FINAL: How to identify adaptation strategies for smallholder farmers in coffee and tea sector

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1. Background and objective of the paper

Cafédirect plc (CD) and the German Technical Cooperation (GTZ) are implementing a three year Public-Private Partnership (PPP) to adapt smallholders in the tea and coffee sector to changing climate conditions. The main objective of the joint project is that producer groups of Cafédirect's supply chain have created examples how to strengthen their capability to cope with the impacts of climate change and how to improve their access to respective financial and technical support mechanisms.

In order to develop adequate adaptation methods some key data regarding climatic and environmental risks and adaptation options have to be analysed. Therefore participatory risk and opportunity analysis (ROA) with selected pilot producer groups will be realised. As input to this data collection and solution seeking process some existing adaptation instruments will be delivered. The present paper gives an overview about the vulnerabilities of smallholders in the coffee and tea production, possible adaptation options and describes the methodology of identifying specific risk mitigating measures to be implemented examplaryly with pilot producer partners.

2. What means adaptation to climate change

Climate refers to "average weather" and represents the state of the climate system over a given time period. Climate changes over time may be due to natural variability or as a result of human induced increases of greenhouse gases in the atmosphere and is reflected in the variation of the mean state of weather variables including temperature, precipitation and wind.

The United Nations Framework Convention on Climate Change (UNFCCC) defines ***climate change*** as a change that is attributed directly or indirectly to human activity, that alters the composition of the global atmosphere, and that is in addition to natural climate variability over a comparable period of time. The Intergovernmental Panel on Climate Change (IPCC) defines it as any change in climate over time whether due to natural variability or as a result of human activity.

The anticipated impacts of human-induced climate change will affect people differently, depending on their livelihood strategies and asset base. Hence, some groups are said to be more vulnerable than others.

The IPCC defines **vulnerability** as the degree of a system's incapacity to cope with climate change effects, including climate variability and extreme events. The **adaptive capacity** is defined as the ability of a system to adjust to climate change impacts and their consequences and to reduce the system's vulnerability. Therefore the climate change risks depend on the intensity and frequency of the climate related hazard (e.g. hurricane, drought) and the vulnerability, i.e. the degree of being affected.

Adaptation to climate change refers to adjustment made in natural or human systems in response to actual or expected climate stimuli or their effects in order to moderate harm or make use of beneficial opportunities. This may be achieved through elimination of the current sources of vulnerability among the different groups. It also refers to coping strategies to actual or expected climate changes impacts.

3. Vulnerability of coffee and tea production to climate change

The agricultural sector is hit most by climate change impacts due to its high dependence on natural resources. Hence smallholder producers in rural areas are seriously affected due to their high vulnerability and the existing lack of financial and technical support mechanisms and weak adaptive capacities.

Coffee is one of the most valuable primary products in world trade, in many years second in value to oil as a source of foreign exchange to developing countries. Its cultivation, processing, trading, transportation and marketing provide employment for millions of people worldwide. Coffee is crucial to the economies and politics of many developing countries; for many of the world's Least Developed Countries, exports of coffee account for a substantial part of their foreign exchange earnings (in some cases more than 80%).

Tea is a beverage made by steeping processed leaves, buds, or twigs of the tea bush, Camellia sinensis, in hot water for a few minutes. The processing can include oxidation, heating, drying, and the addition of other herbs, flowers, spices, and fruits. The four basic types of true tea are black tea, oolong tea, green tea, and white tea.

The ***effects of climate change on the production of tea and coffee*** will differ greatly, depending on the region. The most severe impacts on the crops will be caused by ***rising temperatures*** and ***changing precipitation patterns***.

