interested in knowing its residue levels (service analyses), and who therefore probably had a reasonable hope, due to the kind of management, that the wax would be almost residue free. However, the dramatic decrease of mean levels of coumaphos residues between 2000 and 2001 give a clear indication about beekeepers' response to the EU Regulation on organic farming, which was also encouraged by the development of strains of resistant mites (Lodesani et al, 1995; Milani, 1999) and the discovery of the possibility of controlling mite populations in the beehive with more environment friendly products such as organic acids and thymol (Liebig, 1997; Chiesa, 1991), as well as the higher prices obtained by organic honey.

The reason why residue levels in foundations are much higher than in melted wax is probably due to the origin of samples which are sent to the laboratory for analysis: conventional melted wax usually comes from keen individual producers who want to verify the quality of their wax, often with an idea to converting to organic production methods. Conventional foundations represent foundations found on the market, which come from transformation of multiple lots of wax, and are subject to accumulation and enrichment of residues; organic foundations on the other hand are more often a single beekeeper's product, obtained from the transformation of especially selected cap wax, in certified wax processing firms. Most firms have approached the problem of accumulation of residues by spatial and /or temporal separation of the lots of beeswax according to residue levels.

## Conclusions

These results show that organic beekeeping practices have definitely reduced levels of residues in beeswax although they persist at low levels for a long time.

On the basis of the data we here present, in the first years following application of Reg.CE 1804/99, some Italian Control Bodies adopted 200 ppb for coumaphos and 100 ppb for fluvalinate as threshold levels for declaring wax compatible for use in organic beekeeping.

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# Occurrence and level of patulin contamination in conventional and organic apple juices marketed in Italy

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Key words: apple juice, HPLC, mycotoxin, patulin, *Penicillium expansum*.

## Abstract

A survey on the occurrence of patulin was conducted during 2005 on conventional (98 samples) and organic apple juices (37 samples) marketed in Italy. Patulin could be quantified in 34.8% of the samples ranging from 1.58 to 55.41  $\mu\text{g kg}^{-1}$ . With the exception of one sample, the level of patulin was lower than 50  $\mu\text{g kg}^{-1}$ , the maximum permitted threshold in fruit juices according to the European legislation. A similar incidence of positive samples was found in conventional and organic apple based juices, and the magnitude between the mean contamination levels, although higher in organic (10.92  $\mu\text{g kg}^{-1}$ ) than in conventional juices (4.77  $\mu\text{g kg}^{-1}$ ), was not statistically significant ( $P=0.771$ ; Mann-Whitney test). The current study was undertaken also to investigate the possible influence of the type of apple juice (mixed, clear or cloudy) on the occurrence and level of patulin contamination. Mean levels of patulin were significantly lower in mixed apple juices (4.54  $\mu\text{g kg}^{-1}$ ) than in pure apple juices (9.32  $\mu\text{g kg}^{-1}$ ). Levels of patulin contamination were comparable in clear and cloudy juices.

## Introduction

Patulin is a secondary metabolite produced by some species of *Aspergillus*, *Byssoschlamys* and *Penicillium* (Weidenbörner, 2001). Apples and apple products are excellent substrates for *Penicillium expansum*, the causal agent of blue mould, to produce the mycotoxin. Acute symptoms of patulin consumption can include agitation, convulsions, edema, ulceration, intestinal inflammation and vomiting. Chronic health effects of patulin include genotoxicity, immunotoxicity, and neurotoxicity in rodents, while its effects on humans are not clear yet. The maximum permitted level of patulin in fruit juices and nectars, in particular apple juices and apple juice ingredients in other beverages marketed in Europe is 50  $\mu\text{g kg}^{-1}$ . The permitted threshold is lower for apples juices labelled and sold as intended for infants and young children (10  $\mu\text{g kg}^{-1}$ ).

Previous studies have evaluated the patulin content in apple derivatives commercialized in Italy (Beretta et al., 2000; Ritieni, 2003). During November 2003 – February 2004, 169 samples purchased in Italian markets, supermarkets and organic food shops, including 57 apple juices, 15 pear juices and 57 other juices, were analysed (Piemontese et al., 2005). Sixteen of the 33 conventional apple juices were contaminated, as well as 12 of the 24 organic apple juices.

In this study we concentrated on the occurrence and level of patulin in apple based juices not intended for infants marketed in Italy, looking at the influence of the agricultural production process employed (conventional or organic). A second aim of

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the work was the investigation of the possible influence of type of apple juice (mixed, clear or cloudy) on the occurrence and level of patulin contamination. To our knowledge, this was the first investigation performed on a significant number of mixed apple juices.

## Materials and methods

Commercial apple (clear and cloudy) and mixed juices not intended for infants (135 samples) were purchased at random from Italian supermarkets or organic food shops during the period April – November 2005. In particular, 98 conventional and 37 organic fruit juices produced in Italy or imported were analysed. The extraction procedure used, modified by Arranz et al. (2004), permitted to quantify  $10 \mu\text{g kg}^{-1}$  or lower levels of patulin. Cloudy juices were left overnight at room temperature or 2h at  $40^\circ\text{C}$  with pectinase enzyme solution and then centrifuged at 4500 rpm for 5 min. Thirty g of clarified juice were extracted with ethyl acetate. The organic phase was dehydrated with 15 g of sodium sulphate anhydrous and then evaporated to dryness. The clean-up was performed modifying the procedure of Stray (1978). The sample was dissolved in 10 ml of toluene and 5 ml of sample were cleaned-up with  $\text{C}_{18}$  SPE column previously triggered with 5 ml of toluene. The column was washed with toluene and the sample was eluted with 4 ml of toluene: ethyl acetate (1:1). The final eluate was evaporated to dryness, dissolved with 1.5 ml of acetic acid solution, filtered through a  $0.22 \mu\text{m}$  syringe filter and transferred into a HPLC vial.

The mobile phase, eluting at a flow rate of 1 ml/min, consisted of an isocratic mixture of water-acetonitrile-perchloric acid (96:4:0.1) for 16 min, followed by a washing step with an isocratic mixture of water-acetonitrile (35:65). 100  $\mu\text{l}$  of sample were injected onto the HPLC column and the retention time of patulin was 11.82 min. The amount of patulin in the final solution was determined by using a calibration graph of concentration versus peak area and expressed as ng/ml.

The limit of detection (LOD) and the limit of quantification (LOQ), based on the IUPAC definition, were respectively 1.04 and  $1.57 \mu\text{g kg}^{-1}$ . Mean patulin concentrations were calculated by using LOQ/6 for negative samples. The Mann-Whitney test was used to compare the mean patulin levels. The  $\chi^2$ -test was used to compare the patulin contamination frequencies. Statistical analysis was performed by using the SPSS software (SPSS Inc., version 12.0.1, Chicago, IL, USA).

## Results

Patulin could be quantified in 47 out of 135 pure apple or mixed apple juices (ranging from  $1.58$  to  $55.41 \mu\text{g kg}^{-1}$ ). An overall incidence of 34.8% was observed in the apple based juices, with 24 samples having between  $1.57 \mu\text{g kg}^{-1}$  (LOQ) and  $10 \mu\text{g kg}^{-1}$  patulin, 22 samples having between  $10 \mu\text{g kg}^{-1}$  and  $50 \mu\text{g kg}^{-1}$  patulin, and one sample exceeding the  $50 \mu\text{g kg}^{-1}$  patulin threshold (Table 1). A mean contamination level of  $6.42 \mu\text{g kg}^{-1}$  was calculated for all contaminated samples. A similar incidence of positive samples was found in conventional (35.7%) and organic (32.4%) apple based juices, although the mean contamination level in organic juices ( $10.92 \mu\text{g kg}^{-1}$ ) was double the value found in conventional juices ( $4.77 \mu\text{g kg}^{-1}$ ). The hypothesis that the mean patulin contamination levels in conventional and organic apple juices were not different was accepted ( $p = 0.771$ ; Mann-Whitney test). Even narrowing the statistical analysis to the pure apple juices, no significant difference can be registered between the mean patulin contaminations in conventional ( $8.96 \mu\text{g kg}^{-1}$ ) and organic ( $9.91 \mu\text{g kg}^{-1}$ )

kg<sup>-1</sup>) pure apple juices ( $p = 0.336$ ). According to the typology of juices, the magnitude between the means of patulin level in pure apple juices (9.32  $\mu\text{g kg}^{-1}$ ) and mixed apple ones (4.54  $\mu\text{g kg}^{-1}$ ) was statistically significant ( $p = 0.012$ , Mann-Whitney test). Also the medians of the two juice typologies were significantly different, respectively 1.39  $\mu\text{g kg}^{-1}$  and 0.27  $\mu\text{g kg}^{-1}$ . A patulin incidence of 47.2% was registered in pure apple juices, while a lower occurrence (26.8%) resulted in mixed apple juices. The  $\chi^2$ -test showed that the frequencies of patulin occurrence in pure apple and mixed apple juices were not comparable ( $p = 0.0003$ ). Although higher incidence and level of contamination were found in pure apple juices, also mixed apple juices have a significant mean patulin contamination. The sample with the highest patulin contamination, exceeding the limit of 50  $\mu\text{g kg}^{-1}$  was an organic mixed apple one (55.41  $\mu\text{g kg}^{-1}$ ).

**Tab. 1: Patulin contamination in juices containing 100% apple juice or a certain percentage of apple juice together with other fruit juices, marketed in Italy**

Commodity	Positive / total	%	Number of samples			Mean* $\pm$ SD ( $\mu\text{g kg}^{-1}$ )
			<10 $\mu\text{g kg}^{-1}$	10-50 $\mu\text{g kg}^{-1}$	>50 $\mu\text{g kg}^{-1}$	
Conventional juices	35/98	35.7	20	15	-	4.77 $\pm$ 3.32
Organic juices	12/37	32.4	4	7	1	10.92 $\pm$ 6.37
Conv. apple juices	19/32	59.4	11	8	-	8.96 $\pm$ 4.46
Organic apple juices	6/21	28.6	2	4	-	9.91 $\pm$ 5.91
Apple juices	25/53	47.2	13	12	-	9.32 $\pm$ 5.07
Clear apple juices	14/28	50.0	8	6	-	10.81 $\pm$ 4.27
Cloudy apple juices	11/25	44.0	5	6	-	7.59 $\pm$ 5.62
Mixed juices	22/82	26.8	11	10	1	4.54 $\pm$ 3.88
Total juices	47/135	34.8	24	22	1	6.42 $\pm$ 4.48

\*Mean level was calculated using LOQ/6 for negative samples.

The results also show a comparison of the mean patulin contamination level in clear (10.81  $\mu\text{g kg}^{-1}$ ) and cloudy (7.59  $\mu\text{g kg}^{-1}$ ) apple juices. Such division was possible only for pure apple juices, because all mixed apple juices purchased and analysed in this study were cloudy. The hypothesis that the mean patulin contamination levels in clear and cloudy apple juices were not different was accepted ( $p = 0.940$ ; Mann-Whitney test). A similar incidence of patulin contamination was registered in clear (50.0%) and cloudy juices (44.0%). Moreover, the  $\chi^2$ -test showed that the frequencies of patulin occurrence in clear and cloudy apple juices were comparable ( $p = 0.356$ ).

## Discussion

According to a study carried out by Beretta et al. (2000), organically produced apple juices are more contaminated by the mycotoxin than conventionally produced ones. Ritieni (2003) and Tangni et al. (2003) compared organic and conventional produced apple juices without finding any statistically significant difference. Piemontese et al. (2005) showed a statistically higher incidence of positive samples and mean patulin

concentration in organic products as compared to conventional ones. On the other hand, a similar incidence of positive samples was found in conventional and organic apple juices, with mean patulin concentrations statistically not different. The fact that no significant differences were registered in this study between organic and conventional fruit juices could be explained with the same care used in both production chains in removing decayed and damaged fruit during juice processing. Few reports are available on the occurrence of patulin in mixed juices containing apple and other fruit juices. Piemontese et al. (2005) analysed 57 samples of "other" juices, including fruit juices other than apple and pear or juices containing apple together with other fruit. Probably, the relative high contamination found in mixed juices could be explained with a lower attention to the quality of the single juice added to the mixture: mixed juices generally contain higher quantities of sugars and other additives. Seasonal differences could be responsible in some way for the differing results by other authors (Sydenham et al., 1997). For this reason, the juices analysed in this study were bought in periods of the year (from April to November) representing the old and the new season. From the study we can also conclude that the clarification of apple juice probably did not significantly change the level of patulin contamination in clear juices compared to cloudy ones. In conclusion, most of the data shown in the present study indicate an acceptable situation about the quality of the fruit juices marketed in Italy, with a low level of contamination in the pure or mixed apple juices. With the exception of one sample, the level of patulin was lower than  $50 \mu\text{g kg}^{-1}$ , the maximum permitted threshold in fruit juices according to the EU - legislation.

### Acknowledgments

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## Sensory evaluation of processed wheat from a defined field-trial (QualityLowInputFood)

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Key words: sensory evaluation, organic wheat quality, variety, QDA

### Abstract

*The integrated project QualityLowInputFood (QLIF) aims to improve quality, ensure safety and reduce costs along the organic and "low input" food supply chains. Beside safety, freshness, general health benefits as well as nutritional value, one reason for consumers demanding organic foods are more tasty products (Bourn/Prescott 2002). Therefore it is important to evaluate how the sensory attributes such as taste, flavour and texture of fresh and processed products are influenced by the different management systems. For sensory evaluation, in crop year 2005 seven wheat samples were assessed by a trained sensory panel, each with 4 field replicates (in total = 28 samples). The wheat samples were processed to wholemeal bread and biscuits for evaluation.*

*A descriptive panel (12 persons) was well trained according DIN 10967 as well as for quantitative descriptive analysis (QDA). This method enables to show a complete product profile with all sensory characteristics and their intensity in appearance, aroma, texture, mouthfeel and flavour attributes.*

*For wholemeal-bread, results in crop year 2005 showed no significant differences between the different farming systems. The influence of varieties were higher than farming management effects. The varieties "Paragon", "Zebra" and "Fasan" were significant different to "Monsun" in texture attributes.*

### Introduction

Beside safety, freshness, general health benefits as well as nutritional value, one reason for consumers demanding organic foods is a tastier product (Bourn/Prescott 2002). Therefore, it is of particular importance to compare organic, low input and conventional management systems on farm (field trials) and their influence on the sensory product characterisation. Sensory methods can be classified into three categories (Busch-Stockfisch, 2003) with different requirements for the training of assessors (trained or untrained panellists).

1. Discrimination tests allow distinguishing whether there is a difference in general, but without substantiating the differences in detail or quantifying intensities.

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2. Descriptive analysis method allows describing attributes of a product in detail and compares the intensities of these attributes from different products.

3. Preference and acceptability tests allow reflecting relative degrees of liking. The Quantitative Descriptive Analysis (QDA) was used in this evaluation. It is able to show a complete product profile with all sensory characteristics and their intensity in appearance, aroma, texture, mouth feel and flavour attributes. Under the guidance of a panel leader, a panel group consisting 10 – 12 persons developed a scorecard with a list of attributes which fully describes the products and definitions for each attribute. At the same time a ranking of attributes was done. At least the panellists learned to practice scoring along the intensity scale. The panellists were trained to be able to communicate precisely without subjective descriptions and to work consistent and reproducible (Stone & Sidel 2002).

## Materials and Methods

The following samples were tested: from field trial at Nafferton Ecological Farming Group, Newcastle, UK, 7 wheat samples of different management systems (fertilizer/innoculum system) and varieties (see [www.qlif.org](http://www.qlif.org)) were sent to Kassel University. There wholemeal-bread was processed according standard methods for grain and bread of the German Federal Research Institute for grain (1994) according standard method for wholemeal-bread. Biscuits were also processed on the basis of the standard method for short crust-biscuits, but the recipe had to be adapted to the special conditions of wholemeal (see [qlif.org](http://qlif.org): WP 2.1.1 annual report 2006 effect of crop management practices on quality characteristics of wheat).

Bread and also biscuits were processed 14 hours before sensory training respectively sensory evaluation. Training and evaluation was organised according to following time schedule:

**Tab. 1: time schedule sensory evaluation of wholemeal bread- and biscuits**

time schedule	wholemeal bread crop 2005	Wholemeal cookies crop 2005
general training on wholemeal bread	24.01.-03.02.06 6 sessions	25.04.-05.05.06 6 sessions
training with QLIF-samples with focus score training	07.02.-23.03.06 15 sessions	09.05.-01.06.06 15 sessions
evaluation of QLIF-samples (max. 6 samples per session)	28.03.-06.04.06 6 sessions	06.06.-16.06. 6 sessions

*1 session = 1,5 h-2 h/ generally 3 session per week*

Training and evaluation were carried out according QDA-standards of Stone & Sidel (Stone, Sidel 1993). For the description of wholemeal bread, 29 attributes had been selected, for biscuits the panellists described 24 attributes. The panellists were calibrated directly on the test samples. During data collection, panellists got at maximum of 6 product samples per session in a randomized design order (according to sensory computer software FIZZ, Biosystemes, France). The samples were served in booths, monadically (each panellist got the samples in different order). All data were quantified by ratings of perceived intensities, using an unstructured line scale with end-anchors and offset goal posts (e. g. from weak to strong). Experimental design was as follows:

1. Factorial: each level of a factor is matched with each level of others.
2. Replicated: samples were evaluated 4 times (= field replicates).

3. Repeated Measures: each panellist tasted each sample.

The experimental design yields a four-dimensional data matrix: panellist x attributes x samples x replicates. The data were analysed by "FIZZ" sensory software. Descriptive statistical measures were first calculated for all attributes using scores from panellists. Analysis of variance was performed on each attribute using a randomized block design for balanced data, with panellists as repeated measures. Where F-test indicated a significant difference between test treatments, differences was defined as  $P < 0,05$ .

## Results

In crop year 2005, results of the sensory profiling show significant differences in appearance and texture attributes of wheat varieties for wholemeal bread. No significant differences could be found for wholemeal biscuits.

The influence of varieties on sensory attributes was higher than farming management effects.

