WORKSHOP REPORT

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Instituto de investigaciones para la agricultura orgánica

Stiftung Mercator Schweiz

# The Potential of Sustainable Farming Systems to Promote Adaptation to Climate Change

**Scientific basis and practical implications – reality and visions**

Report of the workshop held on 6th November 2014 in Frick, Switzerland



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EXCELLENCE FOR SUSTAINABILITY

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# 1. Introduction

On November 6, 2014, the first project workshop of the institutional network and the scientific board of the project “The Potential of Sustainable Farming Systems to Promote Adaptation to Climate Change“, funded by the Mercator Foundation Switzerland took place. The overall aims of this workshop were to

a) present the current state of project work and future planning to the institutional network and scientific board;

b) discuss and analyse conceptual and practical aspects and challenges of adaptation measurement and monitoring in structured group work;

c) present the current plans for project sites and the related data availability and data requirements and discuss potential additional project sites and their necessary characteristics;

d) assess the viability and potential of a range of agricultural adaptation measures that are usually not addressed in the context of organic/sustainable agriculture in structured group work.

The workshop report is organized along these four aims with a short synthesis at the end. It is based on the minutes from the plenary sessions and group work, as well as on additional bilateral discussions during the workshop. For completeness, a short project description, the workshop program, as well as lists of the members of the scientific board, the institutional network and the workshop participants are provided in the appendices.

# 2. Project work

Water and nutrient use efficiency in cropping systems are closely related to adaptation to climate change, in particular in geographic areas where water stress is expected to increase with climate change. There is a large body of literature on the impact of different agricultural practices on water and nutrient use efficiency, but this literature is fragmented and an overall synthesis is lacking. It is thus difficult to draw conclusions on which practices may indeed reliably improve water and nutrient use efficiency under changing climatic conditions.

We will carry out meta-analyses based on the available data from the scientific literature to provide such syntheses. Currently, our data-base contains results from 170 studies on 30 different crops, covering a wide range of practices (cf. Table 1). The literature search is still ongoing and we expect to collect two to three times that many studies for our final analysis.

| Table 1: Examples of practices included in the literature search | | |
|---|---|---|
| 1. | CONTR | control group: no amendments and no fertiliser, usually conventional tillage, conv. Irrigation, in the case of ORG: conventional farming management |
| 2. | OA | Organic amendments: manure, compost, municipal solid waste, sewage sludge, Agroindustrial waste, biochar/charcoal, |
| 3. | SA | Synthetic amendments: suberabsorbent polymers, polyacrylamide, zeolite |
| 4. | BioIN | Bio-inoculants: mycorrhiza, PGPB |
| 5. | MIN | mineral N and P fertiliser |
| 6. | CA | Combined amendments: OA+MIN |
| 7. | M | Mulching |
| 8. | PM | Plastic/artificial mulch |
| 9. | IRR | improved irrigation |
| 10. | WH | Water harvesting |
| 11. | NT | No tillage |
| 12. | RT | Reduced tillage |
| 13. | ST | Subsoil tillage |
| 14. | CC | cover crops, mixed cropping, agroforestry |
| 15. | CMP | Combined management practices: OA combined with CC, RT or NT |
| 16. | ORG | Organic farming |
| 17. | VAR | crop variety |
| 18. | AP | fertilizer application technique: broadcasting, soil incorporation, placement, controlled release |

Regarding specific aspects of the meta-analysis and the data used for it, it was pointed out at the workshop that it is important to be

a) very clear on the water and nutrient use efficiency indicators used;

b) to be aware of the differences between direct external nitrogen inputs from synthetic and organic fertilization that are usually reported in such studies, and the nitrogen available from the soil pool (including nitrogen from plant residues from previous crops), which is more difficult to assess;

c) to be aware of the differences between nutrient uptake from organic and synthetic fertilizers and the different effects those may have on the soil nutrient pool and nutrient availability from that;

d) to account for specific effects of crop rotations; and, finally,

e) to account for differences that may arise due to different methodologies being used for measuring nutrients and water quantities.

The first issue is addressed by using the following definitions of water and nutrient use efficiency:. Water use efficiency (WUE) is defined as total harvestable biomass or marketable yield per unit water. Under rain-fed but water-limited conditions the usage of *precipitation* water whereas under semi-arid/arid conditions the usage of *irrigation* water is investigated. The part on nutrient efficiency will consider nitrogen (NUE) and phosphorous use efficiency (PUE), which is defined as total harvestable biomass or marketable yield per unit nutrient (N or P).