Higher temperatures:

- Higher temperatures increase tea leaf temperatures and transpiration which, in turn close stomata and reduce photosynthesis.
- Higher mean temperatures during the cold season demand for earlier planting and ripening of annual coffee crops – reduced growth duration generally diminishes yields.
- Higher temperatures in mountainous areas will shift the area suitable for growing coffee to higher altitudes.
- Higher temperatures lead to a decline in the production of pollen grains of coffee and furthermore reduce the distance to which the pollen tubes extend. As pollen tubes need to extend to the area of the plant containing the female ova, rising temperatures reduce the chances of fertilisation.

Changing precipitation patterns:

- During droughts, the coffee paring is glued to the grain, avoiding its maturation. Heavy rainfalls cause flooding and destroy infrastructure, hindering transportation.
- Changes in seasonal precipitation, distribution and intensity harm the growth of the coffee plant. Coffee requires more than 150mm of precipitation per month (which equals 150 liters) during flowering and maturing, followed by a drier period in spring and summer. Heavy rains during the dry period or droughts during wet season disrupt flowering.
- Precipitation will become more intense but less frequent. This calls for adequate irrigation systems.

What do smallholder producers perceive about climate change?

To identify producers' perception of climate change, the present PPP project started with a producer dialogue. Interviews with nearly 400 smallholders and management team members of their umbrella organisations were realised between July and September 2007 in the six focus regions; Peru, Nicaragua, Mexico, Tanzania, Kenya and Uganda. The topics discussed with the producer groups included experienced impacts of climate variability, options to deal with those impacts, traditional measures in dealing with climate change successfully as well as possibilities to access information and technical and financial support.

As most important impacts of climate changes farmers perceive:

- harvest losses
- scarcity of potable water, less water availability, drying of water springs
- more pests for plants, animals and humans
- soil degradation/ landslides due to erosions and contaminations
- loss of biodiversity
- agriculture comes to its edge, leading to increased migration
- increased floods
- large fires

Nearly all interviewed framers confirm to have experienced climatic changes on their farms during the last 20 years, among them ***important modification of rainfall*** with a tendency to reduced precipitations in more unforeseeable time periods, heavy rainfalls causing landslides and ***increased temperature*** and changed wind patterns.

Producers have many ideas of how to cope with these risks and adapt to changing climate and environment conditions. And people have developed a number of coping mechanisms in order to live with climatic variations and uncertainty, such as diversification of crops and sources of income, migration, reliance on remittances and social support networks. However, these adjustments largely take place within informal economic sectors, and most poor people have little access to formal support or investments.

