

## Opinion on the publication of the Stanford University Medical School study: “Are Organic Foods Safer or Healthier than Conventional Alternatives? A Systematic Review.”\*

**Dr Alberta Velimirov**  
**Dr Thomas Lindenthal (FiBL Austria)**

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**FiBL Österreich / Austria**  
Seidengasse 33-35/13, A - 1070 Wien  
Tel. +43 (0)1 907 63 13  
info.oesterreich@fbl.org, www.fbl.org

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# 1 General and introductory remarks on the Stanford study

The publication of a new meta-analysis by researchers at Stanford University (Smith-Spangler et al. 2012), and particularly the media attention surrounding it, has rekindled the decades-old controversy relating to the health benefits of organic produce.

The Stanford University Medical School researchers evaluated the findings of selected studies previously published in international peer-reviewed journals, posing the question: are organic products safer or healthier than conventional alternatives? Parameters examined in the studies included nutrient levels, pesticide residues and microbial contaminants in a wide variety of foods, as well as the incidence of antibiotic-resistant bacterial strains, and the results of human nutrition studies were also taken into consideration.

Summarising their findings, Smith-Spangler et al. (2012) state that their comprehensive study yielded scant evidence that produce from organic agriculture has any health benefits. There was no clear evidence that consuming organic products offered any health benefits compared to conventionally produced foods, they affirm, although the study findings show that consumption of organic products reduces contamination from pesticide residues and that organically farmed chicken and pork may reduce exposure to antibiotic-resistant bacteria.

Meta-analyses of organic production systems must be viewed with a critical eye, as the authors of the Stanford study (Smith-Spangler et al. 2012) themselves point out in the Discussion section. The overall effects resulting from their calculations, they note, are based on highly heterogeneous data and therefore need to be interpreted with caution. Heterogeneity is a fundamental characteristic in biological systems, a natural phenomenon affecting all living plants and animals. Furthermore, organic farming is in itself highly heterogeneous because of regional, local and traditional factors and the fact that organic holdings may vary widely in terms of production focus and management intensity.

Similar earlier studies had the same flaws as those of the Stanford study, which is in some measure due to the fact that the participating researchers clearly have little knowledge of agriculture. Consequently, production methods that are atypical in organic farming are uncritically cited as reference points for the organic products examined.

The study is nevertheless useful as it shows that when assessing quality we need to take a closer look beneath the surface. The best way to do this is to use the established findings of the basic research, which elucidate and confirm correlations between production method and food quality under controlled conditions that enable comparison. Where the findings are contradictory, we should expect researchers to analyse the specific farming methods and settings. Examining the underlying research in this way can enable us to assess and take into account, for example, factors such as the specific methods used to analyse fertiliser use, field cultivation history, duration of conversion, crop rotation, earlier management measures, regional measures for adapting seed to climatic and soil conditions, and duration of the study, etc. The nuanced and systematic approach that this requires would also help to drive the development of organic agriculture forward, but it also means that researchers need to have prior knowledge of the relationships between agricultural production and quality.

## 1.1 Critical appraisal of the study's findings

### 1.1.1 Beneficial compounds

Use of organic fertilisers (especially compost) has been shown to increase significantly the synthesis of defence-related compounds that may potentially be relevant in health terms (Brandt et al. 2011). This is also confirmed by the authors of the Stanford study (Smith-Spangler et al. 2012) in relation to the total phenolic content of plants (phenols are secondary metabolites with antioxidant, anti-inflammatory and anti-cancer properties).

Smith-Spangler et al. (2012) reduce the significance of the difference from  $P = 0.007$  (significant) to  $P = 0.064$  (merely a tendency), as the authors excluded two important studies from their investigation. One of these is a study by Carbonara et al. (2001), and the other is by Lamperi et al. (2008). The reason given by Smith-Spangler et al. (2012) for excluding these two studies was that they fail to state sample size, but this is not elucidated further.

