Advancing Climate Compatible Development for Food Security

Task 3:
Assessment how food security-related elements of national climate change strategies can harness international climate finance in an effective manner

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Germanwatch e.V.

Lisa Junghans
Sven Harmeling

Bonn Office
Kaiserstrasse 201
53115 Bonn, Germany
Phone +49 228 604 92 22
harmeling@germanwatch.org
www.germanwatch.org

perspectives GmbH

Michel Köhler
Daniela Boos
Sonja Butzengeiger
Axel Michaelowa

Hamburg Office
Baumeisterstrasse 2
22099 Hamburg, Germany
Phone +49 40 399 99 069-1
info@perspectives.cc
www.perspectives.cc

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Contents

List of Tables

List of Figures

Abbreviations

ACR	American Carbon Registry
AF	Adaptation Fund
AFB	Adaptation Fund Board
AP	Alberta Protocol
BAU	Business As Usual Scenario
CO_2	Carbon Dioxide
CO_2-eq	Carbon Dioxide Equivalent
CAR	Climate Action Reserve
CCD	Climate Compatible Development
CDM	Clean Development Mechanism
CDM EB	Clean Development Mechanism Executive Board
CERs	Certified Emission Reductions
CFI	Carbon Farming Initiative
CH_4	Methane
COP	Conference of the Parties
DAC	Development Assistance Committee
DNA	Designated National Authority
ERU	Emission Reduction Unit
EUAs	European Union Allowances
EU ETS	European Union Emissions Trading Scheme
GCF	Green Climate Fund
GEF	Global Environment Facility
GHGs	Greenhouse Gases
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
LDC	Least Developed Countries
LDCF	Least Developed Countries Fund
LoA	Letter of Approval
LULUCF	Land Use, Land-Use Change and Forestry
MDB	Multilateral Development Banks
MOP	Meeting of Parties
Mt	Million tons
N_2O	Nitrous oxide
NAMA	Nationally Appropriate Mitigation Action
NAPA	National Adaptation Plans of Action
NIE	National Implementing Agencies

OECD	Organization for Economic Cooperation and Development
PoA	CDM Programme of Activities
PPCR	Pilot Program for Climate Resilience
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
VCS	Verified Carbon Standard
VERs	Verified Emission Reductions

1 Executive Summary

The integration of mitigation, adaptation, and food security in responding to climate change is a conceptual puzzle that needs to become a practical reality. The complex environment in which food security needs to be pursued, involving aspects such as availability, stability, accessibility and utilization of food on all levels consistent with the right to adequate food, poses specific challenges to addressing climate change in the interest of those most at risk from food insecurity. This report analyses and assesses a broad scale of mitigation and adaptation activities in the agricultural sector, including prospective activities and funding opportunities. Its main objective is to identify synergies and trade-offs between mitigation, adaptation, and food security as well as find comprehensive ways to overcome the barriers and make use of the benefits.

Mitigation and adaptation options in the face of food security

The first part of this report discusses a **number of adaptation and mitigation options** that can be addressed in a cost-effective manner while also benefitting food security in developing countries. With regard to ever rising greenhouse gas (GHG) emissions and the need to limit global temperature increase the pressure to implement substantial short-term mitigation action is rising. As a short-lived and extremely effective heat trapping climate pollutant, the reduction of methane requires more attention in addition to ongoing reduction of CO_2 emissions. As a matter of fact the agricultural sector is responsible for about 50% of global methane emissions. Overall mitigation potential is about 110 Mt CO_2e per year for livestock and manure management and medium to high in regard to rice cultivation. The reduction of methane emissions offers a chance to capitalize synergies between mitigation, adaptation, and food security: Reducing chemical fertilizers both mitigates methane emissions and sustains healthy soils for long-term food security. Moreover, improving rice cultivation through the introduction of a controlled irrigation system can mitigate methane emissions which are significantly higher when continuous irrigation/flooding occurs. In terms of adaptation this reduces water demand and safeguards food security because a reduction of irrigation water by 16-35% does not decrease yields.

Besides reducing methane emissions attention should be given to improved cropland management as it also bears several positive synergies between mitigation, adaptation, and food security. Its mitigation potential lies at 700 Mt CO_2-eq/year at a price level up to 20 USD/t. Prospects for adaptation are also noteworthy as improved soil conditions most likely increase food security. However, as short-term productivity might decrease, solutions to address temporary yield losses need to be developed.

While the agricultural sector offers some sound opportunities to address climate change mitigation, adaptation, and food security at once, some important trade-offs and challenges, particularly concerning mitigation activities, need to be pointed out. For instance, improved agricultural practices, residue management and tillage, agro-forestry, and fossil fuel reduction might bear negative implications on crop yield and thus food security, particularly in the short term. To ensure that farmers

still participate in mitigation activities, the introduction of approaches to compensate for loss of harvest could be considered. An adjustment of regulatory frameworks of the carbon instruments might help to overcome this trade-off (see next section).

Funding options

The second part of the report identifies and assesses what project types have been applied in the context of **international climate change financial assistance**. Despite the fact that some agricultural activities received funding already, some project types have not been covered yet. Within the scope of this report, these shortcomings are identified and approaches for reforms or adjustments are developed in order to enable climate compatible activities access to funding. Main conclusions regarding **mitigation funding instruments**:

- Carbon markets for (co-)financing of agricultural mitigation have been applied in the field of methane avoidance and are successful in terms of registered project activities and mitigated GHG emissions. Most notably the Clean Development Mechanism (CDM) with more than 200 registered methane projects (mainly manure management and avoidance of methane production from biomass decay) is expected to reduce up to 85 Mt CO_2-eq until 2020. However other agricultural activities with tremendous mitigation potential such as improved cropland management have hardly been tapped yet. Main barriers are high transaction costs, missing methodologies how to precisely measure CO_2-eq reductions and the low carbon price due to low mitigation ambition. Therefore increased mitigation targets of potential demand markets would be helpful in order to achieve higher carbon prices (therefore enable more mitigation activities) and avoid undermining the environmental integrity. Any approach of undermining the food security and increasing the marginalisation of vulnerable agricultural groups such as smallholders must be avoided. As a means to contribute to food security the development and introduction of a new carbon market standard (e.g. Food Security Gold Standard) should be considered to guarantee stable or increased food supply. As carbon markets are under debate because of limited transparency and in some cases limited environmental and social integrity (Gaia Foundation 2011, African Biodiversity Network et al. 2011, PAIRVI 2012, PCFS 2012), it must be ensured that smallholders and other participating groups will receive a fair share of financial transactions according to their contribution to reducing CO_2-eq emissions.
- International funds administered by multilateral organisations and Nationally Appropriate Mitigation Actions (NAMAs) under the UNFCCC have not been able to promote agricultural mitigation in larger scale so far. Existing funds are often related to the carbon market, some also directly sponsor agricultural activities. The overall potential of current proposals is expected to be low (~3 Mt CO_2-eq until 2020) and finance is unreliable due to unclear wiliness of donors to make available funding. Therefore not a single NAMA is implemented so far. However NAMAs are expected to play an important role in the agricultural sector in the future, in particular as some concepts precisely take food security into account. Especially if further