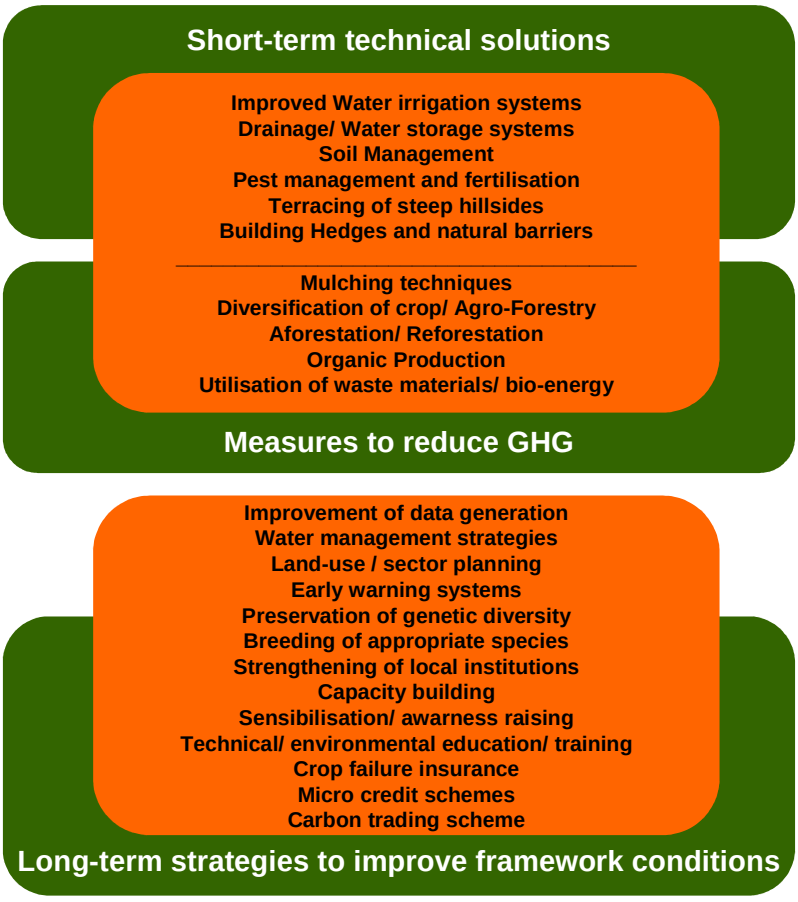
4. Options for adaptation strategies

Effective adaptation strategies imply reducing present and future vulnerability to climate change and include coping strategies or changes in practices and processes in light of the perceived climatic change. The ***capacity to adapt*** depends largely on the assets (natural resources, human and social, physical and financial capital) that one has or can access and how well these are utilised.

Based on the existing information regarding vulnerability and climate change impacts and producer´s demand and ideas for risk mitigation some options for coping strategies were identified.

By developing specific adaptation measures the present project will focuss on three main areas:

- Short-term technical solutions for adapting coffee and tea production and processing to current climate variability (no-regret measures)
- Measures to reduce greenhouse gases and thus contribute to climate protection and carbon credit generation
- Long-term strategies to improve framework conditions for adaptation to future climate risks and build capacities



The overview contains measures that were implemented either by agricultural producers themselves or with support of external experts, mainly in the context of development cooperation programmes.

Short-term technical solutions

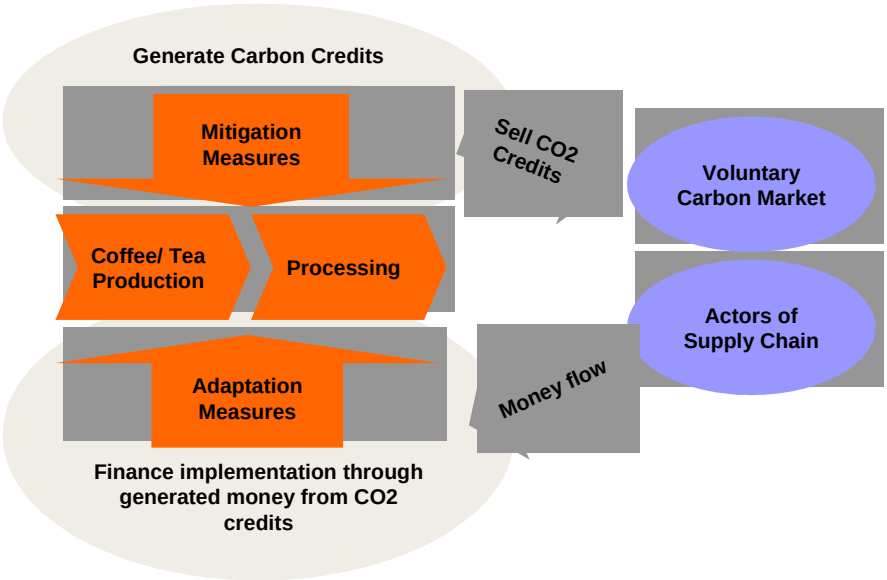
Climate variabilities affect the conditions for coffee and tea production and influence the quality and yields of the products. The most severe impacts on the crops will be caused by rising temperatures and changing precipitation patterns. Negative climate change impacts are even increased by other factors such as environmental degradation and inefficient management of natural resources. Thus the smallholder farmers' demands mainly refer to short-term solutions in order to improve production conditions and hence saving yields and product quality. As water availability and the existence of biomas are the key success factors for agricultural production a lot of technical improvements could be implemented, e.g. efficient water irrigation systems, water storage systems, darinage, soil

management, pest management and fertilisation, mulching techniques, diversification of crops, agro-forestry and the sustainable management of natural resources.