**Tab. 2: Variance analysis of texture attributes wholemeal-bread crop 2005**

Analysis (*1)	Paragon compost:yes innocul.:yes	Zebra compost:yes innocul.:yes	Monsun compost:yes innocul.:no	Monsun compost:no innocul.:no	Monsun compost:yes innocul.:yes	Monsun compost:no innocul.:yes	Fasan compost:yes innocul.:yes	Comp. F	Proba
<b>poresize</b>	6,51	5,29	3,05	3,07	3,07	3,05	5,59	100,33	<0,0001
group (*2)	A	B	C	C	C	C	B		***
<b>firmness (hand)</b>	2,19	3,7	6,76	6,79	6,31	6,53	3,12	171,82	<0,0001
group	E	C	AB	A	B	AB	D		***
<b>firmness (mouth)</b>	2,57	3,51	5,62	5,92	5,56	6,11	3,41	92,75	<0,0001
group	C	B	A	A	A	A	B		***
<b>dry (mouth)</b>	5,42	4,79	3,88	3,81	3,66	3,4	5,06	27,16	<0,0001
group	A	B	C	C	C	C	AB		***
<b>sticky (mouth)</b>	6,17	5,41	4,3	4,77	4,31	4,26	5,52	24,65	<0,0001
group	A	B	C	C	C	C	B		***
<b>grainy (mouth)</b>	4,33	3,94	4,92	4,56	4,71	4,86	4,09	6,31	0,0217
group	ABC	C	A	ABC	AB	A	BC		*

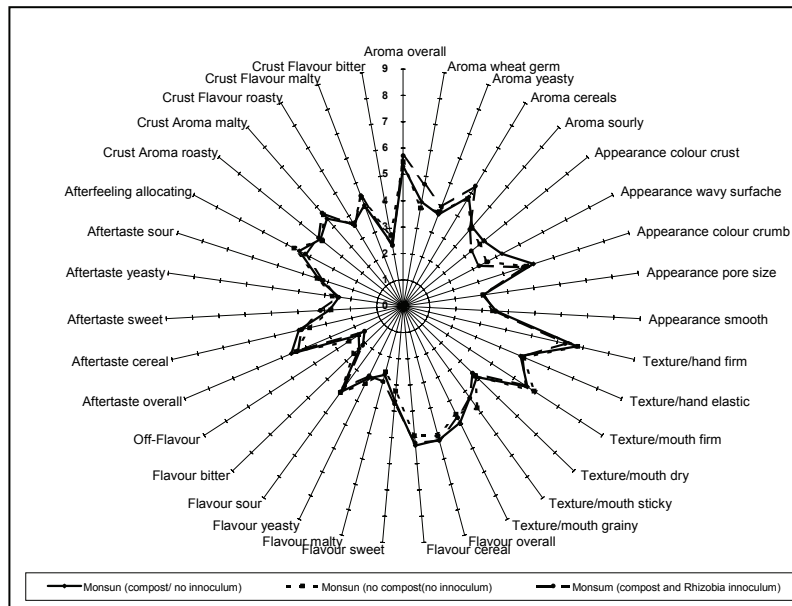
Summary Factor: Product L.S.D. at 5%

\* significant at 5 %/\*\* significant at 1 % /\*\*\* significant at 0,1 %

\*1: analysis of variance FIZZ-sensory software; mean (size 44 - 11 panellists x 4 field replicates)

\*2: group: the difference between levels with same letter is not significant.

Overall, even with compost fertilisation, variety "Monsun" showed no sufficient baking qualities. The rising quality of "Paragon" was too strong, it was also too sticky. "Fasan" and "Zebra" had the best baking qualities.



**Figure 1: Product profile wholemeal bread of wheat variety "Monsun", comparison of different farming systems (mean values of panel group) from harvest 2005**

In appearance, the varieties Paragon, Zebra and Fasan had a significant higher intensity of crust colour, due to a higher rising quality of the dough. This is also shown by a higher size of pores and a less firm. Most intensive in these attributes was the variety "Paragon", followed by "Fasan" and "Zebra" with nearly same intensities. These varieties had also a more sticky and dry mothfeel in comparison to "Monsun".

## Discussion

The reported results are part of a three year comparison of wheat samples within the project QualityLowInputFood (harvest 2005, 2006 and 2007). The results of baking tests as well as the correlation of sensory analyses with data from chemical analyses will be done in autumn 2008.

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## Potential Risk of Acrylamide Formation in Different Cultivars of Amaranth and Quinoa

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Key words: asparagine, acrylamide, pseudocereals, cultivar, food products

### Abstract

*Acrylamide (AA), a potential human carcinogen, is formed in strongly heated carbohydrate-rich food as a part of the Maillard-reaction. The amino acid asparagine (Asn) and reducing sugars are considered to be the main precursors for AA formation. So far, research in AA has mainly focused on potato and cereal products, indicating the relevance of species, cultivars, amount of N fertilizer, and climatic conditions. Potential additional sources of acrylamide in food products might be pseudocereal grains (e.g. amaranth, quinoa). As amaranth and quinoa are often cultivated as cash crops in organic production systems, the aim of this study was to investigate the potential of acrylamide formation in different amaranth and quinoa cultivars. Grain samples were collected from field trials in Germany and Austria consisting of 6 amaranth and 3 quinoa cultivars. The results indicated significant differences in the potential for acrylamide formation of quinoa cultivars and also slight differences between tested amaranth cultivars. It is obvious that the selection of cultivars with a low AA formation potential would offer a suitable strategy for the minimization of AA in foodstuffs.*

### Introduction

In April 2002, the Swedish National Food Administration announced that certain food products contain high amounts of acrylamide. As affected food products mainly carbohydrate-rich foods, such as potatoes or cereal products, were mentioned (Mottram et al., 2002). These findings attracted world-wide attention, especially as acrylamide is classified as "probably carcinogenic to humans" (IARC, 1994). Since the announcement in 2002, considerable progress has been made in basic understanding, and several aspects of acrylamide research have been addressed, such as methods of analysis, occurrence, formation, chemistry, toxicology, and potential health risk in the human diet. So far, most studies on acrylamide have been carried out on fried potatoes to understand the critical factors that may control or reduce acrylamide formation. Results clearly indicated that the amount of acrylamide increased with frying and baking temperature (Tareke et al., 2002). From the results gained so far, it can be concluded that the contamination of foods with acrylamide originates from a reaction of asparagine with carbohydrates at high temperatures as part of the Maillard-reaction. Based on these findings, many studies have been carried out, and have found ways to minimize the levels of acrylamide in heated products. From the current standard of knowledge, minimization can be accomplished either by

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modifying the processing parameters such as pH, temperature, and time of heating, or by elucidating the mechanistic path-ways of acrylamide formation and eliminating precursors or intermediates.

To date, research in acrylamide has mainly focused on potato products (Weisshaar & Gutsche, 2002) and cereals (Weber et al., 2007) indicating the relevance of cultivar, amount of fertilizer, and climatic conditions. Current studies show that, due to customary consumption habits in Europe, bakery products might contribute to about 25 % of total acrylamide intake. A potential additional source of acrylamide in cereal food products might be popped or toasted cereal or pseudocereal grains, e.g. popped amaranth (*Amaranthus spp.*) or quinoa (*Chenopodium quinoa*) flakes in breakfast cereals, due to the heat application for popping, toasting or roasting. It has been shown that popping or cooking can increase the contents of aspartic acid in amaranth grain (Gamel et al., 2005). However, no studies on acrylamide in amaranth or quinoa products are available so far. Amaranth and quinoa grain are high in fibre, calcium, and iron content and have a relatively high concentration of other minerals as well, including magnesium, phosphorus, copper, and manganese. Moreover, grain amaranth and quinoa have higher amounts of protein (14-18 %) than many other cereal grains and have significantly higher lysine contents. Because they are gluten-free, amaranth and quinoa are also popular with consumers who have wheat and gluten allergies. Recent advancements on the potential of grain amaranth and quinoa as a cash crop and as healthy anti-allergic alternative to cereal foodstuffs have led to consider the expansion of these crops especially in organic production systems. As the largest amaranth and quinoa grain consumer is the health food industry, where organic and transitional productions carry a market premium, it seems to be essential to investigate the potential of AA formation in amaranth and quinoa.

Hence, the goal of this study was i) to evaluate the potential of amaranth and quinoa to form acrylamide, ii) to investigate potential differences of AA formation in multiple cultivars of amaranth and quinoa. Grain samples were collected from field trials in Germany and Austria consisting of 6 amaranth and 3 quinoa cultivars.

## Materials and methods

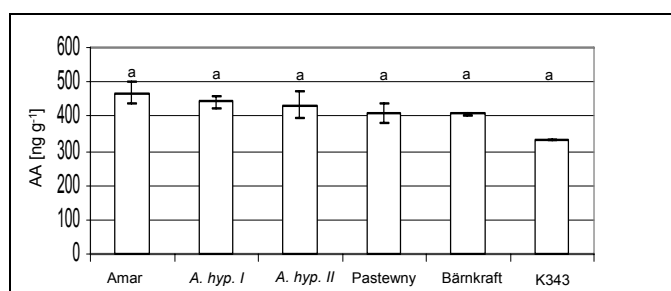
Grain samples of amaranth were collected from field trials in Austria and Germany. Field experiments were conducted on the experimental farm of the BOKU-University at Gross-Enzersdorf in Eastern Austria (48° 12' N; 16° 33' E) during the growing seasons of 2004 and 2005. The amaranth genotypes *Amaranthus cruentus* cv. Amar (Mexican type), *Amaranthus hypochondriacus I* and *Amaranthus hypochondriacus II* (both crossbred lines) were grown under semi-arid conditions of 9.8°C mean annual temperature and 546 mm mean annual precipitation in a split plot design. The soil type was classified as a chernozem of alluvial origin which is rich in calcareous sediments. Since there was a high amount of soil nitrogen available, no N-fertilizer was applied. In Germany in 2003, the amaranth cultivars K343, Pastewny, and Bärnkraft and the quinoa cultivars Faro, Tango, and 407 were cultivated at the experimental station Ihinger Hof (48° 44' N; 8° 56' E) of the University of Hohenheim, Stuttgart, Germany on a loess derived soil with oat as previous crop. Mean annual temperature was 8.1°C and mean annual precipitation was 693 mm. Target nitrogen amounts were 80 kg N ha<sup>-1</sup> for amaranth and 120 kg N ha<sup>-1</sup> for quinoa.

Grain samples were analyzed for free amino acid content by using 2 g of flour mixed with 8 ml of 45 % ethanol for 30 min at room temperature. After sequential centrifugation for 10 min at room temperature and 4000 rpm followed by 10 min at

10 °C and 14000 rpm, the supernatant was filtered through a 0.2 µm syringe filter and filled in vials. Amino acid analysis was performed using HPLC components manufactured by Merck–Hitachi. The fluorescence intensity of the effluent was measured at the excit and emission maxima of 263 and 313 nm were measured. Determination of the sum of reducing sugars was made by using the method of Luff Schoorl (Matissek et al. 1992). AA formation potential was determined according to Weber et al. (2007). SigmaStat version 2.0 was used to compare the amount of precursor factors and of AA formation potential in different cultivars and locations (ANOVA, Tukey). Linear regression analysis was used to determine the correlation between AA contents and precursor factors.

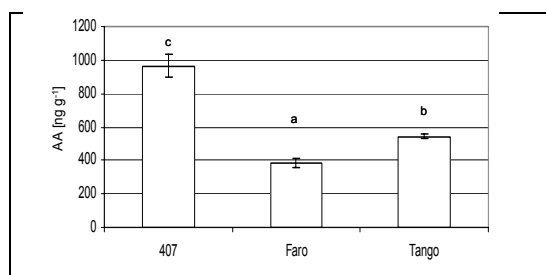
## Results and discussion

Figure 1 indicates the AA formation potential of tested amaranth cultivars and genotypes, respectively. AA formation potential ranged by between 320 and 492 ng g<sup>-1</sup>. No significant difference in AA formation potential was found between the tested cultivars and genotypes. Analysis of the supposed precursors reducing sugars and Asn content indicated a similar capacity of sugar as well as Asn assimilation of all tested cultivars and genotypes. No significant differences were observed between the tested years, or between the locations.



**Figure 1: Acrylamide (AA) potential [ng g<sup>-1</sup>] of investigated amaranth cultivars and genotypes.**

In contrast to amaranth, tested quinoa cultivars (Figure 2) showed a statistically significant difference ( $P = 0.002$ ) in AA formation potential. AA formation potential ranged between 495 and 990 ng g<sup>-1</sup>. Especially, the cultivar Faro showed a relatively low AA formation potential together with a low Asn content when compared to the other tested cultivars. On average, AA potentials of 451 ng g<sup>-1</sup> were found in amaranth, while quinoa indicated a slightly higher AA potential with an average of 613 ng g<sup>-1</sup>. These values are close to NOEL (no observable effect level) at 500 ng g<sup>-1</sup>, suggested by the Federal Institute of Risk Assessment, Berlin. Thus, it indicates a risk potential of AA formation in foodstuffs derived of amaranth and quinoa.



**Figure 2: Acrylamide (AA) potential [ng g<sup>-1</sup>] of investigated quinoa cultivars.**

Further, AA potential of both amaranth and quinoa was 2-3 times higher than in cereal species and thus has to be evaluated in further studies, to estimate potential risks for consumers. Further studies are also required to investigate the role of other amino acids that are present in higher quantities such as aspartic acid, lysine, methionine and glutamine.

## Conclusions

This study investigated acrylamide precursor contents and the potential of acrylamide formation in different amaranth and quinoa cultivars. The results indicated significant differences in the potential for acrylamide formation of quinoa cultivars and slight differences between the tested amaranth cultivars and genotypes. The results suggest that the use of cultivars with low levels of free asparagine and thus a low AA formation potential might be a feasible strategy to lower the risk of consuming acrylamide in foodstuffs derived of the two products described in this paper. In conclusion, to foster the expansion of amaranth and quinoa especially in organic production systems while ensuring premium quality foodstuffs, the selection of cultivars low in free asparagine seems to be an effective strategy.

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## Bioactive compounds of organic plant products

# Cultivation and analysis of anthocyanin containing types of potatoes in organic farming regarding cultivability and additional health benefits

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Key words: anthocyanin content, blue potatoes, additional health benefits, organic farming

## Abstract

*In a two year research project a representative spectrum of blue potato varieties were cultivated and tested in detail regarding disease infestation, yield potential and the influence of production systems (organic). Cultivation recommendations for blue potatoes could be deduced from this. Furthermore the varying anthocyanin content as well as the antioxidant capacity of the varieties used was analysed. Varieties with a particularly high content will undergo further tests to show the influence of the manner of preparation (boiling, steaming, frying) and determine their use for the processing industry. The combination of ecologically produced potatoes with „additional health benefits“ arouses the customers interest. The cultivation of high yield blue types can be an alternative to the cultivation of yellow fleshed high yield varieties in organic operating companies.*

## Introduction

Anthocyanin, the phytochemical which appears in various useful plants such as potatoes and cereal, known especially for its health promoting effects in red wine, have a health promoting effect with their antioxidant properties (KATSUBE et al. 2003, KÄHKÖNEN 2003, MURCOVIC 2002, WATZL et al. 2002). The health promoting properties of anthocyanin are determined by its antioxidant capacity. The health promoting features are for example protection against DNA damage, degenerative illnesses and boosting the immune system (WEISEL 2006). As the potato with a consumption of 60 kg/person/year (ANONYMOUS 2007) still has an important position as a basic food, it is increasingly in the interest of the consumer, nutritional medicine and the food processing industry (e.g. potato crisps production). The goal of the interdisciplinary AGIP research project is the compiling and evaluation of the influence of the organic cultivation system with various intensities (fertilisation/no fertilisation).

## Materials and methods

Within the project a field test was carried out in Germany at the Waldhof experimental station at the FH [University of Applied Sciences] Osnabrück (organic farmed) in terms of a randomized block design with four repetitions. In the test a compilation and evaluation of the influence of various cultivation parameters on technically more favourable type features with the varieties: Blauer Schwede, Blauer Schwede, Blauer

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Schwede, Herrmanns Blaue, Blue Salad Potato, Olivia, Red Cardinal (2006), Highland Burgundy Red (2007), Blaue St. Galler, Vitelotte, Norika 4251 – 4254 (breeding strains) took place. The variety Blauer Schwede was tested with different nutrient levels of 70 kg N/ha and 105 kg N/ha to determine a positive or negative effect on anthocyanin content, all other varieties got no fertilization. The harvest took place at 2006-07-27 and 2007-07-25. The manner of storage has an influence on the anthocyanin content and antioxidant capacity on the ready to consume end product, which will be analysed in the course of the project. To document the effect of storage, there are various time frames for analysis: a) after 4 weeks of storage: investigations into raw harvest crop = analysis of original content b) after 8 weeks of storage: investigation of raw harvest crops = determination of storage losses (raw); c) after 16 weeks of storage: investigations on raw harvest crop = determination of storage losses (raw). During the complete storage period the potatoes were kept dark and cool (8°C). For the determination of the anthocyanin potatoes were washed with water und cut in small slices (incl. potato peel). A mixture of water/acetonitrile/formic acid (87/3/10, v/v/v) was added and the suspension was stirred at room temperature overnight. After the potato pieces were separated from the extract by filtration, the clear filtrate was cleaned-up on Amberlite XAD-7 in order to remove sugars and organic acids. The quantitative determination of anthocyanins was performed by HPLC monitoring at 520 nm using a calibration curve obtained for standard cyanidin-3-glucoside. The determination of the antioxidant capacity was carried out using the Trolox Equivalent Antioxidant Capacity (TEAC) – Test at the FH Osnabrück (HILLEBRAND 2004). Statistical data concerning yield have been determined by ANOVA 2.3 using the LSD test.

## Results

The selected varieties of potato display significant differences in yield in cultivation year 2006 and 2007, in organic cultivation procedures (Tab. 1). Vitelotte, Red Cardinal (2006) and Highland Burgundy Red (2007) only showed a very small yield in both cultivation years. Other varieties such as Blue Salad Potato or Olivia had higher yields in 2007 than in 2006.

**Tab. 1: Yields of selected varieties of blue potatoes in the years 2006 and 2007 in organic farming**

	Total yield (t ha <sup>-1</sup> ) (organic cultivation) 2006	Total yield (t ha <sup>-1</sup> ) (organic cultivation) 2007
Vitelotte	2,0 (a)	2,9 (a)
Red Cardinal (2006)/Highland Burgundy Red (2007)	2,9 (ad)	4,0 (ad)
Olivia	7,3 (b)	18,4 (b)
Blue Salad Potato	4,4 (c)	11,79 (c)
Test used: ANOVA 2.3; 2006 SD 5 % = LSD 2,29; 2007 SD 5 % = LSD 9,53 (significant differences between varieties). Different letters in brackets indicates statistical significant differences between the varieties.		