COP decisions explicitly require certain co-benefits we see high chances to create synergies with adaptation/food security through NAMAs. Conceptualization and implementation should be internationally supported.

With regard to **financial assistance for adaptation**, focus was laid on the three multilateral funds Adaptation Fund (AF), Least Developed Countries Fund (LDCF) and the Pilot Programme for Climate Resilience (PPCR) and the agriculture-related projects that have been approved. Our analysis has shown that the bottom-up nature of international adaptation funding makes it difficult to draw conclusions similar to those in the mitigation sector, in particular since none of the funds require the approval of specific methodologies on the global level. No sectoral priorities are set on the global level for good reasons, but countries identify bottom-up priorities, ideally in a participatory manner involving also those who are most vulnerable. This is for example a specific and valuable requirement in the Adaptation Fund.

Regarding **post-2012** funding opportunities the clear focus is on the **Green Climate Fund (GCF)**. To date, there is no adequate mechanism that particularly encourages funding institutions to focus on integrated approaches that address effective climate change mitigation, adaptation, and long-term food security. The GCF has the potential to overcome this dichotomy:

- The GCF will be the first multilateral funding instrument with the explicit mandate to finance integrated climate change approaches. However our assessment shows that there is little experience with funding integrated approaches, e.g. rewarding mitigation and adaptation at the same time.
- It is important that international institutions create a suitable framework for such integrated approaches, for instance through transferring sustainable development experiences.
- There is need to identify adequate financing instruments for on-the-ground application and scaling up of adaptation and mitigation measures. Hereby it has to be ensured that funds will reach the implementation level, in particular smallholders.

Overcoming barriers: The gatekeeper institution

The analysis of agricultural mitigation and adaptation funding instruments has revealed a significant **fragmentation** of both international support sources and domestic implementation. On the international level homogenised approaches for providing support are rare. A variety of adaptation and mitigation funds, carbon market mechanisms, including NAMAs, provide financial assistance under the UNFCCC. In addition, there are numerous bilateral initiatives. They differ in terms of eligibility criteria, requirements, transaction costs, access procedures and “Measurement, Reporting and Verification “ (MRV). On the domestic level sufficient agricultural area is required to efficiently make use of mitigation approaches. As usually large numbers of smallholders farm the land, information, coordination and monitoring have been identified as main challenges. To overcome these barriers we recommend domestic “**gatekeepers**” that are responsible for linking the international to the local level. Main design features and requirements are:

- Main objective of the gatekeeper is to **overcome the fragmentation** of funding sources and domestic implementation through coordination and channeling of resources. The ability to manage access to and disbursement of funds to a variety of scattered recipients requires a high level of organizational capacity.
- Gatekeeper institutions will need to meet **high fiduciary standards** for receiving and managing funds – from a donor perspective but also from the point of view of domestic stakeholder's interests in social and/or environmental integrity.
- Knowledge of agricultural settings, climate change mitigation and adaptation expertise as well as the ability to manage large numbers of stakeholders are additional, important needs.
- Developing countries are recommended to build gatekeepers on operational existing institutions from the adaptation or mitigation sectors.
- Gatekeepers can be established as single, centralized institution or as a network of several partner organizations.
- Gatekeepers are recommended to **identify and resolve** the analyzed **trade-offs** between mitigation and adaptation/food security. In case projects will lead to decreased yields in the short and mid-term, gatekeepers might be required to engage in compensation management.

Overall, it is highly recommended to disseminate the assessment results regarding activities in the agricultural sector, funding options and overcoming barriers through the "gatekeeper institution" among developing countries. Other important suggestions are i) to initiate a discussion that involves a variety of developing countries and stakeholders, ii) to improve funding instruments and iii) to support the set-up of gatekeeper institutions. Multilateral and international institutions such as CDKN are suggested to actively promote and support this process.

2 Background: climate change and agriculture

In the face of an ever growing population global agricultural production is under significant pressure. Relying on finite, often degraded soils and water resources, conditions are predicted to exacerbate through climate change, most likely affecting agro-ecological and growing conditions. Undoubtedly this will also have consequences for achieving or maintaining food security in its broader sense which goes much beyond just the amount of food produced (see Bals et al., 2008). Adverse effects through climate change can directly impact on the production of food, but also on other determinants of food security such as the availability, stability, accessibility and utilization of food on all levels from global to household. The potential implications of the level of atmospheric greenhouse gas concentration was already recognised in Article 2 of the UNFCCC, since this concentration should be achieved on "a level that would prevent dangerous anthropogenic interference with the climate system", and such a level "should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, **to ensure that food production is not threatened** and to enable economic development to proceed in a sustainable manner" (see UNFCCC, 1992).[1]