Smith-Spangler et al. (2012) found no significant difference between organic and conventional products in terms of carotenoids and other non defence-related secondary metabolites such as anthocyanins and tocopherols. In this case, however, the basic plant-related research shows that these compounds do not depend on nitrogen availability and the corresponding shift in plant metabolism in favour of carbon metabolism, but that they tend to be influenced instead by genetic factors (crop variety) and environmental factors (Brandt et al. 2011). Carotenoids are pigments that have an antioxidant action and act in tandem with tocopherols to protect the plant from damaging UV radiation. Higher levels of certain carotenoids therefore depend first and foremost on sunlight intensity. This is why ripe and sun-dried tomatoes are particularly rich in lycopene, for example. Cultivation method is thus of secondary importance as a factor influencing levels of these compounds. On the other hand, the fact that organic production focuses strongly on promoting availability of ripe local, seasonal produce may have a positive impact in this regard.

Species-appropriate nutrition of dairy cattle, based primarily on roughage, enhances levels of (among other things) beneficial fatty acids in milk. This finding is also confirmed by Smith-Spangler et al. (2012), who found that organic milk contained significantly higher levels of omega-3 fatty acids and vaccenic acid.

Smith-Spangler et al. (2012), however, make no mention of the shift in protein composition of organic cereals towards higher levels of essential amino acids.

In terms of essential minerals, only phosphorus content was found to be significantly higher in organic produce according to Smith-Spangler et al. (2012). Neither was vitamin content found to be higher in organic products. In the case of vitamin C, however, this conclusion could be contested since the study on which it is based states that the use of high levels of mineral fertiliser reduces vitamin C content (Brandt et al. 2011).<sup>1</sup>

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<sup>1</sup> Brandt K., C. Leifert, R. Sanderson & C. J. Seal (2011): Agroecosystem Management and Nutritional Quality of Plant Foods: The Case of Organic Fruits and Vegetables, *Critical Reviews in Plant Sciences*, 30:1-2, 177-197. This meta-analysis is based on almost exactly the same set of comparative studies as the Stanford study (Smith-Spangler et al. (2012)), but the findings and conclusions of the two differ fundamentally. For example, Brandt et al. (2011) found organic produce to have nutritional benefits as a result of having significantly higher levels of beneficial compounds including vitamin C (6% higher) and secondary defence-related metabolites (16% higher). As the health benefits of fruit and vegetables are attributed mainly to these compounds, the authors conclude that consuming organic produce may promote longevity.

Kirsten Brandt, researcher in food quality at Newcastle University in the UK and lead author of the above meta-analysis, wrote a letter to the publisher of the journal *Annals of Internal Medicine*, in which the Stanford study was published, in which she asked a number of critical questions concerning the selection process for the publications included in the statistical calculations and the lack of transparency regarding the manner in which the study deals with sample sizes. Another area where clarity is lacking, she argues, is how plant secondary metabolites are grouped together and why certain relevant compounds are excluded.

In an interview for Huffington Post, Kirsten Brandt also explained that the Stanford authors had clearly mixed up flavanols and flavonols in their analysis (<http://science.orf.at/stories/1705036/>). Flavonols are pigments which protect the plant from UV radiation, while flavanols are secondary compounds with protective effects against cancer.

### Conclusion (by Velimirov/Lindenthal)

Organic production has the potential to positively influence the composition of plant and animal-based food products. The scant evidence of health benefits of organic produce found by Smith-Spangler et al. (2012) is inconsistent with the findings of other comparative meta-analyses, ignores the findings of basic research, and to an extent is the result of methodological shortcomings.

In addition, the importance of randomly selected food quality parameters in relation to the whole system must not be taken out of context. Only a comprehensive interpretation that takes into account all sustainability parameters across the entire production chain can reflect the overall value of a food.

## 1.2 Harmful compounds

The results of comparisons of harmful compounds such as pesticide residues, mycotoxins and pathogenic organisms yield an equally inconsistent picture in the Stanford study.

Smith-Spangler et al. (2012) acknowledge that the risk of contamination with pesticide residues is lower in the case of organic produce. The authors use an unusual metric that presents the level of risk as 30% lower, although this figure would be 81% if conventional statistical methods were used. Professor Charles Benbrook of the Center for Sustaining Agriculture and Natural Resources (Washington State University) has written a detailed critique of the methodology used here.<sup>2</sup>