To avoid harvest losses due to increasing extreme weather events further technical measures like terracing of steep hillsides and building of hedges and natural barriers to protect against landslides or flooding could be implemented. The introduction of sustainable agricultural practices will always improve harvest yields, no matter whether there is a climate change related impact or not. It helps managing the risks of natural hazards and improves the management of natural resources. This is the reason why those measures are also known as *"no-regret"* measures.

Measures to reduce Greenhouse Gases (GHGs)

International scientific and policy institutions recommend combining adaptation to and mitigation of climate change impacts. Agricultural production is highly vulnerable to climatic variabilities, but also offers a valuable potential to reduce GHGs like carbon or methane and hence to mitigate climate change. This potential could be mobilised to generate carbon credits combined with the opportunity to receive additional income and financing for implementing adaptation strategies. The present project elaborates a carbon trading mechanism that involves different actors of the coffee and tea supply chain. The idea is to reduce carbon and other GHGs within the coffee and tea production to generate carbon credits. The credits could either be sold by the voluntary carbon market or bought by the different actors of the supply chains, who want to become climate neutral. Such actors could be manufactures, business partners as well as the consumers.



To use the carbon reduction potential some technical measures could be implemented:

- Utilization of waste materials and generating energy from biomas
- Mulching techniques
- Afforestation and agro-forestry system
- Organic production

The present project will identify and focus on those adaptation measures that offer reduction potential for GHGs.

Long-term strategies to improve framework conditions

Besides technical measures to adapt production and processing to current climate variabilities long-term strategies to improve the framework conditions for adapting to future climate scenarios should be taken into account. Different stakeholders and actors should be involved in the development of coping strategies. One of the main problems with analysing future climate related risks is the availability of valuable weather and climate data. Together with regional and national policies and scientific institutions the data generation should be improved. To improve natural resource management in the long run and with a more sustainable and strategic perspective, governmental institions should be motivated to implement strategies for water management, land-use and sector planning and to establish early warning systems.

Also the preservation of the genetic code and the breeding of appropriate species could play an important role in regards to adaption to future climate change impacts.

Finally capacities should be built at all levels like smallholder farmers, producer organisations, local and national government institution and others. Education and training for climate change and environment should be offered. The sensibilisation process for climate environmental threats could be supported.

Furthermore the financing aspect has to be taken into account. The implementation of adaptation measures needs investments. Public and private funds for adaptation and mitigation could be mobilised. Options for micro-credits should be evaluated. The establishment of a carbon trading system to generate financial support to implement adaptation and mitigation offers another sustainable perspective. Crop and weather insurances may play an important role regarding the risk mitigation of natural hazards and climate change impacts.

A description of every single adaptation measure mentioned above can be found in Annex (a).

5. How to identify adaptation measures – Risk Analysis

To identify measures to be implemented in order to adapt smallholders to climate and environment related risks some key data/ information have to be analysed. The present project uses an instrument that comes from disaster risk management – the Risk Analysis.

A ***Risk Analysis*** or Risk Assessment is a method of determining the quantitative or qualitative degree of risk, defined as the product of hazard[1] and vulnerability. The basic instrument of disaster risk management helps to identify adequate measures for the prevention of disasters and to foster an efficient utilisation of means/resources by identifying weaknesses (risks) and strengths (coping capacities). A Risk Analysis is a process, not a single workshop or a technical design of risk mapping. The goal of Risk Analysis is to estimate and evaluate the possible consequences and impacts of disasters on a population and their livelihoods and on this basis design appropriate risk reduction measures.