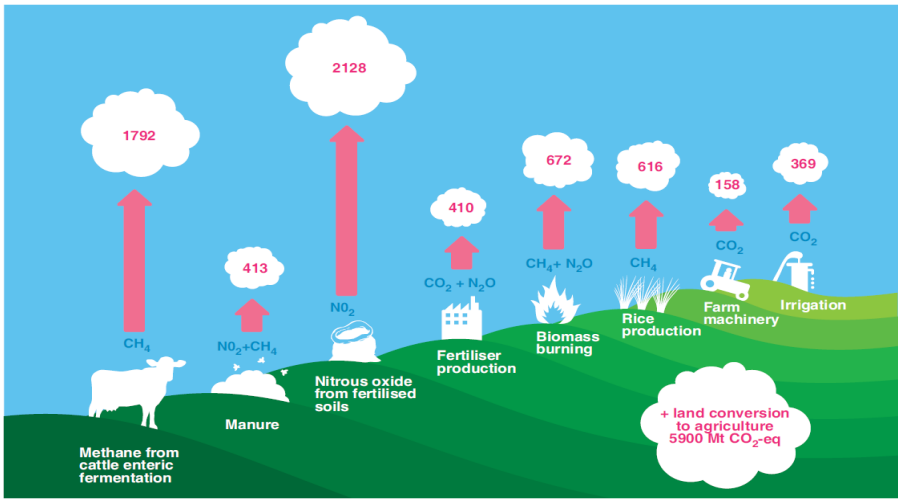
Yet, whilst largely negatively affected, the agricultural sector bears an immense potential for CO_2 emission reductions as it is a major source of global anthropogenic greenhouse gas (GHG) emissions. According to the 4th IPCC Assessment Report, agricultural activities accounted for about 5.1 to 6.1 Gt CO_2-eq/yr in 2005, a global share of 10-12% of total emissions. Major gases are methane (CH_4) with 3.3 Gt CO_2-eq/yr, nitrous oxide (N_2O) with 2.8 Gt CO_2-eq/yr and to a minor extent CO_2.

Methane release is mainly due to decomposition of organic materials through enteric digestion by livestock, from stored manure and flooded rice plantings. Nitrous oxide is mainly generated through the transformation of nitrogen in soils and manure. Carbon dioxide emissions are due to microbial decay, biomass burning and soil organic matter. However CO_2 releases are included in land use, land use change and forestry (LULUCF) and therefore difficult to compare and separate.

Overall, “the balance between flux and removal of CO_2 in agricultural land is uncertain” (IPCC 2007, p.503). Agriculture-related net CO_2 emissions are estimated with 40 Mt CO_2-eq/yr, which is significantly lower than CH_4 or N_2O releases. Additionally electricity and fuel use are also responsible for generation of carbon dioxide, but these emissions are usually counted in the buildings or transport sector. In the context of this study these emissions will nevertheless be linked to agricultural activities and therefore are considered as mitigation potential. An overview of main sources of global GHG in the agricultural sector is given in Figure 1. CH_4 from cattle and N_2O releases from fertilized soils are by far the largest sources beside “land conversion to agriculture”. The latter includes e.g. deforestation and is therefore considered separately in this report.

[1] part in bold highlighted by the authors.

Figure 1: GHG emission sources in the agricultural sector (numbers are in Mt CO_2-eq/yr)

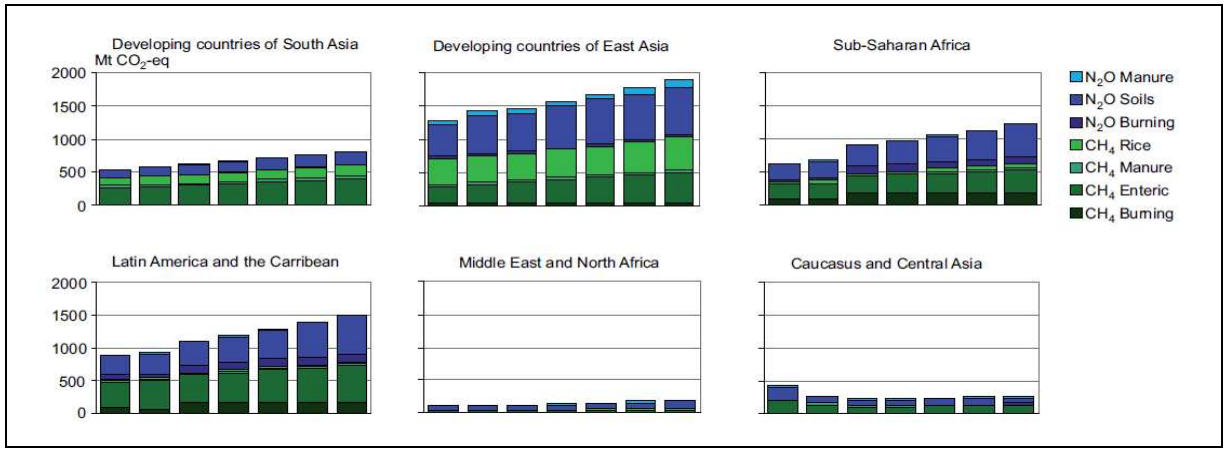


Source: Greenpeace International 2008, p. 7

Between 1990 and 2005 agricultural emissions increased by nearly 17%; the average annual growth was 60 Mt CO_2-eq. This equals the CO_2 emissions of Portugal in 2008. Developing countries are responsible for about three quarters of global agricultural emissions – however these states also inhabit more than 80% of worlds' population and therefore have much lower per capita emissions than the developed world (see also IPCC 2007, p.499f).

Major total emitters among developing countries are countries with highest population such as China or India; however there are significant differences in the emissions' sources and intensity per world region. For instance South and East Asia are responsible for 82% of total rice growth related CH_4 emissions whereas 75% of emissions related to biomass burning originate from Sub-Saharan Africa, Latin America and the Caribbean (see also
Figure 2).

Figure 2: Sources of agriculture related GHG emissions in Non-Annex I countries during the period 1990 to 2020



Source: IPCC 2007, p. 504

While a decline of CO_2 emissions and other GHG must take place (mitigation), measures also need to be introduced to ensure that the growing demand for food is met in face of the mostly adverse impacts of climate change (adaptation). With the world on a track towards 4℃ or more of temperature increase in this century - the current mitigation pledges do not yet sum up to a path below 2℃ as agreed by th e governments from more than 190 countries at COP16 - the climate-sensitive sectors most relevant for food security, such as agriculture, water supply, forestry and fisheries, are likely to face severe constraints adversely impacting on the livelihoods of the poorest and most vulnerable. For many developing countries, in particular those with severe food security constraints, adapting agriculture will be the priority when addressing climate change in this area. Generally, there are different concepts how to distinguish and categorise adaptation measures. One option is to distinguish between short- and long-term adaptation measures. While the former for instance refers to changes in tillage practices or adjusted livestock breeds, more sustainable actions should likewise be introduced to ensure food security in the long-term. Good examples are improved water management practices or the development of irrigation systems.