However, even this clear finding concerning pesticide residues is qualified by the authors of the Stanford study; they point out that in both production systems the risk of levels exceeding allowable limits is relatively low. It should be borne in mind here that in mainstream science contamination with biocide residues at levels below the allowable limits is not considered to be a risk. The key point, however, is that, whether one is referring to food in general or individual products, the issue is not so much about a specific residue but about interactions between several residues, such as pesticides. For this reason, discussions in the EU have focused for some time on how to investigate residue interactions (interactions between various pesticides, for example). Hitherto – and the risk estimation of Smith-Spangler et al. (2012) is also calculated on this basis – we only have ADI (acceptable daily intake) values for individual chemical constituents, and not for manufactured chemical formulations, e.g. pesticides, and these are the allowable limits used in mainstream science to assess risk. Moreover, ADI levels relate only to adults of average weight; in other words, they do not take into account variations in individual sensitivi-

<sup>2</sup> [http://www.foodfirst.org/sites/www.foodfirst.org/files/pdf/Benbrook27s\\_Response\\_to\\_Annals\\_Article.pdf](http://www.foodfirst.org/sites/www.foodfirst.org/files/pdf/Benbrook27s_Response_to_Annals_Article.pdf)

ties or “peripheral groups” such as children or pregnant women, and no gender distinction is made.

Unfortunately neither the scientific community nor the public health authorities know what happens in cases of multiple exposures to pesticides, and the health consequences of long-term or lifelong intake of residues without limitations is even more unclear. Initial research, however, indicates that pesticide mixtures may give rise to combined effects even at low levels of contamination (Kortenkamp 2007). In addition, scientists have long questioned whether the outdated dogma that “the dose makes the poison”, in other words the linear dose-response relationship, can still be considered valid at all in view of the epidemiological evidence, notably of disorders linked to endocrine disruptive pesticides (Vandenberg et al. 2012).

Research on nitrates, which are controversial substances due to their detrimental effects on human health, is not mentioned in the Stanford study. Organic vegetables generally have lower nitrate content than conventional produce as crop fertilisation is based on need. Excess nitrates in food are undesirable because they can be converted into carcinogenic nitrosamines during storage and preparation.

The study findings discussed by Smith-Spangler et al. (2012) on contamination with mycotoxins indicate that the risk is significantly lower in cereals from organic production systems only in the case of deoxynivalenol (DON). DON is a toxin produced by moulds belonging to the globally widespread Fusarium genus. Fusarium toxins can cause serious toxicity via infected food or animal feed. We know from the basic research that the occurrence of field fungi (especially Fusarium species) is triggered by multiple factors and fostered by poor choice of crop succession (e.g. maize before cereals), inadequate cultivation, high levels of nitrogen fertiliser application, poor choice of varieties, excessively dense planting and the use of growth-regulating substances. All of these farming methods-related factors that predispose crops to infection are absent in organic production.

Lower levels of DON in organic cereals means that Fusarium is less prevalent. We can conclude from this that if the incidence of Fusarium-related infection is lower in organic cereals, then other Fusarium toxins must be less prevalent too, although this is not addressed by Smith-Spangler et al. (2012).

In terms of contamination with pathogenic organisms, the authors of the Stanford study also reported no differences between organic and conventional produce for the strains included in the survey: Escherichia coli (E. coli), Salmonella, Listeria and Campylobacter. These findings are surprising in the case of E. coli and Salmonella and we can only assume that Smith-Spangler et al. (2012) were unable to find sufficient literature on the topic.

We know from the available literature that when bovine animals are fed in a species-appropriate manner with adequate roughage, the occurrence of pathogenic strains of Escherichia coli is reduced. According to research carried out in the USA, E. coli 0157:H7 is found one hundred times less often where there is species-appropriate feeding – this is usually the case in organic systems where input-intensity is lower – than where feed contains a high proportion of grain (Gilbert et al. 2005). The reason for this is that the bovine intestinal environment changes when there is a higher level of roughage, making it less favourable to E. coli populations. This is borne out by a 10-year study of bovine animals which showed that E. coli populations were larger in the case of animals fed high-grain diets than if the animals were fed on hay. If the feed was switched entirely from grain-based to hay-based, E. coli populations fell one thousandfold within five days (Callaway et al. 2009).

Regarding Salmonella, a government study from the UK reports a fivefold increase in the occurrence of Salmonella in battery-farmed hens, a practice prohibited in the EU since 2012. More

specifically, the study indicated the presence of *Salmonella* populations in 23.4% of hens from cage-rearing systems, 6.5% from free range systems and 4.4% from organic production systems that afforded the outdoor access prescribed under organic farming regulations (Snow et al. 2007). A report by EFSA (2007) also highlights these findings.