Figure 1 shows the anthocyanin content of selected varieties of blue potatoes after four, eight and sixteen weeks of storage: the anthocyanin content of Red Cardinals is partly increasing, but in Olivias and Blue Salad Potatoes it is decreasing.

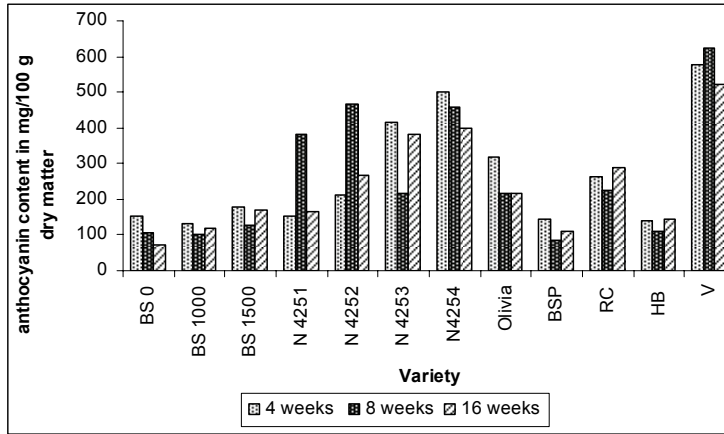


Figure 1: Anthocyanin content in mg/100g dry matter of different potato varieties after 4, 8 and 16 weeks of storage in 2006 (organic cultivation)

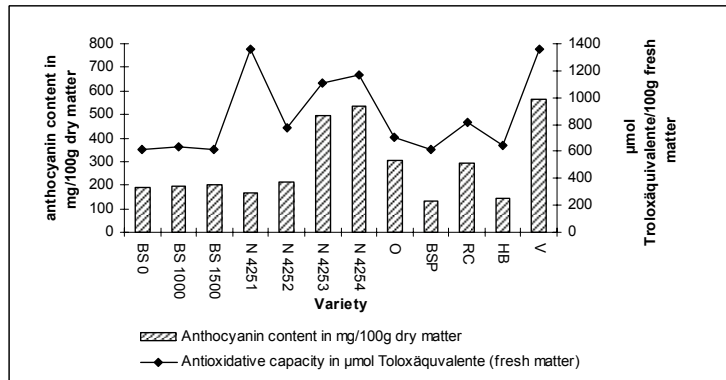


Figure 2: Relation between anthocyanin content and antioxidative capacity at different blue potato varieties 2006 (organic cultivation) Abbreviations: BS 0 = Blauer Schwede, without fertilization; BS 1000 = Blauer Schwede, 70 kg/N/ha; BS 1500 = 105 kg/N/ha; N4251 – N 4254 = Norika breeding strains; O = Olivia; BSP = Blue Salad Potato; RC = Red Cardinal; HB = Herrmanns Blau; V = Vitelotte

Figure 2 illustrates the antioxidant capacity of the cultivated varieties in relation to the anthocyanin content. The investigations in 2006 showed that the level of anthocyanin influenced the antioxidant capacity and therefore the health promoting effects.

## Discussion

The high temperatures and missing rainfall in June 2006 had a negative effect on the tuber growth. Layers and second shoots formed. As a result the exterior and interior quality of the potatoes was often not satisfactory (infestation with potato scurf (*Streptomyces scabies*)). The yields achieved could not be regarded as representative. In the investigations of 2007 it could be recognised that some of the old blue types preferred a relatively high nitrogen content ( $105 \text{ kg ha}^{-1}$ ). Vitelotte and Highland Burgundy Red as well as Red Cardinal could not achieve an adequate yield in organic cultivation, other varieties showed good harvest crop yields up to a total yield of e.g.  $30.22 \text{ t ha}^{-1}$  with the Olivia variety. The investigations in 2006 showed that the anthocyanin content has an influence on the antioxidant capacity and therefore on the health promoting effects. Anthocyanin content and antioxidant capacity are dependent on the variety and according to the results from 2006 are not influenced by the use of a nitrogen fertiliser.

## Conclusions

The results of the research project show that sometimes it is possible to cultivate a particular variety e.g. old anthocyanin containing varieties of potatoes in organic farming, however a breeding process must take place for some types of potatoes concerning the needs of the user today regarding skin texture, shape or taste. Investigations in 2007 have not yet been completed at this point, but will be integrated into the contribution for the conference. This also applies to the investigations into the antioxidant capacity according to various methods of preparation.

## Acknowledgments

Special thanks go to AGIP [work group innovative projects, ministry for economy and culture in Lower Saxony] as well as to DIL [German Institute for food technology], for their financial support in carrying out this project.

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# The Content of Selected Antioxidant Compounds in Bell Pepper Varieties from Organic and Conventional Cultivation Before and After Freezing Process

Hallmann E. & Rembialkowska E.<sup>1</sup>

**Key words:** bell pepper, antioxidant compounds, vitamin C, carotenoids, rutin

## Abstract

*Sweet bell pepper is one of the best sources of ascorbic acid and a fair source of carotenoids in human diets. The levels of vitamin C are very variable and may be affected by maturity, genotype and processing. Vegetable freezing is one of the most efficient and adequate preservation methods. Organic fresh vegetables contained more bioactive compounds than conventional ones. Two bell pepper cultivars (Roberta and Ożarowska) have been selected for analysis. Vegetables were cultivated on organic and conventional farms in Poland. Ripe bell peppers have been collected in the same week of ripening and were chemically analyzed twice: fresh before freezing and after six month of storage in -20°C. Vitamin C content, carotenoids also the total flavonols content have been determined in fruits. Organically produced bell peppers contained significantly more vitamin C and lutein than conventionally grown fruits. Processing with aid of freezing considerably decreases the content of the bioactive compounds in red bell peppers.*

## Introduction

Sweet bell pepper (*Capsicum annuum* L.) is an excellent source of ascorbic acid and a fair source of carotenoids as beta-carotene, capsantin and capsorubin (Haytowitz and Matthews 1984). In addition, peppers are rich in flavonoids (Lee et al.1995) and other phytochemicals (Duke 1992). The levels of vitamin C are very variable and may be affected by maturity, genotype and processing (Howard et al 1994). This vitamin acts as a protector of pigments preserving them from chemical and biochemical oxidation. During the paprika's production there are some steps which decrease the level of pigments (Carvajal et al. 1997). Vegetable freezing is one of the most efficient and adequate preservation methods. During freezing most of the liquid water changes into ice, which greatly reduces microbial and enzymatic activities. Oxidation and respiration are also weakened effectively by low temperature. However, freezing itself slightly decreases food quality (Haiying et al. 2007). Fresh organic red pepper contains more bioactive compounds than conventional one (Hallmann and Rembialkowska 2007). Therefore it has been assumed that also frozen organic pepper would contain more bioactive compounds than conventional pepper.

## Materials and methods

Experiments have been carried out in 2006. Two bell pepper cultivars, Roberta and Ożarowska (common in cultivation in Poland), have been selected to study. Plants were cultivated in certified organic and conventional farms in Mazovia region. The

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organic farm was located 40 km from the conventional farm. The geographical situation of farms was 52°41' N and 20°92' E. Red pepper plants were cultivated in semi-light loamy and sandy soil. In the organic system all recommended rules for fertilization and rotation were applied; compost at dose 30 t/ha has been used. Because of the absence of plant diseases fungicides and insecticides allowed in organic farming have been used.

In conventional cultivation the following mineral fertilizers have been used: ammonium nitrate with lime (450 kg/ha), granulated superphosphate (250 kg/ha), and potassium sulphate (450 kg/ha). Moreover, chemical plant protection (Bravo 500 SC) has been applied. Plants were growing in semi-heavy clay soil. The samples of fully ripe bell peppers have been collected in the same week of period and were chemically analyzed twice: fresh before freezing and after six month of storage in -20°C. Vitamin C content was analyzed with Tillman's method (PN-90 A -75101/11), carotenoids (beta-carotene, lycopene and lutein) have been determined by liquid column chromatography method (Saniawski and Czapski 1983). The total flavonols content have been determined by Christ – Müller's method, described by Strzelecka, et al. (1978). All analyses were carried out in six replications. The results of those qualitative characteristics of fruit were statistically calculated using Statgraphics 5.1 program specifically ANOVA test at  $\alpha = 0.05$ .

## Results

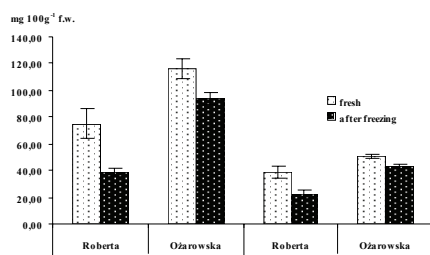
The results of chemical analysis – content of lycopene, beta-carotene and lutein - are presented in a table 1. Results showed that the content of lycopene and beta-carotene in organic red pepper fruits wasn't statistically different from that in conventional fruit, while the impact of the cultivar was significant (table 1). Only in the case of lutein was the level of this compound significantly higher in organic peppers than in the conventional fruit.

**Tab. 1: Content of selected carotenoids in bell peppers from organic and conventional cultivation before and after freezing process**

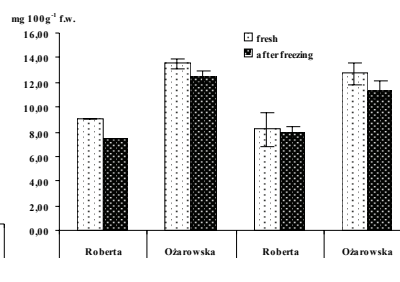
cultivation method	cultivar	lycopene (mg/100 g f.w.)		beta-carotene (mg/100 g f.w.)		lutein (mg/100 g f.w.)	
		fresh	after freezing	fresh	after freezing	fresh	after freezing
organic	Roberta	0.18	0.10	3.09	1.49	0.53	0.62
	Ożarowska	0.33	0.28	2.61	1.01	0.62	0.72
conventional	Roberta	0.22	0.19	2.85	1.17	0.29	0.25
	Ożarowska	0.36	0.23	2.58	0.96	0.56	0.72
<b>p-value</b>		n.s		n.s.		0,04*	
cultivation method		<0,0001*		0,0004*		<0,0001*	
cultivar		0,0021*		<0,01*		<0,0001*	
freezing							
* significant for p<0,05							

The freezing process had a significant decreasing effect on lycopene and beta-carotene content in red peppers, but it increased the content of lutein in peppers.

The level of vitamin C was significantly higher in organic vs. conventional fruits in both cultivars (fig.1), also it decreased considerably in peppers after freezing. In the Ożarowska cultivar the level of vitamin C was considerably higher than in the Roberta cultivar. The content of flavonols was slightly higher in organic vs. conventional peppers (fig.2), but differences weren't statistically significant. Also a decrease of the flavonols level in fruits after freezing wasn't significant. The level of flavonols in the Ożarowska cultivar was considerably higher than in the Roberta cultivar.



**Figure 1: Vitamin C content in fresh and frozen bell pepper**



**Figure 2: Total flavonols content in fresh and frozen bell pepper**

## DISCUSSION

There are only few studies that compare the nutrition value of organic vs. conventional bell pepper. In the case of different vegetables from the Solanaceae family such as tomato, Pither and Hall (1990) found higher contents of vitamin C, vitamin A and potassium in organic tomatoes. Toor et al. (2006) found higher levels of vitamin C in organically produced tomatoes. Rembalkowska et al. (2003) showed that organic red peppers and tomatoes contained more  $\beta$ -carotene, lutein, flavonoids and vitamin C than conventional fruits.

In this study, red peppers from organic cultivation were found to have clearly higher levels of vitamin C and lutein than those from conventional management. These results can be compared with similar results obtained in other experiments with sweet red pepper by the same authors (Hallmann and Rembalkowska 2007). The freezing process allows to keep better quality of the frozen products, but at the same time it decreases the bioactive compounds level in red peppers.

As described above, there is some evidence that organic vegetables (such as bell pepper) often contain more antioxidants compounds than conventional ones. Data presented in this paper, seem to confirm that evidence. The factors influencing organic red pepper and other vegetables quality are complicated and interrelated. Long-term studies are necessary to consolidate the knowledge about the real interdependences.

## Conclusions

Organically produced bell peppers contained significantly more vitamin C and lutein than conventionally grown fruits. The Ożarowska cultivar contained significantly more bioactive compounds (lycopene, vitamin C and flavonols) than the Roberta cultivar, especially under organic cultivation. Processing with aid of freezing considerably decreases the content of the bioactive compounds in red bell peppers.

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## Bioactive compounds in tomatoes: effect of organic vs conventional management in Parma in 2006

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Key words: organic tomato, nutritional quality, carotenoids, polyphenols, TEER

### Abstract

*External and internal factors such as variety, season, location, ripening, growing conditions, technological and domestic processes could affect the content of bioactive compounds in food. The aim of this study was to evaluate the influence of different agronomical practices (organic vs conventional) on the nutritional quality of tomatoes.*

*Fresh tomatoes (cv. Perfectpeel), cultivated under organic and conventional practices were analysed for vitamin C, lycopene,  $\beta$ -carotene, chlorogenic acid, caffeic acid, coumaric acid, naringenin, rutin, quercetin, Total Antioxidant Capacity (TAC) and Ferric Reducing Ability of Plasma (FRAP). CaCO<sub>2</sub> monolayer cell cultures were used for testing membrane damage by Trans Epithelial Electrical Resistance (TEER).*

*Results showed that for lycopene, naringenin and rutin no significant differences were observed. For  $\beta$ -carotene and coumaric acid significantly higher values were found in organic samples. Values of vitamin C, chlorogenic acid, caffeic acid, quercetin and TAC were significantly higher in conventional tomato, but the FRAP values were significantly higher in organic tomato. The observed TEER values were not significant different between organic and conventional tomato.*

### Introduction

Several external and internal factors could affect the composition and content of bioactive compounds in food, such as agricultural factors (e.g. genotype, variety, season, geographic location/climate, stage of maturity, growing conditions), technological processes, and domestic treatments.

The aim of this study was to evaluate the influence of different crop management practices (organic vs conventional) on the nutritional quality of tomato. The physiological properties of phytochemicals and their potential beneficial effects on human health are usually related to their antioxidant activities, that may protect tissues against oxygen free radicals, mutagenesis and lipid peroxidation.

### Materials and methods

Samples: tomato fruits, cultivar Perfectpeel, were purchased as fruits from Stuard company (Parma, Italy), that has several years experience in cultivation of organic tomatoes. Organic and conventional products were cultivated in the same growing conditions: season, location, ripening and plant age. The tomato fruits were derived

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from field cultivation. The cultivation site was on a clay soil in the Emilia-Romagna Region, in particular the Po Valley, near Parma. Organic and conventional tomatoes were cultivated in two distinct plots (4 samples, 5 kg for each). Ripening stage of fruits was 100%.

Analysis of nutritional parameters: Vitamin C, lycopene,  $\beta$ -carotene, chlorogenic acid, caffeic acid, coumaric acid, naringenin, rutin, quercetin, total antioxidant capacity (TAC) and Ferric Reducing Ability of Plasma (FRAP)- were evaluated. CaCO<sub>2</sub> monolayer was used for testing Trans Epithelial Electrical Resistance (TEER).

Lycopene and  $\beta$ -carotene were extracted from food matrix as described by Sharpless *et al.* (1999). The extracts were analyzed by HPLC system and the detection wavelength was set at 450 nm according to Maiani *et al.* (1995).

Determination of polyphenols such as flavonoids (naringenin, quercetin and rutin) and hydroxycinnamic acids (caffeic acid, chlorogenic acid, coumaric acid) from food matrix was carried out as described by Hertog *et al.* 1992. Quantitative analysis was performed using an ESA-HPLC system with colorimetric array detection.

Total ascorbic acid (AA+DHAA) was extracted and quantified as described by Margolis *et al.* (1997); chromatographic separation was carried using ESA-HPLC, equipped with colorimetric array detector (Serafini *et al.* 2002).

Total Antioxidant Capacity (TAC) was evaluated using two different assays, TEAC (Trolox Equivalent antioxidant capacity) and FRAP (Ferric Reducing-Antioxidant Power) assays. The procedure extraction reported by Pellegrini *et al.* (2003), was carried out for TEAC and FRAP determinations. The TEAC assay measures the ability of antioxidants to quench radical cation in both lipophilic and hydrophilic environments in accordance to Re *et al.* (1999). The FRAP assay evaluates the reducing power of the sample according to Benzie and Strain *et al.* (1996).

For Trans Epithelial Electrical Resistance (TEER) evaluation, the tomato extract was tested on a CaCo2 cell line in order to test the changes in tight junction permeability by TEER and the phenol red passage (Delie *et al.* 1997). Different increasing concentrations have been added on monolayer culture Caco-2 (cells from human adenocarcinoma). In the experiment the cells were seeded onto polycarbonate filter cell culture chamber inserts (diameter 6.5 mm; area 0.33 cm<sup>2</sup>; pore diameter 0.4  $\mu$ m), at density of 1.5x10<sup>5</sup> cells per filter and placed in a multiwells Falcon; the filter divided the chamber in two parts: apical and basal that represent the lumen and the basal area of the gastroenteric system. In the two chambers, we have measured the TEER for assessment of tight-junction permeability; this test gives us information about cell damages. At the end of experiment, the permeability was also tested by phenol red: the amount of phenol red detected in the basal chamber confirmed the TEER test. These parameters were used to detect the early intestinal barrier function *in vivo* damages. Each analysis was performed in triplicate. Data are given as the mean and standard deviation. Statistical analysis was performed using the Statistica for Windows statistical package (release 4-5; StatSoft Inc., Vigonza PD, Italy).