The second issue is addressed as we collect data from controlled field trials published in peer-reviewed articles and conference proceedings, as well as from PhD studies only. In such data, either there is enough information available to derive good estimates for the soil nutrient pool and how much nutrients are recycled within the system and how much are derived from external inputs (e.g. using the FiBL nitrogen-tool), or the experiments are set up in such a way, that the soil pool is equivalent for the treatment and comparison plots, thus not biasing results. This also avoids having infinite nutrient efficiency for control trials without external inputs. Similarly, the third issue can be addressed, as there is usually a control trial with respect to which both organic and synthetic or combined fertilizer applications can be assessed. Furthermore, the FiBL Ntool allows differentiating between organic and synthetic fertilizers taking into account the management induced changes to the soil C and N pool. Crop rotations can be assessed by aggregating over the whole rotation, or, depending on how the data is provided, via analyzing differences to the control trial. Methodological differences between different measurement methods will be taken into account by adding a methodology-dummy to the analysis. Furthermore, we will check if information on systematic differences between the methods is available from the scientific literature (e.g. that one method consistently reports lower values than another). Such information may then be used to somewhat reduce potential bias in results due to the use of different measurement methods. If possible, we try to work with the raw data of the studies and not with the reported aggregates only.

Two broader issues were also pointed out. First, effects of management practices on water use efficiency and effects of climate change may be difficult to separate. However, in the meta-analyses, we do not yet address the effect of climate change, we only assess the effect of different management practices, based on the hypothesis that increased water use efficiency is a benefit for adaptation. How water use efficiency then may change with changing climate is another issue we do not address in the analyses but we will include in the discussion of the results. Second, it will be important to agree on some broad boundaries that apply for the studies covered, otherwise, the data set will become huge and too complex for sensible analysis and interpretation. We thus may restrict to situations and contexts that are most relevant for the case study region. This will be decided after having finalized the literature search, which we will keep rather broad; such boundaries will then be applied before extracting and compiling the detailed data from the studies for use in the meta-analyses. This may also be addressed by a separate analysis of broad categories of measures or contexts. Thus, data heterogeneity will be reduced facilitating interpretation of results.

# 3. Adaptation measurement and monitoring

Adaptation to climate change has no clear definition. Important concepts used broadly are adaptive capacity, system resilience (i.e. that a system remains stable under external impact), exposure, sensitivity, and vulnerability. Questions that arise are how to link those broad concepts to very specific variables such as nutrient or water use efficiency, which indicators may be most appropriate to capture relevant aspects of those concepts and how large a system needs to be to serve as a useful unit for adaptation.

Our suggestion is to address these questions in a multi-input/multi-output productivity framework, where the production potential for several outputs for a given input bundle can be assessed. One question that was suggested and which we will pursue is whether adaptation can be addressed rather via changes of how a specific production unit relates to this production potential (changes in efficiency), or rather via changes in the production potential itself (changes in technology). This difference can have substantial effects on what may be achievable with improved adaptation and which aspects are most promising to focus on to support successful adaptation.

This productivity based approach allows assessing classical indicators such as water and nutrient use efficiency (i.e. amount of crop biomass per unit water or nutrient input) separately, but also in relation via trade-offs and synergies between different inputs and outputs. Outputs cover not only agricultural production, but also ecosystem services and public goods, as well as disservices or “bad” outputs, e.g. greenhouse gas emissions. A challenge is also to identify to which aggregation of outputs productivity shall be related to (e.g. “total protein produced in a region” as an aggregation of agricultural outputs with a focus on food availability; or “total farm income” as an aggregation of all outputs with a focus on financial capital in livelihoods).

It was pointed out that a key aspect of climate change is increased variability and that adaptation has to take this into account. One further development of the productivity concept will thus be to attempt incorporating how increased variability as a consequence of climate change affects the production situation and adaptation. Given the formal structure of this concept (estimations of production possibility frontiers), it is in principle possible to account for such variability by adding corresponding error terms and working with expected values.

Two questions were then addressed in the first group discussion on these topics:

*Question 1) What is successful adaptation in agriculture (on farming community level)?* The following aspects were discussed:

**Conserving production capacity:** One aspect of successful adaptation to climate change is assuring the long-term conservation or increase of the productive capacity of a system in the context of a changing climate. Thereby, “production” is understood in a very broad way, including ecosystem services and public goods besides classical agricultural outputs.