The fact – evidenced in many scientific studies – that significantly fewer antibiotic-resistant bacteria are found in organic production systems is confirmed by the study's authors.

### **Conclusion:**

The outlined correlations and research findings relating to safety show that consumption of organic foods is currently the only available means of avoiding most of the relevant, value-reducing residues in foods. In addition, the present study shows that farming methods used in organic production systems also significantly reduce mycotoxin contamination. Zoonoses cannot be ruled out, according to the research, but here, too, species-appropriate livestock management and feeding, which are a prescribed part of organic farming methods, are an important prerequisite for reducing the problem.

## **1.3 Human nutrition studies**

Human nutrition research is not only expensive; it is also, and more importantly, very difficult to conduct. Aside from the difficulties involved in conducting the sort of long-term research that would be required to identify clinically relevant differences, human health depends on a whole range of influences. Diet is only one factor among many, although it is clearly an important one. Because of these major methodological problems, research is usually carried out on animals, with the laboratory animal being the lead organism. Both the universally accepted research on allowable residue levels and recommendations for the use of beneficial additives are based on findings from animal nutrition studies. There are some findings from animal feeding studies involving laboratory rats and hens which show positive effects of organic products in terms of both juvenile mortality and immune function (Velimirov et al. 2010). However, these animal feeding studies are not taken into account in the Stanford study; in this regard Smith-Spangler et al. (2012) follow the current trend in food quality research. This is unfortunate, as it means that they are ignoring important findings and pointers relating to the medium and long-term effects of diet on health.

Smith-Spangler et al. (2012) cite sixteen human nutrition studies which compare either the effects of whole dietary regimes or specific products from different production systems, and which had a duration of between two days and two weeks, except for one study, which was a two-year study looking at young children.

As was the case with the papers comparing constituents, Smith-Spangler et al. (2012) do not take a nuanced approach when assessing the findings of the human nutrition studies.

Two of the studies analysed by Smith-Spangler et al. (2012) focus on pregnant women and young children. A two-year comparative study reported significantly lower rates of eczema risk in young children consuming organic milk (Kummeling et al. 2008). The second study analysed was a lifestyle survey focusing on early antibiotic use and immunisations (Flöistrup et al. 2006). In their Discussion section, Smith-Spangler et al. (2012) refer to three cohort studies and assert wrongly (and in contradiction to their Findings section) that the study by Kummeling et al. (2008) failed to demonstrate any connection with nutrition. They likewise found no nutrition-related connection in the lifestyle study by Flöistrup et al. (2006), although this study was included for

the wrong reasons. The identity of the third study referred to by Smith-Spangler et al. (2012) in their Discussion remains a mystery.

Three studies reporting lower levels of pesticide residues in children's urine are cited by Smith-Spangler et al. (2012). One of these also examined the impact of pyrethroid insecticide use in households. In connection with this the Stanford study comments that it was the use of household insecticides and not diet that accounted for the significant difference. However, in their original study, the authors of the study (Lu et al. 2009) cited by Smith-Spangler et al. (2012) take a more nuanced view, namely that children are exposed to these insecticides continuously throughout the year via conventional foods and this chronic pattern of risk is periodically modified by additional insecticide applications (Lu et al. 2009).

Another study cited by Smith-Spangler et al. (2012) relates to the sperm quality prior to the pesticide season in farmers consuming a high, medium or low proportion of organic produce in their diet (Juhler et al. 1999). One of the findings of this study was a significantly lower proportion of morphologically normal spermatozoa in men eating an exclusively conventional diet. All the other sperm quality parameters were comparable. The decline in male fertility in some western and South American regions has been demonstrated and is attributed mainly to ubiquitous environmental toxins, household toxins, synthetic food additives, contaminated drinking water and biocide residues in food. In this context organic farming contributes in several ways to improving the situation: no synthetic toxins are applied, which is important for both food and drinking water quality, and no risky manufactured additives are used in organic processing systems.

An Italian intervention study also cited by Smith-Spangler et al. (2012) reports that a significant reduction in cardiac and circulatory disease was achieved in both healthy individuals and in patients with chronic renal disease when they consumed an organic Mediterranean diet compared to a diet based on conventional foods (De Lorenzo et al. 2010). We fail to understand why the authors of the Stanford study assert that the clinical relevance of this finding is unclear.