To identify specific climate related risks the instrument has to be adopted. First of all, one just focuses on climate related hazards (droughts, fires, heavy rainfall, cyclones, cold spells, pests, etc.) and their respective vulnerabilities. To evaluate the actual weather related risks one analyses the climate related impacts of the past. On this basis adaptation measures, that are currently valid, are identified. However in a second step, it is of high importance to consider the dynamics that climate change has on the future development of hazards (spatial distribution, occurrence and magnitude). The more future-oriented the projection of hazards is, the more important it is to also consider the dynamics of vulnerability factors (i.e. population growth, agricultural development, etc.). Therefore adaptation measures have to fulfil actual needs of risk reduction, but at the same time also have to be an appropriate answer to future challenges.

Although the focus is on climate related risks, direct causes (that means the hazard) may not necessarily be climate related, although climate induced. For example erosion can be triggered by heavy rainfall; however it is not a climate related hazard. To also cover these climate-induced hazards it is recommendable to work in cause-effect chains, where the links between hazards are analysed.

Furthermore, it is necessary to revise every adaptation measure referring to its susceptibility to other risks (might they be climate related or not), in order to not generate new risks. To give an example: water tanks might be an appropriate measure to fight drought, however the increase of heavy rainfall can result in quick accumulation of eroded material and therefore lower the lifetime of the measure.

The following methods can be used for gathering information about hazard and vulnerability:

- Participatory methods: workshops, field visits (transects), interviews/ discussions with stakeholders
- Technical methods: research, technical investigations, examination of existing data for example with GIS
- Others: expert interviews, analysis of literature

[1] A hazard is a natural physical phenomenon which can lead to a loss of life or damage to objects, buildings and the environment.

The Risk Analysis will be realised with the selected pilot producer groups.

The process is designed as follows:

a) Analysis of existing data and preparation of on-site information collection	Collection of background information Analysis/compilation of information Identification of focus regions and groups Formation of an interdisciplinary RA group (2 members of the producer group, 1 RA expert, 1 environmental specialist) Agreement of timeframe for risk analysis with group and involved partners Discussion and training of the methodology among RA group
b) On-site information collection	Discussion with national and regional key players Field visit and discussions with farmers RA-workshop with the producer group and other relevant stakeholders Compilation and analysis of the findings
c) Identification of adaptation measures	Shortlist of adaptation measures based on criteria: ➢ potential to reduce current and future risk, general feasibility, ➢ combination of short and long term measures (and benefits), ➢ potential to combine adaptation with mitigation of climate change Elaboration of feasibility studies for the selected measures Joint agreement on measures to be implemented

Starting point for the whole process is the identification of focus regions where adaptation measures – from political-institutional to physical options - are to be implemented. The experiences gathered within the process which pilot groups serves as input for a broader intervention. Therefore the pilot producer groups are selected thoroughly, using the following criteria:

- Severity of climate change impacts
- Vulnerability of coffee and tea producers
- Availability of climate related data
- Network of Cafédirect's producer groups and their adaptive capacity
- Vicinity of GTZ's Technical Cooperation Programmes
- Representativeness in terms of transferability to other coffee and tea production regions

Therefore information concerning these issues is collected and analysed. On this information basis decisions about pilot groups are made.

Then, coordinators for the further process of risk analysis in the selected focus groups are to be defined. They have the obligation to prepare and implement the more in-depth on-site risk analysis. Among other responsibilities they have to assort the risk analysis group members, composed of two representatives of the producer group and one environmental expert. The members of the group should assist the process and thus have to be trained in the methodology of risk analysis.

After this preparatory phase the on-site information collection and analysis starts. The risk analysis group provides additional information about the specific context of the producer group: hazards that affect the focus group, vulnerabilities concerning the institutional, political, economical and ecological situation and coping capacities that make them more resilient to negative impacts of climate change/variability. The information collection can be done by interviews with relevant stakeholders, by field visits and discussions with farmers, etc. It is important to look for inputs for the workshop, i.e. topographical maps of the producer group area, information about past damages, etc. In the workshop with the producer group and other relevant stakeholders this information is used and complemented with other data of the participants in order to establish a rough estimation of risks to suffer from climate change/variability. On that basis possible solutions can be outlined and discussed. Afterwards the results of the workshop are to be compiled and analysed by the risk analysis group.