3 Methodology to assess mitigation and adaptation activities

The following chapters describe the variety of mitigation and adaptation activities in the agricultural sector. For identifying the most suitable ones, an assessment according to a pre-defined set of criteria is applied. These criteria might also serve as background for further analysis, decision-making and finally disbursement of financial streams under the control of the gatekeeper institution for Climate Compatible Development (see also chapter 9). The following criteria for assessing mitigation and adaptation activities have been defined by the authors:

- Mitigation potential (global effectiveness)

  This key criterion reflects the ability of a given activity to mitigate GHG emissions globally, with a focus on the conditions in developing countries. Furthermore we assess whether the potential in certain countries or regions is high whereas in other world regions it might be low. It is indicated in the analysis below whether the numbers are based on the economic, technical or theoretical potential. The *economic potential* describes the amount of emission reductions that can be achieved with current technologies and in the context of certain price levels. Regarding carbon markets current average Certified Emission Reduction (CER) prices below 0.5 EUR per tCO_2-eq or 0.7 USD per tCO_2-eq respectively (see Thomson Reuters 2013) provide insufficient incentives for most activities. Most project types are only feasible if the price level increases due to higher demand for carbon credits, if donors are willing to pay premiums or if they use other financial support schemes. The *technical potential* indicates the amount of reductions that would be achievable with currently available technologies. The *theoretical potential* also takes into account expected innovations in the future. Where available the mitigation potential is given in Mt CO_2-eq per year. If literature lacks such quantitative data the mitigation potential is described by the authors in three qualitative categories: Low, mid and high. An individual justification is given for each of the mitigation activities.

- Estimated mitigation costs (efficiency)

  Different mitigation activities have different costs and this has a direct impact on cost efficiency. In the context of an urgent demand for large-scale emission reductions while having only scarce financial resources available efficiency is seen as highly important. Where available mitigation costs are described in USD/Mt CO_2-eq per year. We evaluate the activities in the range “up to 20 USD per t CO_2-eq” and “between 20 and 50 USD per t CO_2-eq”. If literature lacks such quantitative data we attempt to describe the mitigation efficiency in three qualitative categories: Low, mid and high whereas low is seen as unfavourable and high as favourable. An individual justification is given for each of the mitigation activities.

- Synergies between mitigation, adaptation and food security

  The central purpose of the research project is to assess how synergies between mitigation and adaptation can be created and harnessed. Hence the potential to generate co-benefits is considered as decisive criterion for evaluating the suitability of an agricultural activity in the context of CCD and food security. Synergies are described qualitatively and co-benefits are ranked in the three following categories: Low, mid and high. An individual justification is given for each of the mitigation and adaptation activities.

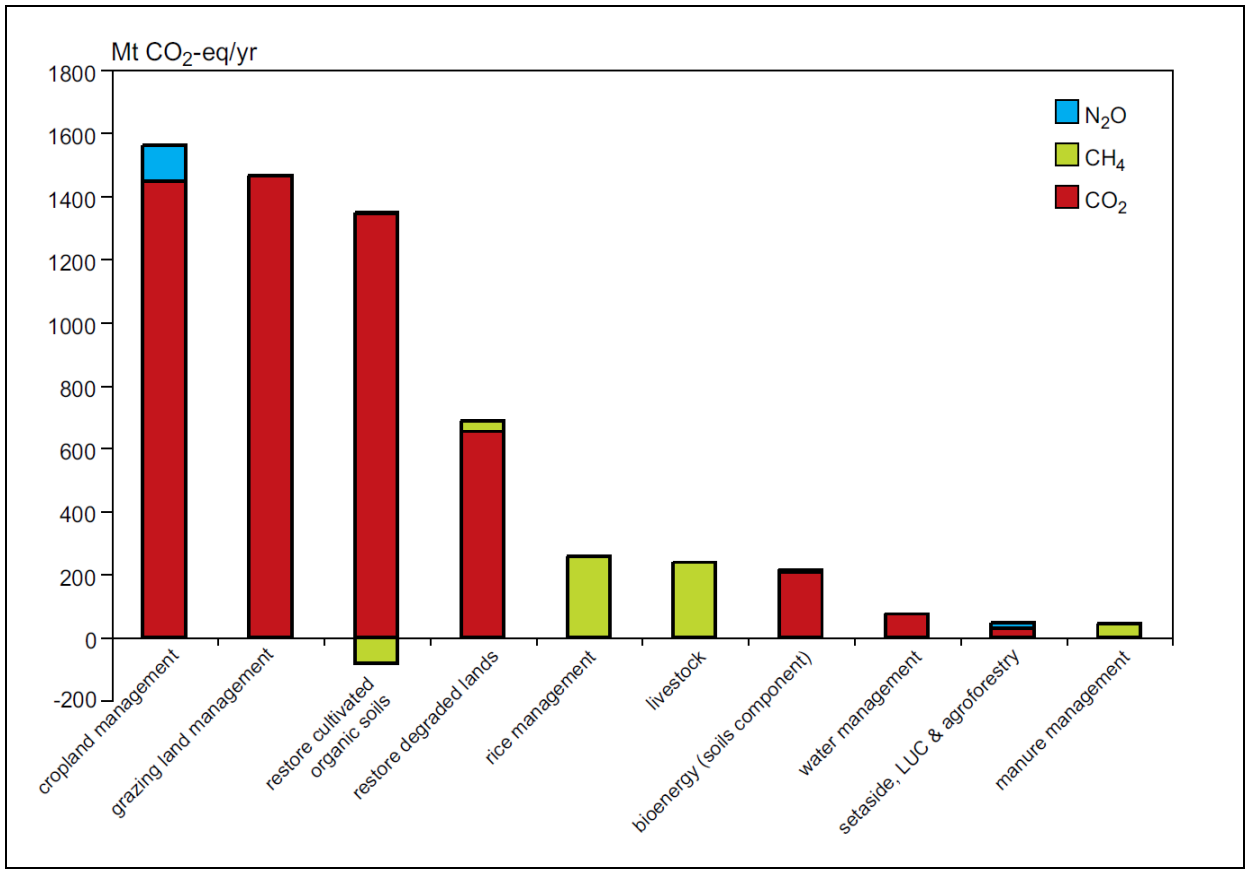
- Adaptation benefits:

  It is well-known that there is not one agreed adaptation metric to measure adaptation benefits. The benefits of adaptation are much more context-specific compared to mitigation and can include economic and non-economic benefits. In fact, any transfer of assessments on the benefits of a certain adaptation practice in one area may not necessarily be equally valid for another area. For this report, many pieces of literature were examined to identify how agriculture adaptation options in the different categories tend to provide adaptation benefits, always taking into account that also agriculture in general is very context-specific.