As regards beneficial substances in blood and urine samples, five studies were analysed by Smith-Spangler et al. (2012), and four of these failed to identify any differences. One of the research studies examined by the Stanford study authors looked at the effects of a wholly organic diet (Grinder-Pedersen et al. 2003), while four looked at the influence of particular products.

The wholly organic diet had higher levels of quercetin and kaempferol, two flavonoids. As a result, levels of these two substances in the urine of participants were also higher. In the case of three other flavonoids tested, there was no difference in dietary levels or levels identified in urine samples. This information is important as it sheds light on the findings of three of the four product-related studies examined by Smith-Spangler et al. (2012). One of the studies related to carrots (Søltoft et al. 2011) while two focused on apples (Briviba et al. 2007; Stracke et al. 2010). In none of the three cases was a distinction drawn on the basis of farming methods (organic versus conventional) between the carotene content of the carrots tested and the polyphenolic content of the apples; no difference was therefore to be expected in levels of these beneficial compounds in the serum of the subjects. The fourth product-based study concerned tomatoes and although those from organic production were richer in vitamin C, carotenoids and polyphenols, the difference in carotenoid content was no longer detectable in the tomato puree prepared from them and eaten. There were likewise no detectable differences in the plasma of the subjects (Cariy-Veyrat et al. 2004).

Smith-Spangler et al. (2012) also quote a study which shows that an organic diet alters the fatty acid profile of breast milk, making it more beneficial in health terms. Since the risk of contamination with residues is also significantly lower in the case of organic produce, we can assume that breast milk is also substantially lower in residues with an organic diet. This is particularly important because higher concentrations of biocidal substances are found in fat-rich milk and new-

borns are a group that is particularly at risk from pesticide residues (- in the days when DDT use was still permitted, mothers were strongly advised against breastfeeding). Lamentably, the authors make no comment on this connection or on the fact that it points to a clear benefit of consuming organic produce, although the benefits associated with avoiding exposure to residues are mentioned elsewhere in the study.

At several points the authors of the Stanford study highlight that such findings lack clinical relevance. However, switching from conventional to organic foods in the short-term is unlikely to produce clinically relevant effects. Moreover, there are intervention studies exploring food supplementation, and specifically supplementation with vitamin C, carotene and other vitamins, which have demonstrated no effect or even a risk to the subjects (Brandt et al. 2011). Epidemiological studies, meanwhile, have demonstrated that there is a positive correlation between intake of fruit and vegetables and reduced health risks. This shows clearly that what we are dealing with here are not just simple linear causal chains linked to particular substances, but a complex system of interactions in an organic association that still holds many puzzles.

#### **Conclusion:**

Switching diets in the short term, as analysed in the Stanford study, does not yield clinically relevant results. A two-year research study involving young children showed that consumption of organic food had a positive health impact. In addition to human studies, research on animal nutrition is vital in order to explore the impact of consuming organic products over longer observation periods on genetically identical animal populations.

## **2 Comparative appraisal of the Findings, Discussion and Summary of the Stanford study**

In the results section of the study, under “Findings” a number of positive characteristics of organic products are mentioned and described in detail. In the Discussion, some of these are then qualified and in some cases in fact presented in contradictory terms. This applies to the following:

- As described above, there was a significantly lower risk of eczema in young children who had been fed organic dairy products (study by Kummeling et al. 2008).
- The reduction in pesticide residues is trivialised in the discussion on the basis that the risk of levels exceeding allowable limits is in any case relatively low.
- The importance of the lower incidence of antibiotic-resistant bacteria in organic products is minimised with the argument that inappropriate use of antibiotics in humans is the major cause of infections with antibiotic-resistant strains in human populations. At the same time, the authors overlook consumer exposure to resistant strains of bacteria through food, and the role of agricultural use of antibiotics as a source of resistant bacteria with the ability to spread in myriad ways throughout broad, cross-linked systems (see Benbrook 2012).

Only one nutrient, phosphorus, was singled out as being present in significantly higher amounts in organic produce. Higher levels of beneficial fatty acids in breast milk and dairy milk were referred to in the Discussion, but not mentioned again in the Summary (see below).