## Results

Tab 1 shows phenolics, vitamin C and carotenoids contents (mg/Kg) and TEAC ( $\mu$ Mol/100g) and FRAP (mMol/Kg) values respect to organic and conventional tomato. For lycopene, naringenin and rutin content there were no significantly different between organic and conventional tomatoes, while  $\beta$ -carotene and coumaric acid

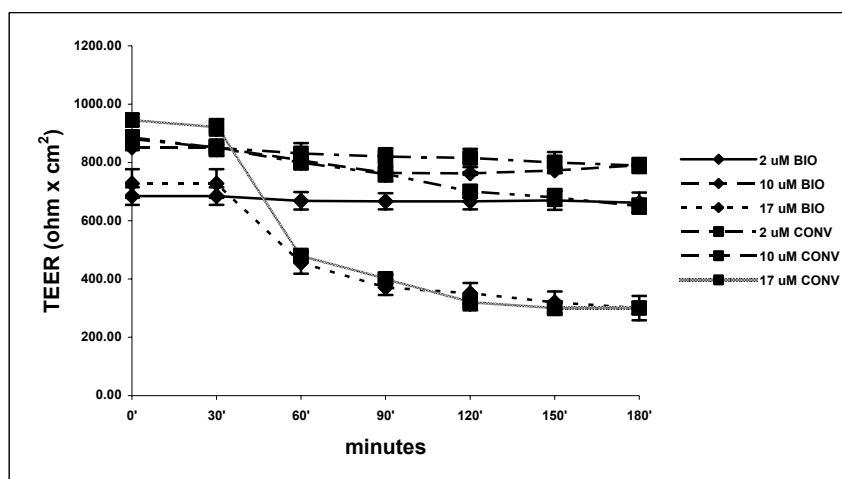


levels were significantly higher in the organic samples. In contrast, values of vitamin C, chlorogenic acid, caffeic acid, quercetin and TEAC were significantly higher in conventional tomatoes, but the FRAP values were significantly higher in organic tomatoes. Figure 1 shows the antioxidant/pro-oxidant results obtained using vitro models expressed as TEER (Ohm/cm<sup>2</sup>) by time in conventional and organic samples respectively for three different concentrations of tomato polyphenolic extract. The observed TEER values were not significant different between organic and conventional tomato, but we have observed, in both samples, a decrease of tight-junction permeability at 17µM of polyphenol concentrations.

**Tab. 1: Mean values±sd of tested nutritional parameters**

	Organic	Conventional	Student T-test
Vitamin C mg/100g	17.73±1.41	20.29±1.49	P<0.03
Lycopene mg/Kg	2.13±0.45	2.40±0.50	n.s.
β-Carotene mg/Kg	0.61±0.09	0.47±0.12	P<0.03
Chlorogenic acid mg/Kg	2.82±0.92	3.52±0.74	P<0.02
Caffeic acid mg/Kg	3.29±0.33	3.61±0.71	P<0.006
Coumaric acid mg/Kg	3.35±0.48	2.79±0.42	P<0.02
Naringenin mg/Kg	41.52±17.71	34.56±11.16	n.s.
Rutin mg/Kg	36.66±17.72	37.06±6.68	n.s.
Quercetin mg/Kg	17.92±10.90	33.90±6.31	P<0.0004
TAC (TEAC) µMol/100g	352±71	485±34	P<0.0001
FRAP mMol/Kg	4.06±0.48	3.15±1.35	P<0.0001

Each value is the mean of three determinations, ± S.D.



**Figure 1: BIO and CONV tomato polyphenols extract at different concentration, each value is the mean of three determinations, ± S.D.**

## Discussion

The TEER results show that conventional and organic samples have same behaviour, and the monolayer system is able to resist until 17 µM of tomato polyphenols extract.

The main polyphenols in above mentioned extracts were quercetin (33.90±6.31 mg/kg in conventional extract; 17.92±10.9 mg/kg in organic extract), chlorogenic acid (3.52±0.74 mg/kg in conventional extract; 2.82±0.92 mg/kg in organic extract) and caffeic acid (3.61±0.71 mg/kg in conventional extract; 3.29±0.33 mg/kg in organic extract). Even if statistical differences were found between organic and conventional extracts in several target compounds, no difference in biological effect was observed in the cell model. Further researches are required to explain this mechanism of action.

## Conclusions

As reported in literature data, there was no unidirectional trend of nutritional parameters towards organic or conventional product. In conclusion:

- the production system could affect the antioxidant content and so the food quality;
- the ripening stage could affect the bioactive molecule content;
- phenols, present in extract at high concentrations, could exert a pro-oxidant effect;
- modifications and alterations of monolayer, after phenolic extract exposition, could induce cellular damage by permeability cell changes.

## Acknowledgments

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# The antioxidant compounds in rat experimental diets based on plant materials from organic, low-input and conventional agricultural systems

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Key words: rat feed, organic, conventional, low input, polyphenols

## Abstract

*Results presented in this paper are part of a study that investigates the effect of four production systems on health effects in rats. This study was aimed to evaluate differences in the levels of flavonols, total polyphenols, beta-carotene and lutein which are well known antioxidants in four rat feeds. Raw plant materials were produced according to four different agricultural systems: organic farming (without synthetic pesticides and mineral fertilizers), low-input 1 (organic plant protection was used in combination with mineral fertilizers), low input 2 (conventional pest management and organic fertilizers were used) and conventional farming (synthetic pesticides and mineral fertilizers were used). The results indicate that rat feed prepared from the organically produced plants contained more antioxidant compounds, especially total polyphenols, flavonols and lutein. Rat feed produced for feeding experiments varied significantly in a series of key phytochemicals and therefore have the potential to produce different health effects in the subsequent feeding trials.*

## Introduction

In opinion of many consumers organic farming may supply safer and healthier food products than conventional farming. There is quite a lot of evidence that organic plant products contain more vitamin C, polyphenols, iron, magnesium, phosphorus as well as less nitrates, nitrites and pesticides residues than conventional ones (Leclerc 1991, Rembiałkowska 2003). However, there are almost no papers about the composition of the processed organic foods and the presented experiment is the only one comparing the exact composition of the rat feed based on organic, low input and conventional crops. The analysed feeds are used in the experiment comparing the health parameters of rats; the results are published separately.

In 2006 a rat feeding trial was established at to assess the impact of four production systems and their two management components -fertility management and crop protection- on the general health and immune status in rats (Baranska et al 2007). Prerequisite for this trial is that food is supplied that varies in its properties depending on the management factors and that this variability is high enough to produce differences in the feeding experiment as well.

Several groups of plant metabolites are thought to contribute to the potential health effects of organic food. For instance polyphenols and especially flavonoids have a role in prevention of cardiovascular disease and carcinogenesis (Czeczot, 2000). Because organic production systems do not use synthetic pesticides plants have to rely on their own defense strategies against insects and pests. A common strategy is to produce more phytochemicals. Consequently, the use of organic agriculture may be a way to increase the phytochemical content of plant foods (National Organic Program 2004).

The aim of this study is to assess whether rat feed produced from grain and vegetables from four different management systems varied in key phytochemical that potentially affect health in the subsequent rat study.

### **Materials and methods**

Barley, potatoes, carrots and onions were produced in the Nafferton factorial systems comparison (NFSC) at the University of Newcastle's Nafferton Experimental Farm, Northumberland, UK in 2006. Conventional crop protection was applied according to the British Farm Assured standards, and organic crop protection according to Soil Association organic farming standards. Under conventional fertility management mineral fertilizers are applied, and composted manure is used under organic fertility management. The combination of the two factors results in four factor combinations: organic fertility and crop protection management (OF-OP), organic fertility management and conventional crop protection (OF-CP), conventional fertility management and organic crop protection (CF-OP) and conventional fertility management and crop protection (CF-CP). Samples from these factors combinations (four replicates, n=16) were dried at moderate temperature in order to keep their nutritive value. Rat feed based on these materials was produced according to the nutritional recommendations for rat feeding trials. Compositional analysis of four above mentioned rat feeds were done in 2007 in the Division of Organic Foodstuff, Warsaw Agricultural University. They include: dry matter analysis by scale method (PN-91/R-87019), flavonols analysis by Christ – Müller methods described by Strzelecka et. al (1978), total polyphenols analysis by Folin – Ciocalteu colorimetric methods described by Singleton and Rossi (1965), beta-carotene and lutein analysis by liquid column chromatography described by Saniawski and Czapski (1983), antioxidant activity analysis by colorimetric method described by Re et al. (1999). The results of these qualitative characteristics of each of the different rat feeds were statistically evaluated using Statgraphics 5.1 program ANOVA.

### **Results and discussion**

As shown in tab. 1, all examined rat feeds contained similar levels of dry matter and differences were not statistically significant. Organic vegetables often contained more dry matter than conventional ones (Rembalkowska 2003, Rembalkowska 2004). Obviously the preparation procedure of the feeds (drying, mixing, cooling, pelleting) reduced differences that might have been present previously.

Total polyphenols content of the rat feed varied considerably between the experimental treatments (Tab. 1). The highest level was observed in organic rat feed (OF-OP), and the lowest in conventional (CF-CP) rat feed. Feeds from low-input systems CF-OP and OF-CP have levels lower than the organic but higher than the conventional feed. Both the fertility management and crop protection as well as their interaction had a significant effect on the polyphenols status of the experimental diets. The low-input version with pesticides and without fertilizers contains slightly more polyphenols than that one with fertilizers. The lack of synthetic pesticides and mineral fertilizers seems to have stimulated the polyphenol production.

The total content of flavonol was the highest in the organic feed and the lowest in the CF-CP feed. Similar levels were observed in feeds from two low-input system (OF-CP, CP-OF). Both, fertility management and crop protection had a significant effect on the flavonol content of the feed. The results confirm a generally found tendency to

higher flavonoids content in the organically produced plant materials (Rembalkowska 2004).

**Tab. 1: The levels of: dry matter, polyphenols, flavonols, beta-carotene, lutein and antioxidant activity in rat feeds from four management systems**

Parameter	Mean				ANOVA P-value		
	OF-OP	OF-CP	CF-OP	CF-CP	Main Effects		Inter- actions
					Fertilizer	Health	
Dry matter g/100g d.m.	90.02	89.85	89.66	89.95	0.76	0.56	0.29
Polyphenols mg/100g d.m.	2166.9	1575.6	1530.3	1137.8	< 0.0001	<0.0001	0.05
Flavonols mg/100g d.m.	3.39	3.00	2.97	2.31	0.03	0.02	0.55
Beta-carotene mg/100g d.m.	0.82	0.82	0.80	0.72	0.68	0.58	0.73
Lutein mg/100g d.m.	0.41	0.33	0.38	0.24	0.04	0.25	0.54
Antioxidant activity uM Trolox/1g.	28.59	28.06	28.16	27.71	0.07	0.13	0.91

There were no significant differences in beta-carotene concentration between the treatments.

Lutein was identified as an important carotenoid in the feeds. The highest level of lutein was found in organic rat feed (OF-OP) and the lowest level in the conventional one (CF-CP). The two other rat feeds were less abundant in this compound and similar in this respect (Tab. 1). Statistical analysis showed that the lutein content was only affected by the fertility management.

There were no significant differences in the antioxidant activities of rat feeds from the organic, conventional, and low-input cultivations.

The composite rat feed that contained barley, potatoes, carrots and onions produced in the four management systems contained significantly different levels of polyphenols, flavonols and lutein. Both, fertility management and crop protection caused these differences but fertility management seems to have a stronger impact. The results shown represent the second batch of rat feed used in the feeding trial and confirm trends observed in the first batch analysed (Rembalkowska et al 2007).

## Conclusions

- 1) Rat feed produced for feeding experiments varied significantly in a series of key phytochemicals and therefore have the potential to produce different health effects in the subsequent feeding trials.
- 2) Rat feeds prepared from the organically produced plants contained more antioxidant compounds, especially flavonoids total polyphenols and lutein.

## Acknowledgments

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# Antioxidant Activity of Vegetables from Different Management Systems

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Key words: antioxidants, potato, escarole, tomato.

## Abstract

*In this paper we considered the relationship between organic farming and accumulation of functional metabolites with antioxidant activity. The level of these molecules, with high nutritional value, usually increases in response to various environmental stresses and, consequently, it may be higher in organic crops that are generally more exposed to environmental stressors compared to conventional crops. Here we provide evidence that organic farming may enhance the antioxidant capacity of 10-15 % in tomato and potato. We also demonstrate that the absence of mulching may cause a 15% increase of the antioxidant activity in organic escarole, indicating that different cultivation techniques may also affect the accumulation of these metabolites. Based on these results, we conclude that organically grown products may also be considered and marketed as potential functional foods.*

## Introduction

There is an increasing interest for organic foods, which are generally perceived by the consumers as healthier and environmentally safer than conventionally grown products. Nevertheless, substantial differences in terms of nutritional value of organic vs. conventional foods have never been proven (Bourn and Prescott, 2002). Although such differences may indeed be minimal or irrelevant for major nutritional components, many secondary metabolites with a recognized nutritional value may significantly change under both different cultivation regimes and various environmental stresses (Maggio et al., 2007a; 2007b). These molecules mostly include antioxidants and radical scavengers that have been shown to be involved in the prevention of several pathologies, including cardio-vascular disease and cancer. Considering that organically grown crops are more exposed to both biotic and abiotic stresses because of a reduced chemical control of the overall cultivation process, we hypothesized that organic crops may actually have a constitutively higher level of functional metabolites. By using a combination of different cultural techniques, here we demonstrate that organic farming may enhance the antioxidant capacity of escarole, tomatoes and potatoes. Consequently, these products will possess intrinsic functional properties that may confer an additional commercial value.

## Materials and Methods

The research was carried out at the experimental fields of the University of Naples Federico II. The results presented in this communication refer to three independent experiments and report only the analysis on the antioxidant activity. Details on the experimental set-up for each species here considered can be found in Maggio et al.

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(2007b) and Paradiso et al. (2007a, 2007b). Briefly, for *ESCAROLE* (*Cichorium endivia* L.), organic (OF) and conventional farming (CF) were compared respect to 1) two soil types (Sandy and Clay); 2) presence/absence of PE mulching film and 3) three N levels (N0 = 0 Kg N ha<sup>-1</sup>, N100 = 100 Kg N ha<sup>-1</sup>, N200= 200 Kg ha<sup>-1</sup>). In OF, nitrogen fertilization was accomplished by combining 3 organic fertilizers (A: N 4% and P<sub>2</sub>O<sub>5</sub> 4%; B: manure-based, N 3.1% and P<sub>2</sub>O<sub>5</sub> 3%; C: slow release, N 6%) all allowed by the EU regulation. The experimental design was a split-plot with 3 replications, with the soil type assigned to the main plots, the organic/conventional regimes assigned to the sub-plots, different N levels assigned to the sub-sub-plots and finally the presence/absence of mulching assigned to the elementary plots. For *TOMATO* (*Lycopersicon esculentum* Mill.), two hybrids for processing, *DRI 5390* (High Lycopene) and *Joy*, were compared in combination with three irrigation levels [replenishment of 100% EvapoTranspiration (ET) (W100), replenishment of 50% ET(W50); no-irrigation (W0)]. Pre-transplanting fertilization was accomplished with 150 kg ha<sup>-1</sup> of N, 40 kg of P<sub>2</sub>O<sub>5</sub> and 37 kg of K<sub>2</sub>O, using a complex fertilizer (N:P:K 12:12:12) and ammonium nitrate (33% N) under CF, whereas in OF we used a mix of seeds meal, manure and hoof/horn meal (N 7%); a mix of organic humus (N 3%) and manure (N 12.5%). In the experiment with *POTATO* (*Solanum tuberosum* Mill.), two cultivar, *Agria* and *Merit*, were compared respect to two planting dates, April 8 (I) and May 19 (II) 2004. Fertilization (top-dressing) was accomplished with dried blood (N 14%) in OF and ammonium nitrate (N 34%) under CF. For both tomato and potato, the experimental design was a split-plot with three replications, in which the organic vs. conventional treatments were assigned to the main plots, whereas the combinations "cv x irrigation" (tomato) and "cv x planting date" (potato) were assigned to the sub-plots. For all three experiments, data were analyzed by ANOVA and means, when significant, were compared by the Least Significant Difference (LSD) test. The Lypophilic and Hydrophilic Antioxidant Activities of the commercial product were determined for escarole as described in De Pascale et al., (2001). The antioxidant activity of tomato and potato was assessed based on the auto-oxidation test described in Gasparoli et al. (1995) and was expressed as the tomato/potato extracts capacity, on a 0-1 scale, of inhibiting the oxidation of a soy oil sample (0=no oxidation inhibition; 1=complete inhibition of the oxidation process).

## Results

As previously mentioned, in this report we will focus only on the antioxidant activity of the commercial product for the three different species and we refer to Maggio et al. (2007) and Paradiso et al. (2007a; 2007b) for yield results and treatment effects of different cultivation variables. *ESCAROLE*: In organic farming, plastic mulching did not significantly affect the hydrophilic antioxidant activity (Fig. 1A) whereas under conventional farming, the hydrophilic antioxidant activity was reduced of 30% in absence of mulching. An opposite response was observed for the Lypophilic antioxidant activity (Fig. 1B). The absence of mulching caused a 15% increase of the antioxidant activity in organic regime, whereas no differences were observed under conventional farming. *TOMATO*: The average antioxidant activity was higher in organic farming (+10% compared to conventional tomatoes) and for the *DRI 5390* hybrid with high lycopene (+20% compared to *Joy*) (data not shown). Specifically, the two hybrids had a different response to the irrigation treatment (Fig. 2). While the antioxidant activity was not affected in *DRI 5390*, either by the cultivation regime or the water availability, the cultivar *Joy* revealed a relatively higher antioxidant activity in organic farming with a slight decay at 100% replenishment of the ET (max water availability). *POTATO*: The antioxidant activity in potato tubers had a remarkable

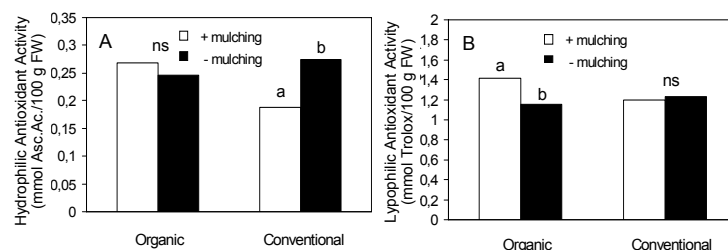


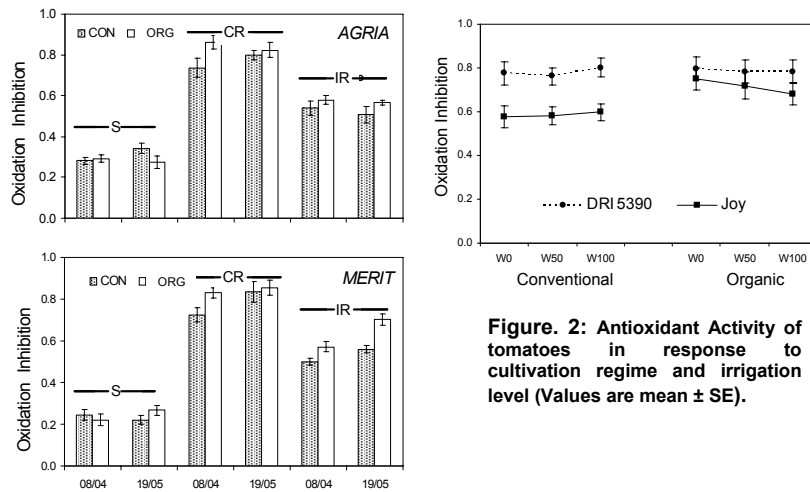
variability from the outer to the inner tuber portions (Fig. 3). A significantly higher activity was observed for both cultivars grown under organic regime only in the cortical region (CR), at the first planting date (Fig. 3A, top panel). Whereas the cultivar Merit grown in organic farming had a significantly increase of the antioxidant capacity of the inner tuber region (IR) at both planting dates (Fig. 3A, bottom panel).