**Thresholds:** A second aspect is that a system should be able to avoid thresholds of fundamental system changes and, if avoiding thresholds is not possible, that the system can deal with such fundamental changes. In other words, adaptation is about avoiding the impacts of extremes becoming too big, and, if this cannot be avoided, providing the capacity to deal with those big impacts of extremes when they arise. The challenge thereby is to identify when a system approaches a threshold, where trespassing cannot be avoided (e.g. how to identify when increasing water use efficiency will not help anymore in a certain region, as in the long term, no agriculture will be possible anymore due to water scarcity).

Successful adaptation requires that the necessary provisions start now. One challenge thereby is to sustain the production or activities in such a way as to assure livelihoods for people and at the same time developing the capacity to deal with unavoidable big impacts of extreme events in the future.

In cases of thresholds, adaptation strategies can then become very fundamental, such as abandoning agricultural activities in a certain region altogether, and taking up other activities or may even planning for migration of (part of) the population. Such fundamental changes will create cultural and ethical challenges and require changes of perceptions and traditions. Such can already arise in the context of less drastic changes, such as a switch from crop production to grassland based animal husbandry, or from intensive agricultural production to less intensive management with increased focus on ecosystem services.

*Question 2) What do you need to know today in order to identify, whether a farming community will adapt successfully or not?* The following criteria were discussed:

**Landscape level:** A first characteristic of the potential to adapt successfully is that adaptation needs to be seen on a regional or landscape level, whereas adaptation on the plot-scale is meaningless. This also means that a community needs to be willing to deal with the whole community future and not only with farmers’ and farming needs. Even more, awareness should be present that community futures have to be assessed within the broader socio-economic context of the regional and national economy and potential governmental development strategies and related potentials and challenges (such as labour supply and demand, infrastructure provision (roads, electricity), etc.).

**Diversification:** A second characteristic of the potential to adapt successfully is a high level of diversification in a system. Thereby, diversification is not only needed in activities (i.e. in scope), but also on spatial scale and in time.

**Attitudes, perception, preparedness and first movers:** Furthermore, a good understanding of perception of changes and attitudes of different players within a community is key. One important supportive attitude, for example, is to be able to agree that there is room for improvement. A change in the environment of an optimally organized system needs not necessarily to be perceived as a worsening of the context for the optimal system. It can also be understood as a possibility that opens up room for improvement of this system, given that the context changes.

To make optimal use of supportive attitudes, one needs to work with the individuals, groups, communities and institutions that are prepared for change and open for new things. Thus, individuals with entrepreneurial attitudes, and that are open to deal witch challenges and to try out new things have to be identified. Those can serve as first movers that then help to build up the momentum that will push others to start moving as well. Thereby, it is important to have a partnership with communities. Change must not be enforced in a top-down manner, but it should be developed through participatory processes within the community, such that the ownership of the processes stays within the community and with the people affected. Identification and development of successful demonstration projects may help to facilitate this process.

Going one step further, it would be ideal to do things in anticipation and to act when there is not yet a problem, to prepare people while there is not yet an urgent need for change. Thus, start out from options that make sense now will help. The momentum that emerges when extreme events emerge can then complement the preparatory efforts and this momentum can be used to foster fast change. Crisis can be a big driver for innovation and change. Besides internal motivation of first movers, such external pressure can help to make changes acceptable. In many cases, change is easier or more accepted after an economic failure, for example.

**Institutions, favourable conditions and incentives:** Here, we understand institutions in a broad way, covering many types of social structures: examples are agricultural research stations, extension services and information provision platforms, but also property rights, subsidies, taxation systems and labels in a certain region, farmers' or traders' organizations, or also loan, credit and insurance systems. The institutional context and related incentives or disincentives play a crucial role as drivers or barriers for successful adaptation and should thus be known. A key aspect of institutions enabling adaptation (e.g. access to loan schemes) is that inequalities in power and property right distributions are not too big. It is important that institutions with adverse effects on incentives for adaptation are identified and dealt with to remove barriers to successful adaptation. Wrongly designed (governmental) crop insurance systems can for example lead to perverse incentives to grow crops not adequate for a certain region or climate. Crop insurance systems lead to payments in case a crop fails. If the insurance system is wrongly designed, such payments can be that big, that they offer better livelihoods than successful crop production. Farmers then have no incentives to reduce the vulnerability of their production and to choose different crops with lower risk of failure.