Again, the authors of the Stanford study cite heterogeneity of results as a complicating factor when it came to analysing the studies. On the one hand, not all of the comparisons looked at additional factors affecting food such as season, weather, soil type, ripeness, variety, storage, processing (e.g. raw or pasteurised milk), which would have allowed these factors to be excluded. Moreover, they state, there was a great deal of variation in organic farming practices. Precisely under such circumstances researchers conducting a literature review must be expected to take account of these factors, which are superimposed on production effects; only then could the various applications of organic farming management practices be treated in a differentiated manner. One way of arriving at a more nuanced appraisal that takes greater account of the effects of organic farming practices would be to include the findings of the basic research and the results of long-term animal feeding studies. The authors of the Stanford study did not do this. Generalised statements of the sort included in the Discussion and most notably in the Summary are not helpful for enabling one to arrive at conclusions regarding the potential health impacts of organic products.

### In the Summary

Positive health impacts of organic produce referred to in the Findings section of the study by Smith-Spangler et al. (2012) are given no mention in either the Summary or in the press releases, and this has sparked a new campaign against organic products in some sections of the media.

Positive findings relating to organic produce which are not mentioned in the Summary include the following:

Organic products

- tend to have distinctly higher levels of total phenols ( $P=0.064$ )
- have higher levels of beneficial fatty acids (omega-3 fatty acids, vaccenic acid) in cow's milk
- result in a beneficial fatty acid profile in breast milk if the mother consumes a predominantly organic diet
- result in lower levels of the mycotoxin deoxynivalenol in cereals
- significantly reduce eczema risk in two-year-old children who are given organic dairy products over a long period (at least one year).

The lead author of the Stanford study, Crystal Smith-Spangler, was cited in an interview with the German newspaper "Die Welt" (5 September 2012) as saying "We were a little surprised that we did not find anything". This is certainly remarkable, and it raises questions about the researcher's statement and/or the role of this newspaper (was the quote communicated correctly?) (see below under "Role of the media").

### **3 Concluding critical comments on the Results**

As we have demonstrated, the study has a number of major flaws, which were clearly given little weight in the peer-review process. This is nothing new in studies comparing the nutritional quality of organic and conventional produce. In addition, studies suspected of coming from the organic “corner” which are published in international peer-reviewed journals are routinely ignored by mainstream science and the media. Even academic studies indicating benefits associated with organic produce are barely acknowledged. A study very similar to the present Stanford study, published by renowned researchers Kirsten Brandt, Carlo Leifert and colleagues (Brandt et al. 2011), was completely ignored. This study, which evidences the benefits of organic products much more clearly (see details above), was certainly known to the Stanford authors via precursor publications. Washington Professor Charles Benbrook also wrote a detailed critique of the findings of the Stanford study, but his critical remarks were conspicuously absent from the debate in the media or in the scientific community. Likewise conspicuous is the exclusion of open-access publications from both the Stanford study and other similar studies. Recurrent systematic errors in these studies make it difficult to dismiss the suspicion that large firms and political interests have attempted to influence matters indirectly. The authors point out on several occasions that they received no external funding for their meta-analysis, by way of indicating their independence. The fact that Stanford University, which provided financial support for the study, itself receives millions of dollars in donations from global players such as the agricultural group Cargill, is not mentioned.

**Conclusion:** Overall, the Stanford study lacks rigour and gives a superficial and in some instances unjustifiable (biased?) interpretation of results. It also frequently displays a fundamental lack of understanding of relevant systemic relationships.

### **4 Need for research for the continued development of organic agriculture – Conclusions**

The continued development of organic farming is not well served by this study, in common with many comparative studies that have been conducted, or indeed by the media coverage such studies receive. What is rather needed is a concerted research effort within the organic sector, especially if there is a desire to see organic production grow.

Comparative studies continue to require significant resources from research budgets that are under increasing pressure. Given the advanced level of knowledge that already exists on the benefits of organic production and its development potential, scarce research resources need to be targeted more specifically towards the continued development of organic farming and hence also towards eliminating its flaws. This would help to expand organic production and the availability of organic products. Alongside health benefits, this would have many positive environmental and socio-economic impacts in terms of promoting sustainable development, which is all the more important and urgent in view of major global threats.

If comparative studies prove to be essential, then it is important first of all to draw precise distinctions among organic products based on production methods, and second to evaluate studies not only on the basis of parameters that can be subjected to chemical analysis, such as levels of nutrients and harmful substances. The interactions of constituents in a living organism cannot be ascertained merely by listing them. Listing constituents is indeed the only reality for consum-

ers at present and is certainly a necessary contribution towards a more complete understanding of the nutritional quality of foods. As set out above, however, inclusion of animal nutrition studies in the analysis could significantly broaden the assessment and provide more sound results.