### Discussion and conclusions

For all the species considered in this work, we observed a positive effect of organic farming on the antioxidant capacity of the commercial products. Indeed, organic farming affected the antioxidant properties of escarole, tomato and potato, indicating that this cultivation regime may in some respect increase the nutritional value of these products. This response was often associated to other variables such as the presence of mulching for escarole (Fig. 1), a cultivar effect in tomato (Fig. 2) or some specificity of the commercial plant organ as we observed in potato (Fig. 3), suggesting that there are margins to identify specific cultivation protocols that may cause a targeted accumulation of functional metabolites in the commercial product. It is worth pointing out that, in the literature, the accumulation of antioxidant molecules has been reported to be associated to diverse stress responses. In this respect, organic farming may partially activate stress adaptation mechanisms and, consequently, it may *constitutively* increase the level of these molecule. Some peculiarities specific to the cultivation procedures exist, however. For example the Hydrophilic antioxidant activity decreased in non-mulched conventional escarole, whereas the Lypophilic antioxidant activity increased in non-mulched organic escarole. These results suggest that the two cultivation systems may have initiated the synthesis (or inhibited the degradation) of different antioxidant pools that likely respond to different environmental stimuli (De Pascale et al., 2001). Improving our knowledge on the physiological mechanisms that mediate the accumulation of these molecules is therefore critical to identify cultivation protocols that may enhance the accumulation of these high nutritional value compounds. Organic farming seems to *predispose* crops to synthesize these functional metabolites. Therefore organic products may also be considered and marketed as *natural functional foods*.

**Figure 1: Hydrophilic Antioxidant Activity (A) and Lypophilic Antioxidant Activity (B) in escarole leaves (within each cultivation regime, different letters indicate significant differences at  $P < 0.05$ ).**





**Figure 2: Antioxidant Activity of tomatoes in response to cultivation regime and irrigation level (Values are mean  $\pm$  SE).**

**Figure 3: Antioxidant activity in potato. S= tuber Skin; CR= tuber Cortical Region; IR= tuber Inner Region (Values are means  $\pm$  SE).**

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# The impact of medium term feeding diets from four management systems on body composition and plasma corticosterone concentration in male rats

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Key words: bioactive compounds, conventional diet, corticosterone, low input diet, organic diet

## Abstract

*The aim of the study was to analyse the influence of feed from different production systems (organic, conventional and two low input systems) on food intake, body chemical composition and plasma corticosterone (Cs) concentrations in rats. The experiment was conducted in 104 Wistar male rats divided into 4 dietary experimental diets (OF-OP, OF-CP, CF-OP and CF-CP, each in four replicates) and one control group consuming feed ad libitum for three months. Plasma Cs levels by RIA, body composition by standard chemical methods and body weight gain were determined.*

*Results show statistically significant lower plasma Cs concentrations in rats fed on CF-CP ( $P<0.05$ ) and standard ( $P<0.001$ ) diets. Body chemical composition also varied depending on the fertility management of the crops used for the rat feed.*

## Introduction

Corticosterone is the major natural glucocorticoid in rodents. Glucocorticoids (GCs) are stress hormones that modulate a large number of physiological actions involved in metabolic, inflammatory, cardiovascular and behavioral processes. GCs predominantly affect the metabolism of carbohydrates, fats and proteins and have other effects on organism functions (Simson & Walker, 2007). GCs also modulate inflammatory cell survival, a process important for the successful resolution of inflammation (McColl et al., 2007).

The hypothesis is that consuming diets based on crops from four different production systems that contain different levels of bioactive compounds affects GCs secretion and thus metabolism regulation, as well as body weight gain and body composition in model animals. Therefore, the aim of the study was to analyse the influence of feed from different production systems (organic, conventional and two low input systems) on body composition and plasma corticosterone concentrations in rats.

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## Materials and methods

Barley, potatoes, carrots and onions were produced in the Nafferton factorial systems comparison (NFSC) at the University of Newcastle's Nafferton Experimental Farm, Northumberland, UK in 2006. Conventional crop protection was applied according to the British Farm Assured standards, and organic crop protection according to Soil Association organic farming standards. Under conventional fertility management mineral fertilizers are applied, and composted manure is used under organic fertility management. The combination of the two factors results in four factor combinations (management systems): organic fertility and crop protection management (OF-OP), organic fertility management and conventional crop protection (OF-CP), conventional fertility management and organic crop protection (CF-OP) and conventional fertility management and crop protection (CF-CP). Samples from these factors combinations (four replicates, n=16) were dried at moderate temperature in order to keep their nutritive value. Rat feed based on these materials was produced according to the nutritional recommendations for rat feeding trials. Analysis of the rat feed confirmed that it contained significantly differed level of key phytochemicals (see Rembiakowska et al 2007). One animal group was fed with standard feed for breeding laboratory animals – Labofeed H (Andrzej Morawski Feed Production Plant, Kcynia near Bydgoszcz, Poland). At the beginning of the experiment 32 female and 16 male Wistar rats were fed on experimental diets (two females and one male on each diet) for two weeks before mating and during pregnancy and lactation period (8 weeks together). Two females and one male were fed on Labofeed H. Six male pups from each familiar group (96 animals) were selected for the subsequent experiment at weaning. The animals were kept in individual polycarbonate cages in steady environmental conditions for three months. They were given free access to food and water throughout the study. Throughout the experiment, all rats were weighed every week and consumption of experimental diets was controlled daily. All procedures were approved by the Local Animal Care and Use Committee in Warsaw. At the end of the experiment, blood was sampled from the heart. Carcasses and plasma were stored at  $-23^{\circ}\text{C}$  for subsequent analyses. Corticosterone analysis was performed using Rat Corticosterone RIA Kit (Diagnostic Systems Laboratories, Inc). After autoclavation and homogenization, the percentage of water, ash, protein and fat in carcasses were determined by standard analytical methods (AOAC, 1960). Data was analysed by multi-factor analysis of variance (ANOVA) with crop protection and fertility management as a discriminating factors followed by the Fisher's least significant difference post-hoc test and by the linear regression method. A difference with  $p \leq 0.05$  was considered as significant. All statistical analyses were performed with the computer program STATGRAPHICS®Plus 4.0.

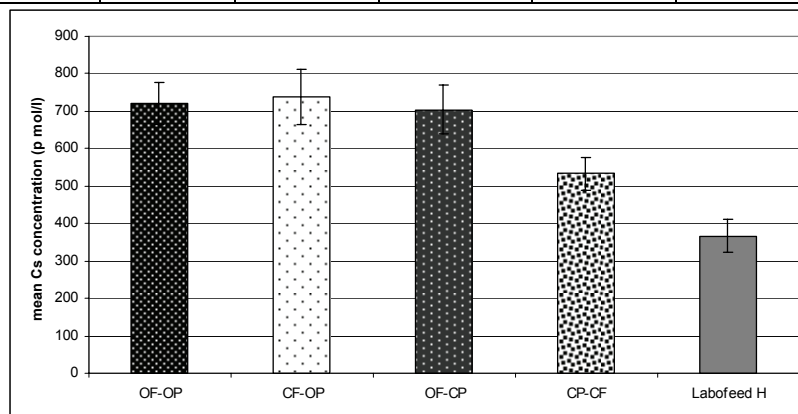
## Results

The final body weight was significantly influenced by the fertility management (ANOVA,  $P=0.004$ ) which resulted in a higher body weight in rats that had organically fertilised diets (OF-OP and OF-CP). Also, the body weight of rats fed with Labofeed H was considerably lower (Table 1). Body dry matter contents in rats fed on Labofeed H were considerably lower than in animals fed with any of the experimental diets ( $P < 0.01$ ; Fisher t-test), but no significant differences between the experimental groups were observed (Table 1). Among the carcass composition parameters only the protein content with slightly higher values in the OF groups was significantly influenced by the fertiliser used to produce the samples.

Plasma CS concentrations were significantly higher in animals fed on experimental diets compared to rats fed on Labofeed H ( $P < 0.01$ , Fisher t-test) (Fig. 1). Lower plasma Cs concentrations were found in rats consuming the conventional (CF-CP) diet, but neither of the experimental factors had a significant effect when data were analysed by ANOVA.

**Tab. 1: Chemical body composition (%) and final body weight (g) in rats fed on experimental diets over 3 months**

Dietary group	Fat (Mean $\pm$ SE)	Dry matter (Mean $\pm$ SE)	Ash (Mean $\pm$ SE)	Protein (Mean $\pm$ SE)	Final body weight (Mean $\pm$ SE)
OF-OP	21,94 $\pm$ 0,16	16,27 $\pm$ 0,59	41,66 $\pm$ 0,44	3,59 $\pm$ 0,04	367,5 $\pm$ 7,36
OF-CP	22,03 $\pm$ 0,13	14,69 $\pm$ 0,54	40,71 $\pm$ 0,40	3,60 $\pm$ 0,04	391,5 $\pm$ 6,22
CF-OP	21,38 $\pm$ 0,25	15,40 $\pm$ 0,61	40,36 $\pm$ 0,75	3,54 $\pm$ 0,04	349,1 $\pm$ 11,1
CF-CP	21,71 $\pm$ 0,15	16,12 $\pm$ 0,60	41,29 $\pm$ 0,32	3,49 $\pm$ 0,03	374,4 $\pm$ 4,04
Labofeed	22,54 $\pm$ 0,10	8,14 $\pm$ 0,34	35,94 $\pm$ 0,45	3,66 $\pm$ 0,07	286,3 $\pm$ 8,90



**Figure 1: Plasma corticosterone concentration in rats fed on feed from different production systems and laboratory animals pellets Labofeed H over 3 months (mean  $\pm$  SE)**

## Discussion

The hypothesis of this paper was that consuming diets based on organically grown plants that contain more bioactive compounds might affect GCs secretion and thus metabolism regulation, as well as body weight gain and body composition in rats. Obtained results showed considerably lower plasma Cs concentration in rats raised on feeds made from conventionally produced crops (CF-CP diet) compared to rats raised on diets made from crops produced in organic and 'low input' systems. However, when ANOVA was used to test for the effect of crop protection and fertilization systems on Cs plasma level no significant effect could be detected. In a short-time feeding trial with male rats (Królikowski, in preparation) we found a similar pattern of higher Cs levels in rats fed on organic feed in comparison with those fed with feed from conventional production system. As was stated by other authors,

certain bioactive dietary compounds alter Cs secretion and HPA (hypothalamus-pituitary-adrenal) axis activity with decreasing of plasma Cs concentration (Butterweck et al., 2004). On the other hand this effect seems to be dependent not only on the chemical nature of these compounds, but also on their dose and the duration of an organism's exposure (Ziołkowska et al., 2006). Butterweck et al. (2004) gave flavonoids at different concentrations to rats for a period of two weeks and observed down-regulated circulating plasma levels of ACTH and Cs by 40 - 70 %. However, none of the tested compounds had a significant effect on plasma ACTH and Cs levels after chronic treatment (given daily for 8 weeks). After 10 weeks in our study moderate effects of the different composition of the experimental diets on the Cs levels were detected. To summarize, although the intake of several bioactive compounds was significantly influenced by the fertilizer type and crop protection, the Cs concentration in rat's plasma showed only moderate, non-significant effects.

## Conclusions

There is some evidence that differences in the chemical composition of rat feed that was produced under four production systems were reflected in the body weight, protein content and plasma corticosterone (Cs) concentrations in rats.

## Acknowledgments

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## Influence of fertilisation on furanocoumarins content in two celeriac varieties

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Key words: celeriac, fertilisation system, furanocoumarins, food safety, anaerobically fermented pig slurry

### Abstract

*The aim of this study was to investigate the effect of the way of celeriac cultivation on the content of naturally occurring toxicants - furanocoumarins. Their levels have been shown to be strongly affected by an individual variety and also fertilization method. Organic farming using anaerobically fermented pig slurry was compared with mineral, combined, and non-fertilized farming. The climatic conditions in particular crop years play an important role in the furanocoumarins occurrence.*

### Introduction

Besides of various biologically active constituents such as vitamins and phenolic antioxidants, many cultivated plants contain specific secondary metabolites which are classified as toxicants or antinutrients in humans and/or farm animals. Risk associated with an occurrence of natural toxicant in human diet is of growing concern both to scientists and regulators.

Furanocoumarins are natural toxic chemicals occurring in edible food plants such as celery, parsnip, parsley, carrot etc. belonging to the *Apiaceae* family, lower levels of these phytochemicals are also contained in citrus fruits and other crops representing the *Rutaceae* family (Søborg, 1996). Since their presence in human diet represents food safety issue of concern, more knowledge is needed to reduce consumers' exposure. More than 50 plant furanocoumarins are known at present (Søborg, 1996), considering their chemical structure, two subgroups can be recognised. The first one involves linear furanocoumarins - psoralen, bergapten, xanthotoxin, trioxsalen, isopimpinellin and bergamottin etc.; the second one is represented by angular furanocoumarins such as angelicin, pimpinellin, sphondin, isobergapten etc. Typical levels of furanocoumarins in root vegetable are in celeriac 4 - 40 mg/kg, in parsnip 3 - 60 mg/kg and in carrot <0.004 - 2 mg/kg. Concentrations as high as 45 mg/kg, 145 mg/kg and 112 mg/kg were found in celery, parsnip and parsley, respectively (Schulzova, 2007). Furanocoumarins are phototoxic compounds, yielding reactive intermediates under UV light irradiation, formation of adducts with DNA can take place (Llano, 2003; Søborg, 1996). In addition, mutagenic and carcinogenic effects have been demonstrated in experimental animals when exposed to high doses of furanocoumarins. The lowest observed adverse effect level (LOAEL) was estimated in the range 0.14 – 0.38 mg/kg body weight. The only information on the average daily

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dietary intake of phototoxic furanocoumarins from vegetables was provided by Nordic group who estimated it 0.5 mg/kg body weight (Søborg, 1996). In any case, dietary furanocoumarins should be considered as potentially health risk for consumers, therefore their intake should be minimised.

Organic farming represents an alternative way of agriculture replacing conventional mineral fertilizing methods by organic fertilizers. Anaerobically fermented pig slurry as a fermentation residue of biogas plants can be used for vegetables fertilization as an optimal replacement of industrial mineral fertilizers. Because furanocoumarins occurs as a result of the plant stress, their level could be different in organic and conventional farming methods. One example of stress conditions is lack of water and/or nutritional deficit during the growing.

## Materials and methods

Celeriac samples (*Apium graveolens rapaceum*) were obtained from field trials managed by Czech University of Life Sciences Prague in years 2005 and 2006. Two varieties of celeriac Albin (A) and Kompakt (K) were examined. Plants were grown from pre-plant seedlings either of variety was grown in each variants of farming in four repetitions (farming sites 0.5 x 0.4 m) on sandy loam brown soil. No pesticide treatment was used. Representative samples consisting of 8 bulbs were taken for the analysis.

The fertilization regimes employed in this experiment were as follows:

**N** - control farming (not fertilized with mineral and/or organic fertilizers)

**O** - organic farming (9.1 L m<sup>-2</sup> of anaerobically fermented pig slurry before planting and 9.1 L m<sup>-2</sup> 43 days after planting). It represents 10 g of nitrogen, 4.5 g of phosphorous and 18 g of potassium per m<sup>2</sup>.

**M** - mineral farming (22.7 g m<sup>-2</sup> of ammonium sulphate, 52 g m<sup>-2</sup> of superphosphate and 4.8 g m<sup>-2</sup> of potassium chloride before planting and 22.7 g m<sup>-2</sup> of ammonium sulphate 43 after planting). It represents 10 g of nitrogen, 4.2 g of phosphorous and 2.4 g of potassium per m<sup>2</sup>.

**C** - combined (50% of organic and 50% of mineral way) farming (4.5 L m<sup>-2</sup> of anaerobically fermented pig slurry, 11.4 g m<sup>-2</sup> of ammonium sulphate, 26 g m<sup>-2</sup> of superphosphate and 2.4 g m<sup>-2</sup> of potassium chloride before planting and 4.5 L m<sup>-2</sup> of anaerobically fermented pig slurry and 11.4 g m<sup>-2</sup> of superphosphate 43 days after planting)

Applied anaerobically fermented pig slurry had this composition: 595 mg L<sup>-1</sup> of nitrogen in ammonia form, 755 mg L<sup>-1</sup> of phosphates, 1.10 - 1.25 g L<sup>-1</sup> of potassium oxide.

Gas chromatography coupled with mass spectrometry (GC/MS) operated in an electron impact ionisation mode was employed for determination of furanocoumarins in ethyl acetate extract of celeriac. Furanocoumarins were separated on capillary column DB-5MS (60m x 0.25mm x 0.25µm). Quantification (selected ion monitoring) was achieved by comparing peak areas of the target analytes with the corresponding standard calibration plot. Detection limits (LODs) of angelicin, psoralen, bergapten, xanthotoxin, trioxsalen, isopimpinellin, sphondin, pimpinellin and isobergapten obtained by this analytical method were in the range 0.01-0.08 µg g<sup>-1</sup>, recovery 89-97 % (spiking level 10 mg/kg), the repeatability of measurements expressed as relative



standard deviation was in the range 3.9 - 4.7 % (for detail information see Peroutka, 2007).