**Information:** Adaptation work naturally has high information needs. Information on the projections of change and exposure will help to assess, whether a system is going to cross a certain threshold or not. Past experience can then help to assess whether a community may successfully adapt. Information on how a community dealt with similar challenges in the past or in another region is a crucial input to get an idea about the potential of adaptation. In particular, this can provide insights on whether adequate institutions are in place or not and on their ability to support adaptation (including governance structures, the role of government, etc.). For a region, assessments of the livelihood capital flows would be important to assess the capacity to deal with threats. For example, the percentage of income from family and community members working in the city or foreign countries can play a crucial role for the families' and communities' livelihoods. Such local information can be combined with national indicators for assessing the broad institutional and policy context and how this may develop.

Ideally, "everything" should be known and success in adaptation would mean to adopt a multidisciplinary, holistic view. However, there will always be a lack of data and knowledge. The challenge is thus to do good adaptation support with only incomplete information. Then, it is important to support measures that are robust in the sense that they lead to beneficial outcomes in a broad range of situations. Soil protection and improving soil fertility, for example, will always be a beneficial measure, and it makes thus sense to set incentives for that. One such robust measure that was pointed out specifically is to set incentives that only renewable resources are used and in a sustainable way. On the other hand, identifying, whether a renewable resource is not exploited can be challenging. For water, for example, the sources and the opportunity costs as well as the external costs of its use need to be known (improving the resilience of a farming community by extracting more water at the expense of water usage in a downstream community, for example, is not a successful adaptation strategy).

**Summary:** Thus, in summary, successful adaptation in agriculture may be captured as follows: it is about avoiding trespassing thresholds and about dealing with thresholds, if trespassing them cannot be avoided. In addition, a broad approach on at least three dimensions is needed: a) problems: it is not only about adaptation, it is about long-term sustainable development on a more general level; b) scale: it is not only about the farm level, it is about communities and regions or landscapes; c) scope: it is not only about agriculture, but other sectors need to be included as well.

# 4. Project sites and data

Currently, we plan to work in phase II with the project area of the project Syprobio (SYstèmes de PROduction BIOlogique diversifies; www.syprobio.net) of Helvetas and FiBL in Western Africa. It was suggested not to extend the work to other study areas, as implementation in one area will already be challenging: Better to do one case study as good and as detailed as possible. Nevertheless, if time requirements for data collection and organization can be kept small, interesting additional case study sites are available from projects of institutions within the institutional network, also outside of Africa. This will be taken up after having specified the work for phase II in more detail and after having collected first experiences from the planned project region. It was also suggested to team up with the "SHARP"-community at FAO. This project aims at identifying communities' adaptive capacity to climate change and where particular strengths and weaknesses lie, but it does not offer concrete adaptation strategies as potential solutions. Our project could provide important inputs for this crucial but missing part. Furthermore, detailed data work may indeed best be done within the context of one project region, but it is important to investigate how results can then be transferred to other regions with similar challenges.

A significant climate change adaptation potential is attributed to agroforestry systems. In the data for the meta-analysis, those are covered. In the envisaged project region, agroforestry systems do not play an important role yet. But we will keep this in mind and it can be a specific focus for an additional project region, if it is decided to include such at a later stage. A particular challenge with agroforestry is the need of long-term secured and clear land rights, as only then the necessary investments will be undertaken.

As there is a general lack of historical data, we asked participants, whether there is experience for working with chronosequences (i.e. deriving insights for a site of interest by using data from other sites that have undergone a similar development in the past as it is expected for the site of interest in the future) in the scientific board or institutional network. There is not much experience around and judgments of this method are slightly critical, but no conclusive recommendation has been made on whether this method offers good opportunities for our work or not. We will decide on using this method when starting phase II, depending on whether the data to build chronosequences for the project region would be available or not.

Regarding the project work in phase II it was also emphasized to aim at realistic analyses. One challenge is the project length of three years only while climate change impacts and adaptation rather have time-frames of several years to decades. Thus, concrete implementations should provide relatively fast and visible results, but at the same time, they should capture core aspects of successful long-term adaptation. To proceed fast with the research context in phase II, it may make sense to work with specifically designed demonstration plots (funds are however not available for that – but maybe it is possible to team up with existing ones), and collaboration with leaders and early adopters should be sought. It may also help to focus on organic agriculture, as this provides clear system boundaries and criteria; however, this may be too restrictive.