4 Overview of agricultural mitigation and adaptation activities

A variety of mitigation and adaptation options have been identified by several institutions. The pre-selection of climate change mitigation and adaptation opportunities for the assessment is based on IPCC 2007. For mitigation, based on findings from IPCC and selected individual sources we assess in the following technical and economic opportunities with the highest potential. The overall potential is shown in Figure 3. In particular the theoretical CO_2 mitigation potential is seen as tremendous. Hereby both increased carbon inputs and reduced carbon losses offer mitigation potential. These processes, described as "soil carbon sequestration" are especially relevant in the context of cropland management and grazing land management. Further interventions to tap CO_2 mitigation potential through abandoning of agricultural areas or restoration of degraded land are partly related to LULUCF, we will assess these opportunities in chapter 4.6. Opportunities to reduce N_2O and CH_4 emissions are assessed across several mitigation options.

Figure 3: Global technical mitigation potential by 2030 of selected agricultural management practices per GHG.



Source: IPCC 2007

For climate change adaptation, a variety of sources has been taken into account and where appropriate analysed in the same categories as those for mitigation. Of particular importance is analytical work undertaken by the FAO. As stated above quantification and comparison of the effectiveness of different approaches is extremely difficult and beyond the scope of this research. It has been judged most important to provide an understanding of the conditions under which different options may provide adaptation benefits.

For each described agricultural practice several activities can be applied. As far as possible we derive mitigation costs and maturity of activities/technology. The results will serve as basis for comparison to internationally funded activities in the next chapter.

4.1 Improved cropland management

Improved agricultural practices

Improved agricultural practices lead to higher inputs of carbon residue, which results in increased soil carbon storage. Additionally, the use of nitrogen-fixing crops enhances fixing of nitrogen in soils. Such practices comprise the use of improved crop varieties or types, extension of crop rotations, reduction of bare fallow (i.e. leaving the land uncropped and free from vegetation by cultivation), rotations with legume crops and so called cover crops (FAO 2009, p. 20).The change towards crop varieties which are more resistant to changing climate conditions (e.g. early maturing, drought-resistance) can result in mitigation and adaptation benefits: soil carbon sequestration can be improved while also resilience to changing weather conditions can be enhanced. Furthermore, due to the greater seed diversity of the same crop, average yields are expected to increase while yield variability should be reduced. To enhance varieties the genetic base of traditional food crops can be broadened and locally-adapted crops supported through a plant breeding program. For example, the use of new varieties of crops and trees enhanced yields in Kenya by 60 percent (FAO 2011, p.9).

With regard to increasing heat stress a suitable adaptation measure is the improvement of cultivar tolerance to high temperature to limit the loss of grain, fill and quality as well as to select crops and cultivars that are tolerant to abiotic stresses. Taking a more lateral approach it might also be useful to select varieties that could be planted earlier in the season in higher moisture. This would require resistance to given diseases; yet as it is easier to breed-in this kind of resistance, this approach might be promising for future undertakings. Generally, in response to changing pest, disease and weed threats it is useful to promote crops and cultivars with disease resistance traits (Stockle et al. 2010).

Extending crop rotation, i.e. growing a series of different types of crops in the same area in sequential seasons and reducing of bare fallow contributes to nitrogen fixing in soils. This, in turn, improves soil fertility and water holding capacity, building up resilience with regard to dry spells. However, in the

short-term it might reduce cropping intensity and lead to initial losses, thus lowering regional food security (FAO 2009, p. 18). Particularly crop rotation with legumes has a high mitigation potential as most of these plants form a symbiotic relationship with nitrogen-fixing bacteria and therefore reduce reliance on external nitrogen input (IFPRI 2011, p. 3). Furthermore the concept has a positive influence on resilience to climate change and yield increases in the long term. The use of rotations helps reducing or even avoiding crop-specific failure or diseases deriving from monoculture – which then often leads to insufficient harvest (Woodfine 2009, p.22). For instance, the practice of growing 'milpa' (maize many times combined with beans) is the foundation of food security in many Latin American rural communities (Altieri et al. 2011, p. 6). Although yields will rise in the long-term, there can be some reduction in cropping intensity in the short-term. This in turn can lead to negative consequences for regional food security (FAO 2009, p. 18). Further, as some farmers (e.g. in the *abonera* system in Central America) already apply this concept, it might be for a reason that farmers in other regions do not see this as an effective approach. Trying to transfer appropriate technology could also lead to problems related to labor and/or markets.

Another example of a plant that provides various synergies for mitigation, adaptation and food security is the multi-purpose Moringa tree. It grows in the tropics and subtropics where most LDCs are located and has potential to contribute to production of bioenergy (mitigation), nutrition for humans and livestock, medical drugs and water purification (adaptation) through low-tech (see also Melesse et al. 2011).

The use of so called cover crops ("green manure crops") that are planted between the sowing of successive agricultural crops or among trees or vine crops affix carbon and also nitrogen to soils and thus contribute to the mitigation of CO_2 and N2O emissions. Regarding food security this practice has some positive and negative effects: Due to reduced soil erosion and nutrient leaching harvests are increased and water holding capacity strengthened. But at the same time there may be a conflict between cropland and grazing land in mixed crop-livestock systems (FAO 2009, p. 52). Several studies on the subject of cover crops show that there was a significant increase in yield (30-50%) comparing cropland management with continuous crop planting (see FAO 2011, p.9).

A similar soil enriching effect can be achieved through maintaining a mulch layer that provides a substrate for soil-inhabiting microorganisms. Re-vegetation and the application of nutrient amendments are two other methods on how to improve yields over the medium to long run as both significantly reduce soil and water erosion. On top of those adaptation measures the construction of (stone) bunds as well as bench and step terraces increase soil moisture and can thus lead to higher crop yields. However, the construction is very labor-intensive, takes up space, can inhibit plough, and might even a potential vector for pests. A similar moisture retention effect with less negative implications can be reached through trash lines, ridges or furrows, which can all limit yields variability,

particularly in dry areas. In addition grass strips, strip cultivation and vegetation barriers can reduce runoff and soil erosion.