## Results and discussion

While in all analysed celeriac samples the presence of linear furanocoumarins psoralen, bergapten, xanthotoxin and isopimpinellin was documented, none of angular furanocoumarins (angelicin, sphondin, isobergapten) and linear trioxalen was detected. The total furanocoumarins content was relatively low, corresponding with literature data. Higher levels (approximately 2 times) were found in celeriac harvested in 2006 (2.4 – 23.5 mg/kg) compared to 2005 (1.7-13.0 mg/kg). Maximum furanocoumarins content was found in variety Kompakt grown in combined farming system (Figure 1).

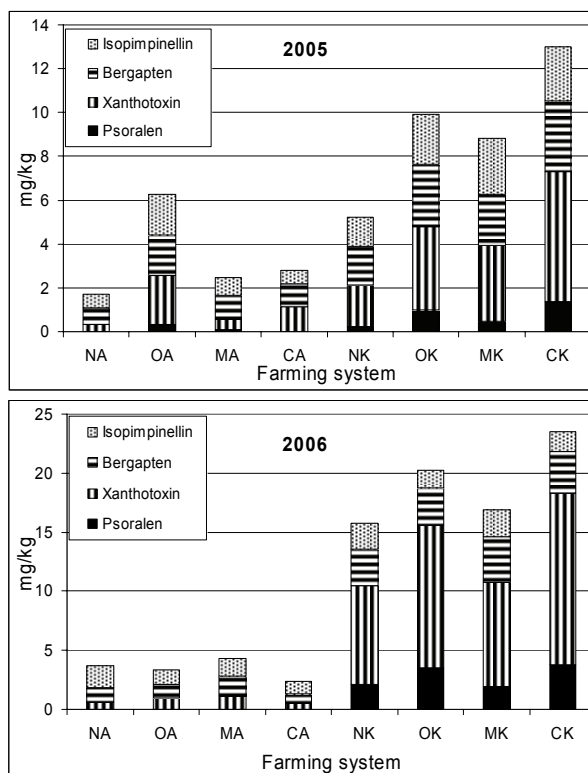


Figure 1: Content of furanocoumarins in two celeriac varieties grown in four farming systems in crop years 2005 and 2006 (mg/kg fresh weight) (A - Albin , K - Kompakt , N - control, O – organic, M – mineral, C - combined)

In 2005 mean furanocoumarin levels were 3.3 mg/kg for variety Albin and 9.3 for variety Kompakt. Next year, the levels were (2006) 3.5 mg/kg for Albin and 19.1 mg/kg for Kompakt. Total furanocoumarins content was significantly lower (t-test,  $\alpha=0.05$ ) in variety Albin (3 times in crop year 2005 and 5 times in crop year 2006). The average temperature in crop year 2006 was higher than in 2005. Rainfall was higher in 2005. Variety Albin was more resistant for climatic changes between individual crop years.

It should be noted mechanical injury or any other stress factors cause large increase of furanocoumarin levels. Interestingly this effect is more pronounced in conventional farming crops (Schulzova, 2002).

### Conclusions

Differences between celeriac varieties in inherent furanocoumarin levels were shown in our study. Inter annual variation is mainly due to climatic conditions in particular crop year. The average levels of furanocoumarins determined in hardy fresh celeriac roots were 8.8 mg/kg, ranging from 1.7 to 23.5 mg/kg. Content of targeted toxicants was relatively low and obviously do not present health risk for consumers.

Anaerobically fermented pig slurry, organic fertilizer with high fertilization efficiency, is a good alternative to mineral fertilization in terms of certain agricultural parameters such as crop yield. However the distinct impact on furanocoumarin levels was not found i.e. no significant relationships between the levels of monitored toxic compounds and the way of fertilization were observed.

Follow up experiments have been initiated since only long term studies may provide information needed for unambiguous assessment of the influence of farming practices on furanocoumarin levels in particular celeriac variety and other similar vegetable. Field experiments have been running also in 2007.

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## Workshops of the 4<sup>th</sup> QLIF Congress

In conjunction with the 2nd ISOFAR Conference, the Integrated European Project 'Quality Low Input Food'<sup>1</sup> (QLIF, [www.qlif.org](http://www.qlif.org)), conducted their 4th congress.

In addition to presentations in the ISOFAR program, QLIF offered a series of workshops that summarized the results and data gained during the first four years of the project. Workshop themes were: product quality; safety of foods; crop productivity; livestock productivity and resource efficiency.

The full papers of the workshops, finalized after the congress in order to include the workshop results, will be made available at QLIF homepage [www.qlif.org](http://www.qlif.org) and the Organic Eprints Archive at [www.orgprints.org/view/projects/int-conf-2008-qlif4.html](http://www.orgprints.org/view/projects/int-conf-2008-qlif4.html).

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<sup>1</sup> The Integrated Project 'Quality Low Input Food' aims to improve quality, ensure safety and reduce cost along the organic and 'low input' food supply chains through research, dissemination, and training activities. The project focuses on increasing value to both consumers and producers using a farm to fork approach. The project is funded by the European Union and will be running from 2004 to 2009. The research involves 35 research institutions, companies and universities throughout Europe and beyond.

## QLIF Workshop 1: Product quality in organic and low input farming systems<sup>1</sup>

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Key words: quality, crops, livestock, primary production, processing

### Abstract

*There is increasing evidence for organic and 'low input' farming practices resulting in an improved nutritional composition of foods. QLIF workshop 1 will critically evaluate the current scientific knowledge about relative nutritional composition of foods from organic and conventional production systems and the agronomic and processing factors affecting food quality. A summary of major QLIF results and recent literature reviews on the topic is provided in this paper.*

### Introduction

The intensification of agricultural production in the last century has resulted in loss of biodiversity, environmental problems and associated societal costs (Niggli & Leifert 2007; Cooper et al. 2007). Agronomic changes introduced during the intensification of agricultural production were also suspected to have caused with negative effects on food quality. However, until recently there was very little quantitative information to underpin this hypothesis (Cooper et al. 2007). Over the last 10 years a wide range of studies have compared the composition of foods from intensive and organic/'low input' systems and several recent literature reviews concluded that there are higher levels of nutritionally desirable compounds (e.g. vitamins, antioxidants, polyunsaturated fatty acids) and lower levels of undesirable compound (e.g. pesticides, growth regulators) in foods from organic and 'low input' production systems compared to food from conventional systems (Cooper et al. 2007; Brandt 2007; Benbrook et al. 2008).

Also the increasing demand and current price premiums achieved by foods from 'low input' and especially organic production systems were shown to be closely linked to consumer perceptions about nutritional and health benefits of such foods.

However, the exact reasons for these differences in food composition are poorly understood. The QLIF project ([www.qlif.org](http://www.qlif.org)) therefore carried out factorial field experiments and surveys to identify the effect of individual production system

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<sup>1</sup> The full version of this paper is available at [www.orgprints.org/13376](http://www.orgprints.org/13376)

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components (e.g. animal and crop genetics, nutrition, health management and husbandry) on food composition. It also carried out pilot dietary intervention studies to test the effect of organic food consumption on immune system, behaviour and hormonal regulation using experimental rat models.

### **Quality of Foods from organic livestock systems**

A major focus of livestock production under QLIF was to study the effect of (a) dairy genotype/breed, (b) husbandry methods and especially feeding regimes on milk composition. They demonstrated that milk from organic and 'low input' production systems contained higher levels of nutritionally desirable unsaturated fatty acids (e.g. omega 3, CLA) and antioxidants ( $\alpha$ -tocopherol,  $\beta$ -carotene, lutein and zeaxanthine) than milk from intensive conventional dairy production systems. In other studies the levels of nutritionally desirable fatty acids and fat soluble vitamins and/or the sensory quality of organic meat and egg quality parameters were also reported to be higher than (Hirt et al. 2007; Sundrum 2007). The improved nutritional composition of meat, milk and eggs was often linked to outdoor grazing based husbandry and high forage feeding regimes in the case of dairy cows and/or the use of more robust and/or slower growing livestock genotypes in the case of poultry (Hirt et al. 2007; Butler et al. 2008). Surveys also showed that levels of antibiotic use in organic and 'low input' dairy cow herds were significantly lower than those of conventional high input herds (Hoyle et al. 2004; Cooper et al 2007).

Standard processing practices (e.g. pasteurisation of milk; cheese and yogurt making processes, standard slaughter and meat conservation practices) appear to have limited effects on relevant parameters (e.g. fat composition, fat soluble vitamin content) between organic and conventionally systems (e.g. Bergamo et al. 2003).

The introduction of strategies to improve product quality (e.g. the introducing of grazing based feeding regimes) is also likely to reduce farm costs in many regions of the EU, especially given the rapidly rising costs of concentrate feeds, but economic analyses under QLIF are still ongoing.

### **Crop production systems**

QLIF crop production focused studies focused mainly on the effect of (a) fertilisation regimes (type and level of mineral NPK fertilisers and/or animal and green manures used), (b) crop rotation design and (c) crop protection protocols (type and level of chemosynthetic pesticides and other crop protection methods) on a range of nutritionally desirable secondary plant metabolites (e.g. vitamins, antioxidants, proteins, phenolics, glycosinolates, vitamins). To a lesser extent the effect of (d) crop genotype/variety, (e) rootstock type and (f) ripening stage at harvest was also investigated in selected commodities (e.g. tomato).

In selected commodities (e.g. wheat and potato) metabolic profiling was supplemented with protein and gene profiling. These profiling studies showed that plant metabolism is affected most by variety choice and fertility management, while rotations position and crop protection have less of an effect in most crops. Where the effect of agronomic methods on total antioxidant activity (e.g. tomato) was compared in soil (as opposed to synthetic growth media), variety and/or rootstock choice and specific organic matter based fertilisation regimes significantly increased antioxidant activity. In addition, the ripening stage at harvest and the age of the tomato plant at harvest had a significant effect on tomato quality, indicating that harvesting immature fruit and the

use of long season tomato production systems reduce the antioxidant content of tomato. These studies clearly indicated that organic soil based and short season tomato production protocols, and the use of short supply chains, which allow the delivery of fully ripe fruit to local markets, will increase antioxidant levels in tomato.

For most other crops a range of specific secondary metabolite groups associated with potential beneficial health effects were monitored under QLIF and field trials and analyses are still ongoing. However, studies from the first 3 seasons indicate that while there is often a trend for more of the nutritionally desirable secondary metabolites to be found at higher levels when organic fertilisation regimes and/or crop protection regimes were applied, some compounds were unaffected and some were increased when conventional fertilisation and/or crop protection regimes were applied (Niggli & Leifert 2007). Recent literature reviews (e.g. Brandt 2007; Benbrook et al. 2008) reported higher levels of nutritionally desirable compounds in organic crops when compared to conventional crops, but were mainly based on research papers, which focused on individual or small numbers of commodities and secondary metabolites. The more differentiated set of results from the QLIF project are therefore likely to make it more challenging to interpret the existing comparative crop composition data with respect to both **(a)** agronomic recommendations with respect to further improving crop quality and **(b)** potential beneficial impacts of secondary metabolite profiles in organic foods on human health.

## Conclusions

The generally beneficial impact of extensive organic production protocols on livestock foods (meat, milk and eggs) composition is becoming increasingly clear and the first studies showing positive health impacts of organic milk consumption have recently been published (Rist et al. 2008; Kummeling et al 2008).

A more differentiated picture has emerged for crop foods, with **(a)** an overall trend for higher levels of nutritionally desirable compounds being detected in organic compared to conventional foods being confirmed by most studies, but **(b)** certain agronomic practices (e.g. netting to protect crops against pests) being linked to negative effects on specific groups of secondary metabolites. Recently published dietary intervention study indicated increased immunological responsiveness and robustness in chicken raised on organic diets based on a mixture of grains and legumes (Huber 2007) and effects on body weight and the immune system in rats and mice raised on organic feed stuff (Lauridsen 2007, Finamore 2004). These studies indicate positive trends of organic food consumption and should be explored further in the future.

Quality expectations of consumers always radiate around four central concepts **(a)** taste (and other sensory characteristics), **(b)** health, **(c)** convenience, and for some consumers **(d)** process characteristics (e.g. organic production, natural production, animal welfare, GMO-free) (Grunert 2005). To what extent improvements in food composition satisfy consumer preferences and hence their willingness to pay for that improved quality is currently being studied under QLIF. Alignments may be needed between consumer expectations and quality improvements to achieve the maximum socio-economic benefits. Alignment could be influenced by governmental policy, marketing strategies and consumer education.

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## QLIF Workshop 2: Safety of foods from organic and low input farming systems<sup>1</sup>

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Key words: food pathogens, mycotoxins, heavy metals, pesticides, antibiotics, growth regulators.

### Abstract

*A range of food safety issues have been raised with respect to organic primary production and processing. These include concerns about enteric pathogen, mycotoxin and heavy metal and agrochemical residues. QLIF workshop 2 will critically evaluate the current scientific knowledge about relative food safety risks in organic and conventional production systems and the agronomic and processing factors affecting contamination levels in foods. A summary of major QLIF results and the recent literature reviews is provided in this paper.*

### Introduction

Important food safety issues relating to primary food production include contamination with **(a)** enteric pathogens, **(b)** mycotoxins, **(c)** heavy metal and **(d)** agrochemical residues (especially pesticides, plant growth regulators, antibiotics and other veterinary medicines).

It is widely accepted that agrochemical residues are absent or significantly lower in foods from organic production systems. However, it has been hypothesised by some scientists that **(a)** the risks of enteric pathogen and heavy metal contamination is higher for organic foods (because of the more widespread use of organic fertilisers) and **(b)** organic foods contain higher levels of mycotoxins than conventional foods (Avery 1998; Trewavas 2001). Several work packages of the QLIF project investigated the effect of agronomic practices used in organic, low input and conventional systems on these four main food safety issues.

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## Enteric pathogens

For enteric pathogens (where studies focused on pathogen shedding in pigs and enteric pathogen transfer from organic fertilisers onto lettuce) no difference in risk between organic and conventional systems could be detected, as long as farmers complied with "good agricultural practice" standards for manure use. Based on QLIF and other results, a HACCP-based quality assurance scheme for organic and 'low input' systems was developed to provide guidelines for producers allowing food safety risks to be further minimised (Köpke et al. 2007a; Leifert et al. 2008). The scheme is based on 6 main **risk reduction point (RRPs)**.

At **RRP1** (livestock production system) the focus should be on animal health and husbandry methods that reduce pathogen levels in animal faeces and manure. For example WP2.2.2 of QLIF has clearly shown that outdoor pig production significantly reduces *Salmonella* shedding at slaughter. However, it also showed that the transport time for pigs from organic and low input outdoor systems is longer than that of intensively indoor reared pigs, due to the smaller number of abattoirs processing pigs from low input systems. Since enteric pathogen shedding is known to increase pathogen shedding in pigs due to the stress associated with transport, further improvements can be made. Outdoor livestock management (**RRP2**) can be optimized to eliminate the risk of faecal material entering irrigation water (Leifert et al. 2008).

Manure storage and processing is another important risk reduction point (**RRP3**). For example WP4.4 confirmed that the risk of using non-composted raw manure increases the enteric pathogen transfer risk, while the use of composted manure was not significantly different to that of mineral fertilisers. Soil management practices (**RRP4**), and timing of manure application (**RRP5**), can also be adjusted to reduce the survival of pathogens originating from manure. During irrigation (**RRP6**) pathogen risks can be reduced by choosing a clean water source and minimizing the chances of faecal material splashing the growing crop (Leifert et al. 2008).

A HACCP-based quality assurance manual to minimise enteric pathogen contamination in organic and low input production systems is currently being developed under WP6.2 under QLIF.

## Mycotoxins

For mycotoxins (where QLIF studies focused on wheat, the main European food crop in which mycotoxins are an issue) no major differences in risk between organic, low input and conventional production systems could be detected. In 6 out of seven trials levels of *Fusarium* mycotoxins were similar under organic and conventional management and in 2005 levels were significantly higher in conventional than organic systems. A meta-analysis of the available literature showed that *Fusarium* mycotoxin levels tend to be higher under conventional compared to organic management (Brandt et al. in preparation). Several management practices that are exclusively or mainly used in conventional farming (e.g. maize and wheat as a pre-crop, minimum tillage, high mineral nitrogen inputs and certain fungicides) were shown to increase mycotoxin contamination in both wheat and maize. Where such practices are introduced into organic systems (e.g. 2<sup>nd</sup> wheat crops and late slurry applications increasingly used in organic arable rotations in the UK) the risk of mycotoxin contamination risk is also likely to increase. Guidelines for the minimisation of mycotoxin contamination in organic systems were produced as part of the QLIF Project (Köpke et al. 2007b). A HACCP-based quality assurance manual to minimise mycotoxin contamination in

organic and low input cereals production is currently being developed under WP6.2 under QLIF.

### **Heavy metals**

For heavy metals (which were studied in a wide range of crops under QLIF) no major differences could be detected between organic and conventional systems and no specific WPs therefore focused on reducing heavy metal loads in 'low input' farming. However, the long term impacts of high manure inputs on heavy metal balances should be further investigated in the future.

### **Antibiotics and veterinary medicine use**

For antibiotic use QLIF studies (WPs 2.2.1 and 4.5) focused on dairy production systems, where >60% of antibiotics are used in organic systems. Organic and 'low input' grazing based cattle production systems were shown to be associated with **(a)** significantly lower levels of antibiotic use and **(b)** lower levels of antibiotic resistant faecal *E. coli* in calves than intensive conventional systems under QLIF WP2.2.1. Guidelines to further reduce antibiotic and other veterinary medicine use in organic and low input systems were also developed (Klocke et al. 2007, Maurer et al 2007, Biavati et al 2007)

### **Pesticides and plant growth regulators**

The prohibition of chemosynthetic pesticide use under organic crop production standards has been shown in a range of scientific studies to result in no or lower residue levels in organic foods compared to conventional foods (Baker et al. 2002). Low input farming systems which minimise agrochemical inputs were also shown to result in reduced pesticide residues compared to intensive conventional production. This was confirmed by the residue analyses carried out as part of the QLIF project (Lueck et al 2007). However, in certain commodities (e.g. cereals) fertility management practices were shown to affect chemical residue levels. For example, when the same pesticide spraying regime was used, levels of the plant growth regulator CCC were 3 times higher (and close to the permitted maximum residue levels) in a 'low mineral fertiliser input' conventional system than in a standard 'high input' conventional system (3<sup>rd</sup> annual QLIF-report, unpublished). This indicates that certain pesticide safety issues may arise when farmers switch to organic matter based fertilisation regimes without reducing pesticide input levels.