# 5. "Innovative" practices with potential for adaptation in agriculture?

This fourth part of the workshop addressed the question whether there are limitations on what can be suggested for adaptation in agriculture. Questions like "Is there a need that agricultural practices are organic?", "Are synthetic fertilizers to be avoided?", "Is it permissible to promote suggestions without knowing the chance of failure or success?" framed this topic.

The following two questions were specifically addressed in this second group discussion:

*Q1): Are practices that are promising but "not compliant with sustainable agriculture" acceptable for increasing adaptation?* The following issues have been discussed:

Some discussion evolved around why there may be a need to differentiate between acceptable/unacceptable practices at all and within which context this may make sense. We started from organic agriculture as a reference system. This gives clear criteria that restrict certain practices. Clearly, these may reduce the possibilities of potentially promising approaches that however lay beyond organic farming. The approaches subsumed under integrated soil fertility management (ISFM) are one such example. Furthermore, having a broader range of practices than only organic ones will help organic farming to evolve. Such promising approaches may require adapting system boundaries. As the combination of organic and synthetic fertilizers seems to improve nutrient and water use efficiency, the increased use of urine as readily plant available nitrogen source should be tested in combination with organic fertilizers in organic farming.

It is important to have empirical evidence to thoroughly assess a certain approach and also for comparing different suggestions. To gain such, there is a considerable demand for data on the treatments and practices of interest. Collecting such data can be demanding and, in certain cases and for certain aspects, it is not available. Regarding the performance of synthetic or organic fertilizers, a combination thereof, or for “new” natural sources of mineral fertilizers (e.g. urine), for example, comparison data for these different applications are needed.

Another discussion evolved around what exactly is meant by new practices as this depends on the context. Much potential lies in transferring knowledge between areas rather than inventing, developing and implementing new approaches. It thus has to be differentiated between really new approaches and transferring well-established options from one region to other regions, where they are unknown. There is much knowledge around in certain regions that could be introduced to other regions. Some inspiration may also be taken from historical development, i.e. by re-introducing and modernizing promising practices that have been used already in the past.

Generally, a utilitarian approach prevailed: The outcome is the main criterion to be used for judging legitimacy of using inputs or practices. It is important to pragmatically achieve aims rather than adopting a philosophical perspective. Thereby “outcomes” have to be understood in a broad sense not only covering yields but also ecosystem services, economic revenues and institutional aspects, such as how dependencies and power relations are affected. One encompassing criterion is whether some action increases “adaptive capacity” (however, this term needs to be clearly defined). This could be framed such that one criterion for acceptability would be to investigate what stakeholders want to have as outcomes (often food security/sovereignty) and then to choose the system/actions/practices that are most adequate to achieve this (where the conviction is often that this is some sort of “sustainable” or even organic agriculture). Given outcomes are achieved, organic certification may become less important than supporting the related practices with other means, based on the argument that they are good for the environment and avoid external costs. Finally, for adaptation of a family or community and focusing on food security, the result is not primarily what they produce but what they eat. Thus, physical yields in production are only one aspect in successful adaptation and economic revenues are at least as important.

In the following, we shortly present three examples for “new” systems have also been discussed in somewhat more depth:

a) Agroforestry: a system with recognized potential in many contexts, which is however not yet implemented as widespread as its beneficial qualities may suggest. In many cases, it can be a promising system for improvements. Many options exist, such as with animals and trees (chicken or pigs in forests), or with crop-tree systems. For successful implementation of agro-forestry, land rights and security are particularly relevant, as otherwise, these long-term investments will not be undertaken.

b) The System of Rice Intensification (SRI) has been mentioned as a success story. It was however contested, whether it may not be promoted more than it should. SRI has many components. Some of them are clearly beneficial while others may be more contested. Thus, when supporting such systems, all details need to be scrutinized to avoid subsidies that lead to wrong incentives. It has also to be investigated, whether promotion of such systems is a democratic process or not and really backed by the people. One way forward would be to test all the different components of SRI and to analyse which of the options make sense in a specific case, not adopting the whole bundle of SRI unquestioned. Such cautious attitude clearly applies to organic agriculture as well.

c) Combined aquaculture and crop production. Such systems have been successfully maintained for a long time in Asia, e.g. China, while they are not known in Africa or Western countries. Such successful schemes thus should be transferred to new regions. Often, these systems are very diverse, show high productivity and seem optimal for successful adaptation.