With regard to climate change farmers are also advised to adjust their planting as well as harvesting timetables to prevailing conditions of the past 3-4 years to reduce the likelihood of crop failure. This will maintain production even under erratic rainfall patterns or seasonal precipitation changes, however requires subtle changes to cultivars. However, as uncertainty about local climate change impacts still prevails, a certain flexibility with regard to planting dates should be taken into account (Meza and Silva 2009).

Besides harvesting changes farmers are advised to diversify the cropping composition (limit the reliance of farmers on one or two crops) to ensure that not all agricultural products are lost in an event of a longer-lasting dry spell (Thornton et al. 2010). In this regard it is also useful to consider traditional food preservation techniques to ensure that grains are stored safely from moisture (e.g. through the construction of silos for communities and households). As pointed out by Meza et al. (2008) climate change may also allow for early sowing potentially leading to double cropping in certain areas where currently only one crop is feasible. Yet, it needs to be taken into account that nitrogen levels and water demand might increase, partially undermining a sustainable development path.

As coastal areas and its nearby vegetation are already experiencing the impacts of climate change it is advisable to plant littoral vegetation as buffers against salt spray and at the same time identify and select suitable species against soil salinization, such as Halophytes. This salt-tolerant plant species, provides multiple benefits as it plays a key role in the ecosystem, for instance preventing soil erosion and seawater intrusion into freshwater habitats. In fact, the plant is also a (yet unexploited) source of novel genes that can enhance drought and salinity tolerance in crop varieties (ICARDA 2011).

Nutrient use

Often, fertilizers are used inefficiently causing high Nitrogen emissions to the atmosphere. Therefore, improving an efficient use of Nitrogen can lead to a reduction in N_2O emissions of soils but also indirectly of GHG emission at the production of Nitrogen fertilizer. This can be reached by several practices, e.g. the adjustment of application rates based on particular estimation of crop needs (precision farming) and improved timing, using nitrification inhibitors or the precise placement of Nitrogen into the soil (IPCC 2007, p.507). Improving crop productivity in the short-term, it can in the long-term increase the crop's resilience to climate change. However, it might also lead to greater yield variability in the face of more frequent droughts. Additionally, numerous case studies show that the adoption of organic fertilizer has a positive effect on the yields (see FAO 2011, p.10).

As the use of commercial fertilizer is under dispute in the face of sustainable development the proper management of soil fertility and organic matter as well as improved efficiency of nutrient inputs are three other methods how to increase production with proportionally less fertilizers. Averaged across years Uniform Manure and Site Specific Manure can also produce greater yields than commercial fertilizer. Particularly the latter is a good method of improving less productive soils or sites within the field (Hernandez 2011).

Residue management and tillage

During tillage the soil gets aerated which leads to an enhanced microbial decomposition and erosion and thus to carbon emissions. Modern weed control methods permit to grow crop with reduced or no use of tillage (reduced or no-tillage). As consequence there is a cut in carbon emissions from soils and from energy-use. On the contrary these benefits may be redeemed by the increased use of herbicides which contributes to GHG emissions and also may have negative effects on biodiversity (Greenpeace 2008, p. 9). In addition, retaining residues in the soil improves soil fertility and supports water retention resulting in higher yields and high mitigation potential through increased soil carbon sequestration. An important trade-off however is the use of crop residue as animal feed. Further, in terms of weed management and potential water logging the positive effect of less tillage is undermined. Finally, avoiding burning of residues also eliminates emission of aerosols but may promote CO_2 emissions from fuel use (IPCC 2007, p.507).

All in all, residue management and reduced tillage tend to have high mitigation potential and at the same time positive effects on climate adaptation and food security due to improved soil fertility and water-holding capacity (IFPRI 2011, p. 3). However it seems to be unlikely to find a general, globally applicable approach for these practices. An important barrier is the risk of CO_2 and/or methane leakage as there is no peer-reviewed literature that adequately assesses the time CO_2 and/or methane can stay underground in no-tillage farming (Schroeder 2012). Until it is not clear to what extend reduced or no-tillage can reduce CO_2 and/or methane emissions in the long-term, there should preferably be a case-to-case basis to identify individual proceedings.

Water management

Water management can be classified into irrigation and drainage. Through improved irrigation and (seasonal) water harvesting technologies higher yields and a greater intensity of land use can be achieved. When systems are well designed and maintained this can reduce production variability and enhance climate resilience. Other indigenous water techniques include planting pits, micro-basins, raised-bed mounds, ridge and basin cultivation as well as basin irrigation. In areas where flooding is problematic yields can be increased though the diversion of ditches. In addition small-scale water storage, and drop irrigation can help to increase productivity of small farmers while at the same time

co-benefitting the environment. In the longer-term water management measures can help in adapting to a changing climate and hence support stable food security conditions (GTZ 2008, p. 23).

In terms of mitigation carbon storage and yields can be enhanced by increased or more effective irrigation in dry climate zones as more CO_2 can be sequestered and thus builds up more organic matter. Moreover, productivity is increased by drainage of cropland in humid regions. Both practices could support carbon storage but also may promote the loss of N_2O. Thus, the mitigation potential depends on several factors and ranges from low to high (IPCC 2007, p.508).

It also needs to be taken into consideration that water irrigation can have negative effects if operationalised in an unsound manner: First, there is the danger of salinisation of farmland, which will cause CO_2 emissions through reduced organic matter and loss of productivity, second there is the risk from excessive (water) abstraction, and third limited access to water might cause farmers to inappropriately use fossil water for irrigation. Furthermore, additional energy use due to irrigation might redeem the mitigation benefits through fossil fuel consumption, except where this energy is e.g. generated through renewable energies such as solar or wind water pumps.

Rice management

Methane emissions from rice growing under flooded conditions account with over 600 $MtCO_2e$/year (approx. 10 % of global agricultural GHG emissions per year) significantly to the biggest sources of agricultural emissions (FAO 2009, p. 26). A reduction in CH_4 emissions can be obtained by draining the rice one or several times during the growth period as the flooding and as a consequence thereof the absence of oxygen enhances the reproduction of anaerobic bacteria and thus the production of methane. The positive effect of draining is weakened by increased emissions of N_2O. During the seasons without rice growing an improved water management can be implemented with the aim to keep soils as dry as possible and preventing water logging. Besides, methane emissions can be cut by a better timing of residues addition (in the dry period rather than in flooded periods), by composting the residues before adding or by alternate wetting and drying technology, which at the same time significantly improves water use efficiency (Greenpeace 2008, p.34).