Basic research should focus on investigating specific applications such as plant nutrition or animal feeding to assess their metabolic effects and ascertain potential impacts on gene expression patterns. This could make it easier to assess agricultural methods and make a significant contribution to improving organic production systems.

In addition, research in the field of food quality must take a much longer-term approach, for example examining health impacts throughout the duration of pregnancy and in the early years of childhood.

## 5 Health in relation to food production systems

With their meta-analysis the authors of the Stanford study indirectly assert that conventional food production systems are just as healthy and safe as organic food.

Where, then, does the increase in chronic nutrition-related health disorders (obesity and all its consequences, type II diabetes, certain cancers, cardiovascular diseases, high cholesterol levels, etc.) come from? Eating habits and dietary composition play a major role, while other important factors include the proportion of fresh versus convenience foods, and possibly also chronic pesticide residue contamination. In this regard organic food demonstrates only benefits, as it also incorporates healthier eating habits. For example – in line with the recommendations of the World Health Organisation (WHO) – reducing meat consumption and increasing consumption of fruit and vegetables, promoting the sale of fresh, ripe local produce and prohibiting the use of synthetic pesticides are all an inherent part of organic production systems.

It is undisputed in the scientific community that the environmentally and ecologically sound production methods used in organic farming impact on a wide range of health-related issues, ensuring clean drinking water and groundwater and affecting the environment positively in other important ways. An aspect that is routinely underestimated is that organic food could potentially bring even greater health benefits if organic farming expands and if then, for example, pesticide drift from conventionally farmed land to organic land is further reduced, and antibiotic use curbed.

Organic food and, related to this, organic farming, are vitally important in terms of whether agriculture can continue to operate sustainably over the coming years and decades, and whether we will be able to feed the ever-growing world population. The fact that this will not be possible with current lifestyles – partly due to high levels of meat consumption in industrialised countries – is slowly but surely being articulated even in conventional circles. Organic products and organic farming could also help enhance the social acceptability of fundamentally new principles of economic management. By this we mean principles that move away from the current exploitative system that poses a major threat to the natural environment and its resources, but also to humans and their psychological and social stability. The FAO has also confirmed that the way out of the food crisis, especially in developing countries, is to promote smallholder farming based on organic production systems.

When the Stanford study under discussion here was published, the International Herald Tribune (7 September 2012) asserted once more that higher yields, biocidal products, chemical fertilisers, GMOs and other components of industrialised food production are essential if we are to feed a constantly growing world population. It is lamentable to see the publication of a study

being misused to promote a misguided and ultimately harmful form of industrialised agricultural development, especially as the study in question does not even address production issues, focusing as it does exclusively on the health effects of foods.

## 6 Consumers and the media

The victims in controversies of this sort, unfortunately, are always the consumers, torn between their own perceptions and the disputes within the scientific community. Of course consumers cannot be expected to study the meta-analysis by Smith-Spangler et al. (2012) themselves. It is the job of the media to present a consumer-friendly version. This, however, assumes that those responsible in the media and relevant NGOs either read the study in question themselves in its entirety or publish a critical report containing a spectrum of opinions from a variety of perspectives from specialists in various disciplines. This requires a responsible approach aimed first and foremost at providing consumers with objective information. In the present controversy, on the other hand, as in previous cases of this sort, the main emphasis is on claiming that there is no difference between organic and conventional products – with the exception of the reduced risk of pesticide residues. Publications which demonstrate health benefits of organic products, such as the study by Brandt et al. (2011) carried out in the UK, are largely ignored.

Irrespective of the media coverage, however, consumers can find information via public bodies that have objectivity as part of their remit (such as the internet portal [www.oekolandbau.de](http://www.oekolandbau.de) or the consumer information produced by [www.fibl.org](http://www.fibl.org)).

Consumers of organic products have the distinct advantage of buying the best produce currently available. On the one hand, only organic production and processing systems can reduce or eliminate pesticide residues completely. At the same time, organic food potentially has higher nutritional quality. Quite aside from this, in order to assess the overall value of a food, all of the sustainability parameters relating to its production (including environmental and socio-economic parameters) need to be taken into account – and organic products fare much better in this regard too.

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