*Q2): What would be needed to make new, not widely testes practices acceptable?* The following criteria have been discussed:

**Absence of dependencies:** For acceptable adaptation strategies, farmers must not become dependent from business companies. Increasing dependence from large international companies for seeds and or chemicals, for example, is an increasingly important topic and must be avoided (cf. GMOs). Farmers should have control over new technologies, practices and inputs. GMOs thus cannot be supported because there is currently hardly a possibility for the farmers to own the technology and have their own control. Such dependencies may also arise with synthetic soil amendments provided by industry.

If possible, strong reliance on subsidies should also be avoided and farmers should – at least in the longer run – be able to afford inputs without subsidies. At least, subsidies which may have detrimental effects for the environment and socio-economic aspects (e.g. subsidies for synthetic fertilizers) should be abandoned.

**Access to resources and inputs:** Local or regional access to resources needed for new technologies and practices should be guaranteed. There are many examples of projects that promoted the introduction of new technologies which have then again be abandoned as soon as the supporters left the area because no institutions have been established for assuring reliable access to the necessary resources. New technologies thus need to be running self-sustainingly after a specific project for their introduction and support has been finished. Clearly, this also needs the presence of an adequate and favourable institutional context.

**Farmer reality:** Be aware of the discrepancy between developments as planned by NGOs and other institutions versus what the farmers want. Favouring organic practices may not be realistic for a farmer if biomass for fertilizer production or labour for its distribution is scarce. It is of crucial importance to acknowledge farmers' reality. Farmers often have subsidies for the use of synthetic fertilizers, but may hide those if they produce organically. This clearly is very different from what one would have liked the farmer to do. A promising approach is then to tightly involve farmers when showing them alternative practices. Practices need to be easy to apply and ideally bring some obvious benefits in rather short terms. An ideal case would be to improve the system that much that no farmer wants to be going back to the older system (e.g. because of new income sources, diversification, more exchange with other stakeholders and higher resilience etc.). On average, farmers are rather risk averse. If farmers see success stories and try the related technologies themselves as well, these technologies will spread more easily. Thereby, economic feasibility is a key criterion, but acceptance by farmers is clearly needed for success as well.

**Diversity:** The diversity of agricultural practices between farmers and also on community level needs to be accepted and accounted for. There is no need to convince a whole community right from the beginning. Some farmers may start with new things while others may want to do things differently.

**Farmer-researcher approach:** In the Syprobio project region, farmers are asked in detail on what they are doing. This helps to identify and promote innovation in the system from within the communities: The farmer needs to be the investigator, and the ideas from the farmers are key for success. The demand for change should come from the farmers. Thereby, gender issues may often be a sensitive and important issue.

In this situation, improved practices are basically developed by the farmers and the farmers pull the action, and are not pushed towards it. Such an approach supports farmer/community ownership of innovation and changes and this is important for spreading of innovations and long-term impact. Adaptation projects and NGOs can then contribute to facilitate the transition towards wide-spread application, can help to connect with universities, research stations and other institutions, and can provide support for field tests.

Relevant institutions established for such increased knowledge exchange are farmer field schools, farm-to-farm exchange/education settings or innovation platforms, ideally developed together with farmers and on the farmers' lands so that they can directly see how performance may change. NGOs and adaptation projects can also support development of such institutions. For Syprobio, these approaches worked well with the farmers and also the politicians were quite open for discussions and participation, but the long-term perspective needs to be re-evaluated. It has always to be kept in mind that farming needs time.

**Summary:** Thus, summarizing, adaptation in agriculture should show the following characteristics: It achieves the aim of ensuring long-term livelihoods for communities, does not lead to dependencies, involves easily accessible resources and is developed in a participative process where farmers and communities have ownership.