Agro-forestry

Agro-forestry is an approach of using the benefits from combining growing trees with crops and/or livestock. It combines agricultural and forestry technologies to create more diverse, productive, profitable, healthy, and sustainable land-use systems. Such combined systems increase soil carbon sequestration and reduce soil carbon losses from erosion. Further, through enhanced rainwater management and reduced erosion greater yields on adjacent cropland can be achieved. The improvement in soil conditions may induce both: an increase in yield as well as numerous benefits in terms of livelihood diversification, which in turn can also be beneficial for building resilience to climate change impacts (FAO 2009, p. 21).

Assessment of mitigation / adaptation potential and food security

In general the mitigation potentials, costs and yield increase of the practices described before depend on regional climatic conditions and therefore have to be evaluated adequately. Overall it can be estimated that there is an average mitigation potential of 0.33 – 3.93 Mt CO_2e/ha/year in tropical areas (South and Southeast Asia, Carribean, Latin and South America) and 0.62 – 5.36 Mt CO_2-eq /ha/year in warm dry regions (Africa, Latin and South America) (FAO 2009, p.23). The global technical mitigation potential of all GHG (CO_2, N_2O, CH_4) by 2030 for improved cropland management is estimated at almost 1,600 Mt CO_2-eq per year. The actual mitigation potential has to be considered as a function of mitigation costs which, in turn, depends on different climatic conditions and to a minor extent on local economic conditions such as labor costs. Thus, the average mitigation potential is estimated at 750 Mt CO_2-eq /year at a price level of up to 20 US$/t$CO_2$e. If the cost would rise up to 50 US$/t$CO_2$e, the mitigation potential would increase by approx. 150 Mt CO_2-eq /year. Consequently, improved cropland management is the practice implying the highest mitigation potential along all measures considered in this report (IPCC 2007, p.519). According to GTZ, about 15 percent of global cropland emissions can be avoided at no cost and 22 percent could be mitigated for less than 30 US$/t$CO_{2e}$, (GTZ 2008, p. 12).

As has been shown above, a number of practices tend to provide also adaptation benefits if applied in a manner that the current and expected impacts of climate variability and climate change are taken into account. The following table provides an indication of potential beneficial options, with more intense consideration required when a specific practice should be applied locally.

Activity	Mitigation potential	Adaptation	Productivity	
			short term	long term
Improved agricultural practices	High	+	↓	↑
Nutrient use	High	+	↑	↑
Residue management and tillage	High	+ (long-term) - (short term)	↓	↑
Water management	Low to high, depending on energy intensity/source of irrigation	+	↑	↑
Rice management	Medium to high	+	↑	↑

Agro-forestry	High	+	↓	↑
Mitigation cost in US$/tCO$_2$e	**Up to 20**		**20 to 50**	
Mitigation potential in MtCO$_{2e}$/year	**750**		**900**	

Sources: FAO 2009, Smith et al. 2008, IPCC 2007

4.2 Improved grazing land management/pasture improvements

Grazing intensity and rotational grazing

Carbon storage in soils is highly affected by the intensity and timing of grazing since carbon sequestration is often higher on optimally grazed lands than on ungrazed or overgrazed lands. Accordingly rotational grazing, whereby livestock is strategically moved to partitioned pasture areas, leads to increased carbon storage but also increased forage availability over the long term. Nevertheless, there is still no information on the effect of grazing intensity on emission of non-CO_2 gases, except for the direct influence on emissions from adjustment of livestock numbers (IPCC 2007, p.508). The best solution to encounter climate change is a "holistic" grazing management, containing grazing plans which are tailored to specific local conditions. Apart from the mitigation potential rotational grazing can lead to higher yields due to greater forage availability and quality in the long-term. This can enhance food security and also increase livestock productivity (Woodfine 2009, p. 36). In the short-term however it may have negative implications on the numbers of livestock supported.

Increased productivity

Similar to the above mentioned practices for cropland management there are multiple measures to improve the productivity of grazing land and hence to promote soil carbon storage. Adding fertilizer or organic amendments can increase forage return and thus improve soil carbon storage, although the production and use of nitrogen fertilizer could stimulate N_2O emissions and offset some positive effects. Similar impacts are considered for irrigating grasslands, an example of this are seasonally-flooded water meadows. This can support soil carbon sequestration but also has some negative effects due to energy use - if produced from fossil fuels - for irrigation (IPCC 2007, p.509). Besides, irrigation of large areas may have adverse impacts on food security, especially in dry regions. By irrigating extensively, the groundwater level could drop to such an extent that plant growth or even drinking water resources of surrounding areas could be endangered. This would undoubtedly result in maladaptation practices. With In regard to managing nutrients on grazing lands, caution needs to be

taken to the deposition of faeces and urine from livestock, as they are not as easily controlled nor as uniformly applied as nutritive amendments in croplands (Oenema et al., 2005).

Fire management

In order to renew the grass, it is common to burn grassland which releases GHGs, notably CH_4, as well as reactive hydrocarbons and nitrogen gases. The smoke from burning produces a range of aerosols which can have either warming or cooling effects. Besides, frequently burning of grassland often affects the fertility negatively. Eventually, the land may not recover which results in permanent loss of protective vegetation cover. Therefore, one mitigation action could be the reduction of the frequency or intensity of fires. Another action could optimise the timing of burnings, i.e. burning at a time of year when less CH_4 and N_2O are emitted. Reducing the frequency or intensity of fires typically leads to increased tree and shrub cover, resulting in a CO_2 sink in soil and biomass and apart from that in an improvement of quality and quantity of grazing (Greenpeace 2008, p. 33).

Species introduction

The introduction of new grass species as for example types with higher productivity, deep-rooted grasses or mixing grass with legumes can increase soil carbon. This is due to carbon allocation to deeper roots or enhanced productivity from the associated nitrogen inputs of legumes. However, the applicability of the results regarding soil carbon storage has not been widely confirmed yet (IPCC 2007, p.509).