### **Conclusions**

Overall it can be concluded that there is no evidence that organic and 'low input' production systems pose higher food safety risks than food from conventional systems as claimed in articles by Avery and Trewevas (Avery 1998; Trewevas 2001). In fact agronomic practices used in organic farming were shown repeatedly to reduce risks associated with agrochemical and veterinary medicine, mycotoxin residues and the development of antibiotic resistant pathogenic microorganisms in food. However, it is important to stress that risks can never be excluded 100% at the primary production stage. For example, for poultry meat microbiological safety relies on control measures during processing (heat treatment during cooking), since the complete absence of pathogens such as *Campylobacter* cannot be assured during primary production, especially under outdoor conditions. It is therefore essential to establish efficient food

safety focused quality assurance protocols for both primary production and processing of organic and low input foods (Leifert et al. 2008). This objective will be addressed under the ongoing WP6.2 of QLIF which focuses on the development of improved HACCP based food safety and quality assurance manuals and training programmes.

### Acknowledgments

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## QLIF Workshop 3: Performance of Organic and Low Input Crop Production Systems<sup>1</sup>

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Key words: crop yield, wheat productivity, potato productivity, intensive agriculture, conventional agriculture, ecosystem services

### Abstract

*Yields in organic and low input production systems tend to be lower than those obtained in intensive conventional systems. To narrow the productivity differences a range of challenges associated with organic and other 'low input' systems have been identified. These include the need to (a) develop improved organic matter-based soil management and fertilisation protocols, (b) address key crop protection challenges via improved management, variety selection, and alternative treatment approaches and (c) address food safety concerns raised about organic and low input production. QLIF workshop 4 will summarise results from the crop production focused subproject (SP3) of the QualityLowInputFood IP. This paper summarises crop productivity focused QLIF results from SP3 (and to a lesser extent SP2) in the context of current scientific knowledge.*

### Introduction

Compared with intensive mainstream agriculture, marketable yields per hectare of most field crops of organic agriculture systems under conditions of European temperate climate are generally lower (Tab.1).

**Table 1: Yields of field crops produced in central European temperate climates relative to conventional reference yields (rel.=100) (Offermann and Nieberg 2000, Niggli et al., 2007)**

Crop	Country <sup>2</sup>				
	DE	AT	CH	FR	IT
Wheat	58-63	62-67	64-75	44-55	78-98
Barley	62-68	58-70	65-84	70-80	55-94
Oats		56-75	73-94		88
Grain maize	70		85-88	66-80	55-93
Oilseeds	60-67	78-88	83	67-80	48-50
Potatoes	54-69	39-54	62-68	68-79	62-99
<b>Pulses</b>	<b>49-73</b>	<b>83-85</b>	<b>88</b>	<b>83</b>	<b>73-100</b>

<sup>2</sup>DE=Germany; AT=Austria; CH=Switzerland; FR=France; IT=Italy

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Clearly improvements in yield need to be a major target under organic and low input production systems in the context of an increasing world population, predicted reductions in the global land area available for agricultural production due to climate change and increasing use of crops as animal feeds and for energy production.

The aims of workshop 3 are therefore:

1. To identify productivity limiting factors in organic and low input systems in comparison with intensive agriculture.
2. To measure the impact of the QLIF project on the yields of organic and low input systems.
3. To discuss further approaches to increase productivity and yield stability of organic and low input systems.

### **Output and contribution of the QLIF project to the state-of-the-art**

#### ***Effect of crop management practices on yield of wheat***

A recent review of the literature on conventional and organic management systems for wheat identified soil nutrient deficiencies (especially phosphorus and nitrogen) and competition from weeds, as the main reasons for lower yields in organic grain production. (Mason and Spaner, 2006). Declining soil fertility under organically grown wheat has also been reported, with P levels often deficient, especially at sites managed organically for 30 to 70 years (Entz et al., 2001). Reduced yields in organic and low-input production may also be caused by a higher incidence of certain diseases. For example, Poveda et al. (2006) reported higher incidences of *Septoria* in organically managed wheat than conventional wheat. Studies under WP2.1.1 of QLIF showed that foliar *Septoria* disease is the only yield limiting disease in organic production systems, while other diseases such as mildew and lodging only had a negative effect on yield in conventional systems (Leifert et al. unpublished). Studies under WP3.5.4 of QLIF indicate that two of the main problems relating to the sustainability of the current organic wheat production methods (lower yields and protein contents) can be addressed by changes in cultivar choice, fertility management and pre-crop management practices (Wilkinson et al. 2007).

#### ***Effect of crop management practices on yield of potato***

Previous studies (e.g. those carried out as part of the EU FP5 Blight-MOP project) showed that **(a)** potato blight is a major factor affecting yields and **(b)** the impact of the disease on yield can be significantly reduced by improved variety choice and management practices (e.g. Speiser et al. 2006). However, even in years with low blight incidence yields in organic production often remain 30-40% lower than those in intensive conventional production. Studies under WP2.1.2 of QLIF showed that productivity and the differential in yield between organically and conventionally managed plots increased from approx 30% in years 1 and 2 after conversion to 50% four years after conversion. Thus, insufficient supply of macro-nutrients is a further reason identified for lower yields in organic potato. Potato have very shallow root systems and are associated with high nutrient (N, P and K) losses. The development of **(i.)** more N and P-efficient potato cultivars and **(ii.)** organic matter based fertilisation regimes that improve nutrient supply (especially N) at key development stages of potato (e.g. tuber initiation) are therefore thought to be the main approaches to increase potato yields in organic and 'low input' systems.

### **Effect of crop management practices on yield of field vegetable crops**

Yield differentials between conventional and organic/low input vary significantly among different vegetables. Studies under WP2.1 of QLIF showed significantly lower (usually between 20-40%) yields for cabbage (linked to fertility management practices), while yields for organic onion and lettuce were similar or only slightly reduced (10-20%) compared to conventional crops. In cabbage protective netting was significantly more efficient than pesticides for controlling cabbage root flies and resulted in an increase in yield in organic systems. Also, in lettuce the higher *Sclerotinia* incidence in conventional crops (associated with the use of mineral fertilisers) resulted in a reduction in marketable yield. Improvements in field vegetable crops should therefore focus on improving fertilisation protocols that do not simultaneously exacerbate problems from crop pests and diseases.

### **Conclusions**

Crop productivity in organic and low input systems is based on key pillars, i.e.

1. a fertile soil which provides sufficient capacity to allow for plant growth while preventing soil-borne diseases,
2. high quality, disease-free seeds and plant material,
3. a crop-specific soil fertility management plan to provide sufficient nutrients for optimum plant growth,
4. adequate varieties/cultivars,
5. crop protection techniques to prevent damage due to noxious organisms (Tamm et al., 2007).

The QLIF project has developed improved component strategies to overcome technological bottlenecks in annual (wheat, lettuce, tomato) and perennial (apple, results not discussed here) crop production systems further. Improvements in productivity were very clearly shown to be possible under the precondition of:

- favourable soil structure and soil chemical fertility as well as weather conditions
- high availability of nutrients (especially N and P), due to high amounts of soil-borne as well as added nitrogen.

More than in any other production systems the term 'productivity' in Organic Agriculture is strongly related to product quality, an overall aim of Organic Agriculture from the beginning. Thus, the term productivity in Organic Agriculture *per se* includes the production of a marketable yield of highest quality and therefore contrasts with the traditional term of productivity measured in yields or Megajoule output per hectare, only.

Lower *per se* productivity opens niches for higher product quality and ecological services and benefits (Brandt and Møldgaard 2001; Cooper et al. 2007). For example

1. Lower nitrogen inputs can potentially reduce N leaching, thus, resulting in higher groundwater quality
2. Lower density of cereal stands resulting from lower N availability may cause higher density of wild flora and endangered wild plants.
3. As a function of planned (crop rotation) and associated biodiversity in crops and wild plants, favourable habitats for insects, soil microbes, and wild and endangered animals are provided. Thus, Organic Agriculture offers benefits by on-site nature conservation.

4. Since lower productivity generally results in conditions enabling a multifunctional agriculture approach (i.e. the provision of ecosystem services), we strongly discourage using the words 'productivity gap of organic and low input systems in comparison with intensive agriculture', because this suggests a shortcoming of Organic Agriculture needing correction. The overall aim is system optimisation in the framework of Organic Agriculture's multifunctional approach, rather than realising yields equivalent to conventional farming at the expense of the environmental services provided by Organic Agriculture.

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## QLIF Workshop 4: Performance of organic and low input livestock systems: a matter of sound design?<sup>1</sup>

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Key words: endoparasites, ectoparasites, enteric pathogens, sensory quality, amino acid balances

### Abstract

*A range of challenges associated with organic and other 'low input' (especially outdoor) livestock production systems have been identified. These include the need to identify alternative approaches for the control of parasites and gastrointestinal diseases to further reduce veterinary medicine use and antibiotic/anthelmintic resistance development. QLIF workshop 4 will summarise the fourth year's results of the livestock subproject (SP4) of the QualityLowInputFood IP. At the same time, it will contribute to the discussion on how organic livestock farming systems are being evaluated: by their design (input) or by their performance (output). This paper summarises QLIF results from SP4 in the context of current scientific knowledge.*

### Introduction

Organic production systems aim to provide various benefits to society. These benefits are associated with the four main principles of IFOAM: Health, Ecology, Fairness and Care (IFOAM, 2005). Implementation of these principles into organic livestock systems involves careful study on how housing and management factors affect the health and welfare of animals, the environment we live in and the farmer's income. This is not an easy task, as the underlying housing and management techniques used to make the principles operational do not always complement each other (Hovi et al 2003; Cooper et al 2007). This is the main reason why there are still a number of technological restraints in organic livestock production systems, which affect quality

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and safety of organic and “low input” foods as well as the cost of production (Spoolder et al. 2007). The QualityLowInputFood (QLIF) project aims to address some of the most relevant gaps in our knowledge when taking up this challenge. The gaps relate to: **(a)** the control of endo- and ecto-parasites (WPs 4.1 and 4.2, **(b)** alternatives to antibiotics for the control of gastrointestinal infections and mastitis (WPs 4.3 and 4.5), **(c)** feeding regimes which improve meat quality and minimise amino acid imbalances in monogastric production systems (WP4.4) and **(d)** the problem of negative energy balances in dairy systems, while improving milk quality (WP4.5).

#### **Output and contribution of the QLIF project to the state-of-the-art**

##### ***WP4.1 Improved preventive strategies for controlling endo- and ectoparasites and bacterial zoonoses of pigs and poultry.***

**POULTRY** The risk of parasitic infections is increased in hens in free-range systems compared to systems without outdoor access (Permin et al, 1999). Improvements in run management and reducing the stocking density from 5m<sup>2</sup> / hen to 10 m<sup>2</sup> / hen can significantly reduce faecal egg counts FEC of the two helminth species of poultry (*Ascaridia galli* and *Heterakis gallinarum*) on outdoor runs. Experiments on the effect of litter management on litter infectivity and transmission of *A. galli* and *H. gallinarum* as well as feeding trials with potential anthelmintic plants are ongoing.

**PIGS** - *Ascaris suum* is the most prevalent helminth on organic pig farms (Carstensen et al., 2002) and is transmitted mainly via the faeces. A first study therefore focused on assessing the efficacy of different protocols for cleaning the dunging area of pigs on *Ascaris suum* transmission to pigs. Experiments are ongoing, but preliminary results suggest that improved cleaning protocols alone are not able to reduce *Ascaris* infections, but should be part of a package of measures against *Ascaris*. A second study quantified the effect of dietary inclusion of dried chicory roots on Oesophagostomum spp. infections in naturally infected sows and boars, since pilot studies had shown that dietary inclusion of dried chicory roots may reduce infection and egg excretion levels in pigs (Spoolder et al., 2007). Dried chicory abolished egg excretion within 2-6 days, but after withdrawal of the chicory faecal egg counts increased. Nevertheless, overall egg excretion remained significantly below that of the control animals in both trials and can therefore be recommended for use strategic use in organic and ‘low input’ pig production systems.

##### ***WP4.2 Alternative treatment strategies for controlling endo- and ectoparasites of pigs and poultry.***

**POULTRY** Control of the poultry red mite *Dermanyssus gallinae* is a challenge for organic as well as conventional egg producers. A range of alternative treatments including diatomaceous earth supplemented with pyrethrum and essential oils, a liquid formulation of silica were tested *in vitro* and tests with plant extracts and different oil types are ongoing. In on farm experiments, diatomaceous earth was effective during a limited period only, whereas 2 liquid formulations of silicas had a very good residual effect against red mite.

**PIGS** In organic pig farms, this percentage of pig livers that need to be condemned due to *Ascaris suum* is often higher than in conventional pig farms. To reduce the use of synthetic drugs (e.g. benzimidazoles, levamisole and macrocyclic lactones) herbal preparations were tested for the prevention and control of a mild infection of *Ascaris suum* in growing and finishing pigs. While not decreasing the number of infected pigs some herbal treatment reduced the average number of worms in the gastro intestinal tract. Studies currently focus on identifying the suitable period to supply this herb

mixture to sows and the potential of combining herbal remedies with reduced doses of veterinary drugs.

**WP4.3 Methods to augment non-immune system based defence mechanisms against gastrointestinal diseases in the pig.**

Probiotic *Bifidobacterium* strains, prebiotic and acidified nitrite supplements were assessed for their potential to control gastrointestinal pathogens causing diarrhoea in pigs. The ability of microencapsulated probiotic strains to pass through the acid barrier of the stomach and establish increased population density in the intestine was demonstrated. However, although antimicrobial activity of acidified nitrite treatments and the ability of probiotic strains to inhibit enteric pathogens was demonstrated *in vitro* (Biavati et al. 2007), this could not so far be confirmed in experiments *in vivo*. Also supplementing organic growing-finishing pigs with maize silage, grass silage or a probiotic preparation did not significantly affect performance and carcass traits.

**WP4.4 Strategies to improve sensory quality and food safety of pork without the use of amino-acid supplements, while improving production efficiency within organic farming conditions.**

Due to the restricted availability of limited amino acids in organic livestock production protein accretion capacity is limited compared to conventional production. Sensory quality of pork is to a high degree influenced by the intramuscular fat (IMF) content and previous studies showed that pig diets were the main source of variation for the IMF content in pork. In on-farm trials the effect of the implementation of a specific feeding strategy using a high portion of home-grown grain legumes on the IMF content of pork, was assessed under different conditions on German and Austrian organic farms. Results showed that different to previous feeding regimes had no significant influence on the IMF but that there was great variation between the farms for IMF. It was therefore concluded that there is a need for a direct assessment of IMF-content of pork at the abattoir to fulfil the expectations of consumers with regard to a high eating quality of organic pork.

**WP4.5 Efficient farm/farmer group specific mastitis prevention plans.**

The objective of this ongoing study is to identify the main factors influencing udder health in organic dairy farms under different climatic and structural conditions. Results show that improvement of housing/environmental conditions and farmers' skills allow a partial conversion to a non-antibiotic treatment scheme based on teat sealant dry-off prophylaxis. Also, calves reared with their mother were shown to grow faster, while no negative effect of suckling on the somatic cell count or a negative impact on animal health status were observed. The effect of suckling calves on the resistance of adult animals to mastitis and the overall results of the mastitis prevention plan programme will be known at the beginning of 2009.

**WP4.6 Bovine feeding regimes which improve production efficiency, microbiological safety and/or sensory quality of milk.**

Preliminary observations at IGER showed that feeding clover silages (CS) increases the polyunsaturated fatty acid content of milk. However, the effect of CS based diets on faecal shedding of enteric pathogens was not previously investigated. Studies at IGER gave no clear indications that feeding red clover silage affects faecal shedding of *L. monocytogenes* or *E. coli*. However studies demonstrated that milk and milk protein yields can be significantly improved by feeding red clover silage (RCS) as 1:1 mix with maize silage, but that the efficiency of utilisation of forage N was reduced when diets contained more than 10% RCS.

## Conclusions

The results obtained in the QLIF project over the last four years have provided recommendations to farmers and other stakeholders on how to improve organic livestock farming. Significant progress was made in areas of housing, feeding and management. Often the recommendations are straightforward, and ready for implementation, e.g. the recommendation to provide roughage to pigs (WP4.4) to improve gut health, or the inclusion of dried chicory to combat *Oesophagostomum* (WP4.1). In other areas challenges remain. For example, reducing endoparasitic burden and keeping the use of conventional anthelmintics to zero appears to be rather difficult (WP4.2). In some cases, progress with respect to one objective have created new challenges. For example, under WP4.5 the maternal rearing of calves increased calf live weights at weaning, but resulted in unacceptable levels of cow, calf and farm stress at weaning. In these cases it is difficult to decide whether or not a change is an overall improvement or not.

To facilitated decision making the following key questions will be discussed as part QLIF workshop 3 at the Modena IFOAM/ISOFAF congress

1. What constitutes a high performance organic livestock system (consider the various stakeholders - farmer, animal, consumer, certification body, broader society, etc)?
2. Given answers to the above question - what are the key indicators of organic livestock system performance?
3. How do we measure these indicators?
4. Are there any major conflicts when trying to achieve high levels of system performance – what are they, who do they affect and can we reduce them?

## Acknowledgments

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## QLIF Workshop 5: Resource efficiency of organic and low input systems in comparison to intensive agriculture: Extended summary<sup>1</sup>

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& Niggli, U.<sup>7</sup>

The results from the QLIF project and other results presented here show that organic crop production systems are normally superior to conventional systems in terms of energy use and greenhouse gas emissions whether this is calculated on a per area basis or on the basis of kg of food produced. As the productivity of organic systems is lower than that of conventional systems, the comparison is most favorable when calculated on the basis of the area of land.

With animal production systems this is more variable. Where ruminant animals can use extensive areas, or where much feed production can be based on ley crops in the rotation with legumes to supply N, organic production may come out with clearly better energy balances than conventional systems. However, the feed use efficiency in organic production is often lower than in conventional production, and if the production is based on cereals and other products from annual crops, this leads to a somewhat better energy balance in the conventional systems.

There are some examples where organic production is found to use clearly more energy than conventional production. This is mainly related to the more intensive productions. As an example, organic pork production can have less energy efficiency and lead to larger loss of N by leaching and N<sub>2</sub>O by denitrification because of the free range systems employed. In production systems where the manure can be collected and later applied to fields at an optimal time and amount, the environmental load can be reduced. In this case, the requirements for improved animal welfare lead to a less environmentally friendly system in terms of N losses, energy balance, and greenhouse gas emissions.