# 6. Conclusions and Outlook

We will take up all those inputs in the project work. Here, we shortly emphasise some most important points: First, we will take measures to minimize potential biases in results due to differences in measurement methods and the different role of nutrients from external inputs versus soil-pools. Second, we will choose most adequate system boundaries and restrictions to the studies covered in the meta-analysis to avoid pooling too different approaches in the analysis, which could lead to overly complex results that are difficult to interpret. One option is to do a number of separate meta-analysis focusing on particular aspects or group of practices. Third, we will have a particular focus on data from agroforestry as this is generally seen as a promising approach. If the data is available, we will attempt to draw some specific conclusions on climate change adaptation in agroforestry systems. Fourth, in the conceptual work on adaptation indicators, we aim at adopting a regional or landscape level and we will pursue the idea of differentiating between describing adaptation as changes in efficiencies vs. describing adaptation as changes in technology/production possibility. This rather technical point may bear the potential to provide some indicator to differentiate between fundamentally different adaptation cases with correspondingly different requirements for successful adaptation activities. Fifth, for the implementation, we will always account for the socio-economic context and we will investigate how power relations and dependencies may change with introduction of new practices, as the criteria for successful adaptation as discussed above must be met to the largest possible extent. We will focus on the Syprobio case study region, where farmer-researcher approaches are already established, which has also been identified as an important aspect. If it is possible to extend the empirical work at low costs, we may include additional case study regions in projects from institutions of the network.

Finally, we present a short outlook for the work in 2015: We will produce a compilation of the activities and results of this workshop in the form of an article for a specific development cooperation magazine such as Rural21. This may also already take up some further linkages that came up during this workshop, e.g. with the work of the SHARP-group at FAO (SHARP: Self-evaluation and Holistic Assessment of climate Resilience of farmers and Pastoralists). The conduction and completion of meta-analyses on WUE, NUE, PUE will take place in 2015, as well as drafting scientific publications of the results. In parallel, the conceptual work on indicators for adaptation to climate change will be further developed and finalized. An important part of work will be to start the implementation phase in the case study region, in close exchange with the external evaluation of the project conducted by Prof. Lutz Breuer. In the third and fourth quarter of 2015, there is a second project workshop planned and a conference on the results of phase I.

Further activities linked to the project include a dialogue session to be conducted at Global Soil Week 2015 in Berlin, with the topic "The role of society in sustaining soils" (pending acceptance).

# Annex I: Background and aims of the project

The project addresses the potential of agriculture to adapt to climate change, which was identified as a key topic for further research in the previous project funded by the Mercator Foundation Switzerland on mitigation of climate change in organic agriculture and soil carbon sequestration. It thus complements the previous work on climate change mitigation and will exploit and expand the database established under this former project with respect to the adaptation potential. The overall goal is to identify economically and ecologically sound agricultural practices and farming systems for food production capable to adapt to a changing climate.

The project is split-up into two phases. In phase I we identify already existing and develop new indicators to assess the success or failure of adaptation. Furthermore, we conduct a comprehensive literature review followed by meta-analysis to identify farming practices and farming systems with optimal adaptation potential and to understand the influence of these practices and systems on the various indicators for adaptation. In phase II, we assess the results from this work in a case study to assure that the adaptation strategies and processes chosen are practical and viable.

# Annex II: Workshop program

**Thursday, 6.11.2014, 09.30 – 16.30**

| Time | Topic | |
|---|---|---|
| 09.00 | Welcome coffee | |
| 09.30 | Opening address | Plenary |
| 09.35 | The Potential of Sustainable Farming Systems to Promote Adaptation to Climate Change - project goals and objectives | Plenary |
| 09.55 | Workshop goals and structure | Plenary |
| 10.00 | Short introduction of the participants | Plenary |
| **Session I** | **Assessing adaptation to climate change** | |
| 10.15 | Aim I: Presentation of the state of the project work on indicators for climate change adaptation, productivity and efficiency; discussion | Plenary |
| 11.00 | Coffee break | |
| 11.15 | Aim II: How is/could/should adaptation in agriculture be measured and monitored?<br>Introduction to the group work on this topic (detailed questions, structure, methods, goals, outputs) | Plenary |
| 11.25 | Group work | Groups |
| 12.20 | Synthesis and discussion of results | Plenary |
| 12.40 | Lunch | |
| 13.35 | Group Photo | |
| **Session II** | **Implementation of adaptive measures in drought prone areas** | |
| 13.40 | Aim III: Presentation of project regions, data availability and data requirements for phase II of the project; discussion | Plenary |
| 14.25 | Aim IV: Innovative practices: which potential do they have for adaptation in agriculture?<br>Introduction to the group work on this topic (detailed questions, structure, methods, goals, outputs) | Plenary |
| 14.35 | Group work | Groups |
| 15.35 | Coffee break | |
| 15.50 | Synthesis and discussion of results of the second group work | Plenary |
| 16.20 | Concluding remarks and outlook | Plenary |
| 16.30 | End of the meeting<br>Apéro/Get together (optional) | |