Adaptation measures are identified on the basis of the workshop results. However, in order to design measures which are feasible within a well conceptualised project approach, the workshop results are revised several times: The first revision is based on some principal criteria:

- potential to reduce current and future risk, general feasibility,
- combination of short and long term measures (and benefits),
- potential to combine adaptation with mitigation of climate change

The measures of the so established shortlist are then specified by elaborating a short description (a short feasibility study) of the intended activities. They respond to the following points of interest:

- Effectiveness to reduce vulnerability significantly
- Cost-benefit relation
- Innovative character
- Support from local and regional level
- Realizable within the project's lifetime
- Chances for sustainability
- Institutional conditions for the implementation
- Potential to combine with mitigation measure

In this second round those measures showing a positive performance with respect to the above mentioned criteria are prioritised. If it proves to be necessary, the short project descriptions can be

complemented by more profound technical studies, which investigate the technical feasibility more in detail. A joint agreement on the selected adaptation measures represents the final point of the risk analysis.

Expected outputs:

- Profound basis of information concerning present and future vulnerabilities and hazards related to climate change/vulnerabilities the producer groups are facing.
- Joint elaboration of possible adaptation measures.
- A set of prioritised adaptation measures per pilot group which is feasible, coherent and innovative. In addition, it should be possible to integrate the measures into the overall development process.
- Interest and ownership of the producer group respective the adaptation measures and their implementation.

Comments

MG, Imani: the only major comment is that it does not mention market issues and how the market responds to tea or coffee quality. Changing the plant type and reducing output has serious market implications, this must be taken into consideration. The cloned tea bushes give various outputs and qualities, which the market may reject or reduce the price paid for. I feel you should include market considerations at least in the risk analysis if not more generally in the paper.

Annex (a)

Adaptation options to climate change in the coffee and tea sector

1. **Breeding and selection of suitable sorts which are less susceptible to water shortage and pests**

Generally durable sorts with a high climatic tolerance and a small susceptibility to infestation by pests should be preferred instead of high yield sorts.

2. **Diversification of the cultivated crops**

Diversification of the cultivated crops reduces the danger of complete harvest loss by weather extremes and pests. In this context "under shadow" cultivation especially in the coffee sector has to be highlighted. In the context of the bio-trends in agriculture, the "under shadow" cultivation gets a new quality because of its contribution to the preservation of biodiversity, soil fertility and the minor application of pesticides due to lower susceptibility to parasites.

3. **Mulching**

Mulching is a method of horticulture, where the open soil between vegetable plants, flowers, bushes and trees is covered with cutted pasture, leaves, etc. Mulching not only reduces evaporation, but also lowers erosion evoked through water and wind. In addition, the mulching layer prevents siltation of the soil. By covering the soil roots are kept cool, the humidity loss of the soil is decreased and pest plants are impeded in growing. Furthermore, the gradually composted mulching layer is transformed into humus, which results in organic fertilisation.

4. **Control of fungal attacks and loss of soil fertility**

Control of fungal attacks and loss of soil fertility are measures which will get a high priority in the context of climatic change. On the one hand due to the changing conditions the plants are in stress and become more susceptible to parasites and fungal attacks. On the other hand the soil loses its fertility due to erosion. A sustainable cultivation therefore has to look for ecological solutions to overcome these problems. There are already ecological fungicides available (i.e. by using extracts of *neem* trees), and natural fertilisation is nothing new at all.

5. **Planting of hedges**

Hedges protect the plantations against storm damages and the soil against wind erosion and evaporation. Furthermore they protect against cold winds and frosts and have a stabilising effect on the micro-climate. Hedges are planted particularly in those places exposed to wind. By providing a niche for birds and other small animals hedges also contribute to ecologically preventing pest attacks. In Europe hedges were often used as fuel suppliers.