A special point is that organic animal production may lead to reduced ammonia gas losses. As ammonia gas from agriculture adds N to the near surroundings, this can be a major advantage. In areas with intensive agricultural production, ammonia losses lead to eutrophication and thereby loss of species living in nutrient poor ecosystems.

Also in the field, intensive productions can lead to environmental problems in organic production. When horticultural crops are grown, the production value per hectare is very high compared to arable crops, and the economic loss to the farmer if yield or quality is reduced is very big. Therefore horticultural producers often choose to err on

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<sup>1</sup> The full version of this paper is available at [www.orgprints.org/13352](http://www.orgprints.org/13352)

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the side of caution and choose safer options sometimes using methods which are less than ideal from an organic point of view, while still adhering to rule governing horticultural production without chemical fertilizers, pesticides, or herbicides. Net covering against insect pests or flaming against weeds are two examples of such energy demanding practices. In fertilization vegetable farmers tend to also err on the side of caution combining green manure effects and high application rates of organic manures. This can lead to significant risks of N leaching losses, and as these manures could have replaced chemical fertilizers elsewhere, it is also a problem in terms of energy balance.

The conclusion that organic farming methods show similar or improved energy balances and tend to contribute less to green house gas emissions is based on a number of key assumptions which should be kept in mind when interpreting such results.

One is that energy input is compared to food output. But crop and food production can also be expressed in terms of energy. Crop production normally represents a clear net energy production (production of crops in heated greenhouses is an exception here). Even though the amount of energy produced per kJ of energy used may be better in the organic systems, the higher productivity of the conventional systems mean that conventional system tend to have a higher net energy production per hectare.

The significance of the area used for crop production is another open question when comparing different production systems. While the organic systems may have the highest productivity per amount of invested energy, they have a lower production per area. What is most important here investment of energy or area? Our area for crop production is not unlimited, and the extra land we need for organic food production could be used for other purposes. Growing a hectare of green manure for a year or two may cost little energy, but what is the significance of the land area it takes up?

We tend to compare organic systems with conventional systems producing the same commodities. However, if we compare commodities, the differences we find are much larger. Cereals and some vegetables show high net food energy production per hectare, whereas low yielding crops as lettuce and some other vegetables show much lower net food energy production. Greenhouse production of vegetables show a net energy cost, at least if production is continued during cold winter periods. Conversion of plant products into animal products such as milk or eggs includes the loss of most of the energy from the plant products, and to the release of greenhouse gasses as CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O. Thus, the environmental footprint varies strongly among products, and animal based products are in most comparisons much worse than plant based food products.

Another problem is the C which circulates in the system. When calculating the energy balance or green house gas release due to organic or conventional cropping, we obviously include the C released from fossil fuels when producing fertilizers or pesticides, or when doing mechanical field operations. However, within the systems a lot of C "bound in energy rich compounds" is circulating, and the way we take this into account on our calculations is not very clear or consistent. As already mentioned, food production can also be expressed in energy equivalents, but so can the C and energy content of crop residues, organic manures and of soil organic matter accumulated or lost due to the production systems is relevant. The assumption that organic manures have no energy value, though they contain a lot of C and organic matter is determining the outcome of many of the comparisons. These comparisons could look very different if the manure energy content was included. The inclusion of the energy content in

manures and crop residues become increasingly relevant as the energy prices go up, and the attempts to use these resources for bio-energy production are increasing.

Storage or loss of C and energy from the soil organic matter pool can also be important. Here organic systems tend to have a better effect than conventional systems, especially if they can add more ley crops and cover crops to their rotations than the conventional systems they are compared with.

Taking into account some of the aspects mentioned here could significantly alter comparisons between systems and between commodities in many cases. Therefore, a discussion about which aspects are really relevant to include in the comparisons is needed. There will certainly not be one clear set of answers for this, but depending on the question we ask, the aspects we should include in the analyses will differ. We need to discuss what inclusion of various aspects of energy balance, greenhouse gas emissions, nutrient or pesticide loads means for the conclusions we can draw from the comparisons we make.

Analyses made as part of the QLIF project indicate that consumers consider both the quality, safety and environmental attributes of organic food as important when making decisions about whether to, and for what price they are willing to buy organic products. As a result, from a consumer and marketing perspective, it is very important that the real environmental advantages of organic production for different products are calculated. This will allow for better, more accurate and credible communications on the real environmental footprint of organic production systems to be developed. Analyses showing environmentally weak aspects of some current organic production methods are also important, to help us develop better organic production methods for the future. Communicating the environmental value of organic products will play an important role in encouraging those consumers motivated primarily by environmental concerns to make better consumption choices that result in a shift in their consumption away from products that have been scientifically shown to have an adverse impact on the environment.

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## **Workshop**

### **Food, Fairness & Ecology: An organic research agenda for a sustainable future**



# Food, Fairness & Ecology: An organic research agenda for a sustainable future

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Key words: Organic research agenda, sustainability, food security, ecosystem services

## Abstract

*The European Union Group of the International Federation of Organic Agriculture Movements (IFOAM EU Group) and the International Society of Organic Agriculture Research (ISOFAAR) are developing a strategic research agenda focussing on ecological intensification, on sustainable rural regions, on high quality food for healthy nutrition and on ethical values of people vis-à-vis technology development in food production. The strategic research agenda (currently in its second draft, Niggli et al., 2008a) invites farmers, processors, traders, NGOs and scientists to debate on how practice and science should co-operate on future innovation. The final goal of the debate is a widely supported technology platform for organic agriculture and beyond.*

## Introduction

Organic food and farming is a constantly growing sector in the European Union (EU) and globally. It has a good potential to respond to the big challenges the EU and the world will face in the next decades, both in the area of environment (mitigation of and adaptation to climate change, including soil, water and biodiversity management and conservation) as well as in the area of food (sustainable productivity and high quality), rural development and animal welfare.

Innovation generated by the organic sector has considerably driven general agriculture and food production towards sustainability, high quality foods and low risk technologies in the past. Thus, strengthening research activities will have an impact far beyond the certified organic sector.

Technology platforms are permanent, industry-led schemes, involving the research community, public authorities and civil society.

## General situation of the organic sector in the EU

In 2006, the European organic market grew by more than 10 percent, and it was worth approximately 14 billion €. In many old member states, production accounted for up to 13 % of the total agricultural land; more than 6.8 million hectares were under organic management in the EU.

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Until the 1980s, research was mainly carried out by private initiatives. In 1982, the first universities took organic farming on their curricula, in the 1990s, the first EU-funded projects on organic farming started, and a growing number of national state research institutes became involved in organic farming projects.

Many national action plans include special programs for organic farming research. With the ERA-Net project CORE Organic, the cooperation among funding agencies of research programmes led to a joint call of 11 countries in 2006. The total national funding for organic research in these 11 countries was 54 million Euros in 2005.

From the 5<sup>th</sup> EU research framework programme to the 6<sup>th</sup>, project funding increased from 15.4 million € to 22.1 million (without national co-funding).

Long-term observations and a shift from a multidisciplinary to an interdisciplinary research culture are characteristic for organic farming. Increasing emphasis is given to trans-disciplinarity where researchers, practitioners and stakeholders cooperate in order to address complex challenges of the society and find feasible solutions.

### **Strengths and weaknesses of organic agriculture and food chains**

Analysing the strengths and weaknesses of organic agriculture is the first step towards identifying future research priorities. Such a critical analysis also helps to dynamically optimize the framework of organic agriculture, looking at its principles and standards, implementation rules and indicators which are used in the quality management system. For references used for assessing organic systems see Niggli et al., 2008a.

Among the ecological and environmental strengths of organic agricultural are to be found: i) reduced pollution (nitrates, pesticides), ii) improved biological and physical qualities of soils and iii) strongly increased diversity at landscape, farm, field, species and genome level. Furthermore, organic farming systems are likely to be better able to cope with climate change, as they are more resilient and have inherent techniques which reduce greenhouse gas (GHG) emissions ( Niggli et al., 2008b).

The socio-economic situation of organic agriculture is inconsistent. Therefore, state direct payments are vital for organic farms in order to compensate for the fact that, in organic farming, negative environmental and social costs are externalized to a lesser degree. Organic farming combines similar or higher incomes with the creation of higher employment, as it contributes to rural economic development through value-adding activities such as direct marketing, local processing of specialities and tourism.

Generally, consumers attribute positive characteristics to organic foods and they perceive them as healthy, tasty, authentic, local, highly diverse, fresh, minimally processed, natural, free of undesirable residues and safe. Several meta-studies confirm not all but many of these quality claims. Health claims, however, are generally only poorly substantiated by scientific research, mainly because intervention and cohort studies are very expensive.

When designing future research programs, it is, however, more interesting to know the weaknesses of organic agriculture and the organic food chain. Among these, the most pressing ones are the productivity and yield stability gaps, both caused by severe deficits in the knowledge of how agro-ecological systems work and the lack of appropriate technologies for organic systems. These gaps need to be addressed in a consequent way in order to fully exploit the positive impacts of this farming method on the environment, on biodiversity and on climate change mitigation and adaptation.

## Vision for research and strategic priorities for 2025

The strategic research priorities are based on i) the principles of organic agriculture, ii) scientific innovation and iii) best integration of indigenous knowledge of farmers. The priorities focus particularly on the conflicts between economy, ecology and social cohesion/harmony inherent in most concepts for sustainable agriculture and food production, and they propose research activities and insightful learning concepts far beyond the niche that organic farming currently still represents. Each of the four research priorities (see figure 1) is underpinned with examples of possible research activities (see Niggli et al., 2008) which are not outlined here.



**Figure 1: Vision for research and strategic priorities for organic systems.**

The magnitude of challenges outlined by foresight studies (e.g. SCAR, 2007) indicate that agriculture is based upon distinctive ethical values. This is especially true for questions like rural development, decentralised food production, the quality of the landscape, the conservation of biodiversity, the sustainable use of natural resources as well as fair trade, livelihood of farm families and animal welfare.

The ethical value system of organic agriculture is described by the principles of health, ecology, fairness and care (IFOAM, 2005). It provides a unique basis for developing complex assessment and decision tools and for modelling future sustainable food and farming systems in a practical context where stakeholders along the whole food chain can participate and where civil society is strongly involved into technology development and innovation.

Locally produced raw materials with specific qualities will increase the diversity of European food in a considerable way and will keep agriculture, food production, culinary culture and tourism very competitive. Wellness, high quality food, locally processed foods from traditional recipes and geographical denomination will create jobs and wealth in rural areas and will add to their attractiveness. Organic farming has taken up very early this concept of multifunctionality. This forerunner role is very fruitful for the society and helps to adjust technology development and innovation.

In this regard, organic agriculture represents one of the best developed multifunctional strategies in agriculture so far. Therefore, it is an excellent starting point for an ecologically and environmentally sound intensification in balance with ecological goods and services, nature protection, animal welfare and social objectives.

The weakness of organic agriculture, so far, is its currently insufficient productivity and stability of the yields (especially of intensive cash crops). This may be solved by an appropriate “ecological intensification”, i.e. via a better and more efficient use of natural resources, improved nutrient recycling techniques and agro-ecological methods for the enhancement of diversity and health of soils, crops and livestock. Successful research strategies are i) the clever integration of leguminous plants into cropping, ii) the better use of the nitrogen (and other nutrients), derived from livestock production, iii) reversing the separation of crop and livestock production, which has often resulted in soil degradation on croplands and in nutrient excess in livestock operations with yet unsolved environmental problems, iv) the exploitation of ecosystem services via clever habitat design and v) the use of novel technologies (such as sensors, robots, information technology and smart breeding).

Individual and social well-being strongly depend on both the quantity and quality of the food we eat, the composition of the diets and how it is processed and prepared. The power to choose foods that meet the highest standards of ethics and craftsmanship, is a manifestation of every citizen's everyday's control of his life circumstances, the key prerequisite for a long and healthy life. Therefore, an improved quality of life is intricately linked with an increasing demand for foods of the highest standards such as organic food. Food quality research includes a whole chain approach and will address the most critical steps which influence the quality of the food from primary production to processing, transportation, packaging and consumption.

### Conclusions

A sustainable approach to agriculture and food production means coping with trade-offs between ecosystem services while not reducing some of them in favour of others. The rationale behind organic agriculture is providing sufficient food and fibre while increasing *regulating* services (e.g. increasing the adaptive capacity of farming systems to climate change) and maintaining or restoring *cultural* (e.g. pleasant landscape) and *supporting* services (e.g. soil fertility). As human well-being depends not only on the quantity of food but also on its quality and diversity, the vision also addresses food, nutrition and health aspects. Organic farmers practise a pragmatically optimised equilibrium between the services the society expects agriculture to deliver. It is therefore an excellent starting point for truly sustainable food systems.

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**Workshop**  
**Research carried out in the Sixth**  
**Framework Programme on organic and**  
**low-input agriculture**

## EU supported organic and low-input agriculture research in the Framework Programmes (FP6 and FP7): scientific support to policies and quality products

Tissot, D.<sup>1</sup>

As part of the Organic World Congress held in Modena in June 2008, the European Commission, DG Research, organised a specific session to give an overview of the research carried out in the Sixth Framework Programme on organic and low-input agriculture, together with a presentation of the results of some of the supported projects. The session has included a panel discussion to highlight success stories and identify areas where priority for future research should be given.

The status of Organic Food and Farming Research in Europe has been assessed primarily in 2002 and was followed in 2004 by a seminar in Brussels with the main objective of stimulating trans-national cooperation. The main outcome of the 2004 seminar was a list of recommendations and priorities for trans-national research co-operation in organic food and farming in Europe directed towards the Commission for uptake in the 7<sup>th</sup> Framework programme. Within the areas of research identified more specific topics can be listed. Some of them have been addressed in the 6<sup>th</sup> Framework programme (FP6), while others will be taken into consideration in the *Knowledge-Based Bio-Economy* (KBBE) to be developed in Theme 2 "Food, agriculture and fisheries, and Biotechnology of the 7<sup>th</sup> Framework programme (FP7).

The different priorities can be broken down into three main strategic areas:

### Promoting technical innovation and methodological development to overcome producers' problems

**Crop protection** with methods acceptable to organic/low-input farming and environmentally friendly practices is one of the main problems encountered by producers. In particular, protection against fungal diseases in seeds, fruit and vegetable is difficult to ensure without the use of strong chemical treatments. The project **REPCO** (Replacement of copper fungicides in organic production of grapevine and apple in Europe) has produced exploitable knowledge on the use of several potentiators of resistance and organically based fungicides in organic production of grapevine or apple. Such novel products showed promising activity against downy mildew of grapevine (*Plasmopara viticola*) and/or apple scab (*Venturia inaequalis*) and may have a potential in controlling other plant diseases. Implementation by end-users and industry has been emphasised and transfer of the knowledge of integrated use of control measures to growers can be delivered. The **ENDURE** network has the objective to optimise and reduce pesticide use. It also aims at designing innovative crop protection strategies while improving basic knowledge of crop-pest systems.

**Innovative processing methods** respecting consumer expectations on organic products while preserving the quality of the products along the food chain have been explored in the **QualityLowInputFood** integrated project. In particular chlorine replacement strategies for fresh cut vegetable have been assessed as well as strategies that may improve the composition of dairy products. The **ORWINE** project is

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currently exploring alternative methods to sulphite addition in the winemaking process coupled with improved management practices and on-farm application of innovative methods.

Future research is already planned and prepared on **breeding and management practices** in livestock production systems through a project that will be funded after the second call of FP7 and a call will be open soon to a similar approach for crop production systems.

A Commission strategy paper for future calls in FP7 is currently being discussed and will consider among other priorities specific techniques for aquaculture and alternatives to chemicals for veterinary treatment of animals.

The **Welfare Quality®** Integrated Project is addressing the improvement of **husbandry systems with respect to animal welfare** covering in particular welfare monitoring and assessment in order to establish standardised animal-based measures for a list of parameters appropriate to each species. In addition practical strategies to improve specific aspects of animal welfare are being identified.

### **Supporting the production of high quality organic food and feed for better impact on human and animal health**

This is the ambitious objective of the **QualityLowInputFood (QLIF)** Integrated project. It is the first time that such a large-scale project on organic and low-input agriculture has been funded at EU level. Research executed by a multidisciplinary consortium from all over Europe represents the best option to guarantee unbiased results over such a sensitive issue as organic farming and other low input production systems when compared with conventional farming. The QLIF project has been running for more than after 4 years and addressed the **impact of organic foods on nutritional, sensory, microbiological and toxicological quality and safety of foods**. By collecting sound scientific data the project is giving a strong scientifically based and informed perception of differences in the quality and safety between foods produced in different production systems (conventional, low-input, organic).

### **Increased co-ordination and communication, infrastructures network and training and demonstration:**

An efficient co-ordination between Member States has been achieved by the **CORE-Organic ERA-Net**. The project draws on public funds from 11 countries. There is a clearly identifiable interest in national research programmes to co-operate more actively in the area of organic farming, which the Commission is considering proposals to open a new ERA-Net building upon the results of the CORE-Organic project while extending its scope and geographical area, possibly through multilateral joint programming.

Specific developments of organic farming policy have generated needs for **scientific research in support to** the revision of the organic farming regulation (**EEC/2092/91 revision** project) and to the European Action Plan for Organic Food and Farming (**ORGAP** project). In addition the opening of channels of communication between the Accession and Candidate Countries and the EU in ecological farming has been ensured by the **CHANNEL** project.



In conclusion the increased visibility of European research as described above in organic and low-input farming, and at international, and member state level is likely to contribute to the development and the competitiveness of organic agriculture in Europe.

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Benbrook, C.	832	Capitaine, M.	220
Bennett, R.	828	Casini, M.	156
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Costa, C.	780	Finotti, E.	806
Coulier, L.	714	Fischer-Arndt, M. T.	768
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Daniel, M.	498	Fonseca, M.F.	368
Darolt, M.R.	518	Fontaine, L.	618
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Deittert, C.	216	Garaguso, I.	806
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Demeler, J.	90	Garibaldi, A.	784
Denver, S.	502	Gassner, B.	400
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Dowson, K.	70	Giorgetti, A.	156
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Durazzo, A.	806	Giudici, P.	328
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Hagmüller, W.	110,	Jones, S.	614
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