6. **Drainage systems**

There is a steady trend of increasingly heavy rainfalls accompanied by erosion, especially on long and steep slopes. Therefore superficial or sub-surface drainage systems can be an option for adaptation to climate change. These systems can also be combined with tanks where water can be stored for dryer seasons.

7. Natural barriers

Natural barriers are erosion-restraining structures of grass, bushes or a construction of organic material and stones. They prevent step slopes from erosion and increase the infiltration of rainfall. Positive side effects are achieved through the decreased risk of inundations and the auxiliary income generated by sales of the products of the "natural barriers".

8. Water storage

It is known that climate change will decrease the amount of precipitation in some areas and rainfall will be concentrated in fewer but more violent events. Water storage systems can lower the variability of water availability. This means that vulnerability to droughts can be reduced by using more or less sophisticated water storage techniques.

9. Improved irrigation techniques

In some tea and coffee plantations irrigation already plays a vital role. Where water stress will increase due to climate change, irrigation techniques will have to be improved. However, the more sophisticated they are, the more demanding is their implementation.

10. Terracing

Agro-technical measures can improve the groundwater level and therefore foster the expansion or protection of rain-fed agriculture. One of these techniques is the terracing of slopes that reduces the steepness and thus leads to accelerated infiltration of precipitation water.

11. Management of water resources

The more efficient management of water resources plays a key role in the context of climate change. A reduction of the absolute amount of precipitation in many regions will lead to increased competition for the scarce resources due to population growth, export orientation of agriculture, industrialisation, etc. Therefore the management of catchment areas and the coordination among different sectors (agriculture, industry, etc..) have to be tackled.

12. Crop insurances

Crop insurances offer the possibility to protect the income of harvests against weather-related extreme events. This can prevent smallholders from getting into the vicious circle of disasters and poverty. However the initial transaction costs are very high as the requirements for establishing such a system are enormous.

13. Traditional "insurance schemes"

In many societies there are traditional (informal) mechanisms for sharing and reducing risk. There is the diversification of the sources of income, for example via activities apart from agriculture (e.g. by labour migration, part time farmer, etc.), as well as family and clan networks, that can help in emergencies. These traditional "insurance schemes" can be strengthened.

14. Micro credits

Adaptation to climate change requires investments, both for short-term measures (e.g. the fast rehabilitation of basic production conditions destroyed by extreme weather events) and long-term

projects (e.g. the conversion of a production system). Micro credits are an option for smallholders without financial security to get access to urgently needed financial resources.

15. Early warning systems

Early warning systems can reduce harvest losses. For the agricultural sector early warning systems which predict drought periods and heavy rainfalls are of special interest. Agronomical droughts can be predicted by using indicators like precipitation patterns and temperature. Heavy rainfalls can be predicted on a real time basis by using satellite images.

16. Planning approaches

Among political and planning approaches, spatial planning plays a vital role. It helps to orient economic and social activities within a given space and to organise the sustainable utilisation of resources along planning guidelines. Land use planning and management of catchment areas are one of the best known instruments of spatial planning. Also sector planning (referring to the development of strategies for specific sectors and their interactions) has to fit in into these planning schemes. Laws, norms and standards complement the planning approaches.

17. Capacity Development

By strengthening local institutions the resilience of communities against disaster impacts can be improved. Well organized communities are a prerequisite for implementing adaptation measures and to overcome disasters. The formation of local capacities is a key element to strengthen local institutions. Besides technical issues of adaptation measures also their integration into development planning has to be tackled. Sensitisation of the population and of political decision makers is very important to sustain a basic understanding of the importance of new topics and processes, and finally for their acceptance.

18. Knowledge Management

There is quite a big knowledge gap referring to the topics climate change and adaptation. Cooperation, knowledge management, access to information and the establishment of local data pools therefore play a vital role to overcome these deficits and to adequately address the effects of climate change in the medium and long term.