Specific adaptation measures

In terms of improved pasture management the following modes of adaptation can be identified: decrease grazing pressure (limited number of livestock, less time spent on grazing land), extension of grazing land as well as improved know-how and better equipment. The latter refers to the exploration of remote zones, the assignment of grazing areas for different times/seasons, the preservation of reserve sectors during the rainy season and the use of fertiliser (night paddocks) in less-productive environment (Nettier et al. 2011).

Assessment of mitigation/ adaptation potential and food security

Improved grazing management has a very high technical mitigation potential of about 1,500 $MtCO_{2e}$/year. But it also seems to have quite high mitigation costs: for costs up to 20 US$/t CO_2-eq there is a rather lower economic mitigation potential of 150 $MtCO_2e$/year compared to the technical potential. This potential increases up to 400 $MtCO_2e$/year if mitigation costs raise up to 50 US$/$tCO_2e$. Nevertheless improved grazing management implies significant benefits in terms of adaptation to climate change and also increased productivity. Thus, for example, sustainable grazing management is already being used in Namibia, South Africa, the Northern Rangelands of Kenya and Ethiopia (IPCC 2007/ Woodfine 2009, p. 35).

Activity	Mitigation potential	Adaptation	Productivity	
			short term	long term
Grazing intensity and rotational grazing	Mid	+	↑	↑
Increased productivity (fertilization)	Low	+	↑	↑
Fire management	High	+	↑	↑
Species introduction	Cannot be generalized	Cannot be generalized	↑	↑
Mitigation cost in US$/tCO$_2$e	**Up to 20**		**20 to 50**	
Mitigation potential in MtCO$_2$e/year	**150**		**400**	

Sources: IPCC 2007, Woodfine 2009

4.3 Livestock management

The most important source of CH_4 in the agricultural sector is livestock such as cattle and sheep, respectively enteric fermentation. Additionally, livestock produces N_2O emissions from manure. However several mitigation practices targeting livestock are available. Among these are improved feeding practices, specific agents and dietary additives and long-term management changes (IPCC 2007, p. 510).

Improved feeding practices

By feeding more concentrates (normally replacing forage) which are usually low in crude fibre content and high in total digestible nutrients (e.g. cereals and grains like wheat, rice, barley, sorghum, maize, etc. and milling by-products), methane emissions can be reduced. Although daily emissions per animal may increase, there is a positive net result of emissions per kg-product, since animal numbers and slaughter-age can be reduced. In total, the net benefit depends on nitrogen content of the manure, likely land use changes and emissions from producing and transporting the concentrates. Some more measures related to feeding practices are adding certain oils or oilseeds to the diet, improving pasture quality (especially in less developed regions) and optimize protein feeding to reduce

nitrogen in manure. They all result in diversified sources of feed which, in turn, strengthens the resilience of livestock to changing climatic conditions (IPCC 2007, p.510).

Further, in regard to climate change adaptation higher livestock yields can be achieved through a diversification of livestock feeds as well as through improved diet supplements such as legumes. Further, through the adjustment of herd and water point management to altered seasonal and spatial patterns of forage production the resilience of livestock farms to climate change can be improved.

However in this context, it has to be considered whether the availability of the according food can be guaranteed especially with regards to climate change. Moreover, the implementation of improved feeding practices strongly depends on the farmers' income, since supplemental feed for example is cost-intensive and thus smallholders often lack the capital to realize such practices (Woodfine, p. 40). It is also important to consider what end result farmers are actually aiming for? Do they want their livestock to be resilient to climate change or are they looking for gains in weight? While farmers in South America are might want their cattle to grow quicker, people in Asian highlands rather want their livestock to make it through an icy winters or dry summers?

Specific agents and dietary additives

In many developing countries, mainly in Africa and South Asia, most ruminants get a very fibrous diet. By adding specific agents and dietary additives to the food, livestock will produce more milk and meat per animal. Thus the improvement of nutrition has some positive impacts on production and consequently on emissions per-kg of animal product. These improvements are very easy to achieve regarding technical aspects. But currently, most of livestock producers in developing countries are lacking of capital as well as knowledge for applying such techniques. Apart from the emissions benefits, an increase of livestock productivity enhances food security and potentially provides extra income from milk and/or meat (Woodfine 2009).

Longer-term management changes and animal breeding

Further possibilities for increasing productivity of livestock are breeding and better management practices, e.g. extending the period between calving in dairy cows and altering the composition of livestock holding (e.g. raising the number of non-ruminants). The breeding of new locally adapted livestock breeds and species can also strengthen their ability to withstand increasing changes in climatic conditions (both with regard to extreme events as well as slow-onset processes).climate extremes. By improving the efficiency due to breeding, animals producing meat reach slaughter weight at a younger age. As a result lifetime emissions of these animals are reduced. Nevertheless, these measures do not always lead to a decrease in emissions as for example in dairy cattle intensive selection for higher yield may reduce fertility requiring more animals in the cattle (Woodfine 2009, p. 40).

Stocking

Destocking, the matching of stocking rates with pasture production or the effective use of silage are three other methods to increase the resilience to climate change, particularly when forage availability is a key factor in livestock output (Howden et al. 2008, Nardone et al. 2010). However, potentially increasing production per unit of livestock in the long-term may initially decline in the short-term, as the total amount of livestock is decreased.

Health management

To improve livestock health, integrated pest management, the provision of veterinary services, and the sanitation of canals and treatment of animals is also advisable as it can significantly reduce the livestock's susceptibility for diseases such as liver fluke. To avoid large outbreaks in the future the identification, monitoring as well as documentation of the spread of pests and pest activities are also central.

Assessment of mitigation/ adaptation potential and food security

Considering the evaluation carried out by the IPCC, a reduction of about 100 $MtCO_2e$/year could be achieved applying mitigation costs up to 20 US$/$tCO_2e$ for livestock management. If mitigation costs climb up to 50 US$/$tCO_2e$, the mitigation potential does not change significantly (150 $MtCO_2e$/year) (IPCC 2007, p. 519).

Activity	**Mitigation potential**	**Adaptation**	**Productivity**	
			short term	long term
Improved feeding practices	Mid	+	↑	↑
Specific agents and dietary additives	Unknown	+	↑	↑
Longer-term management/ animal breeding	High	+	↑	↑
Mitigation cost in US$/$tCO_2e$	**Up to 20**		**20 to 50**	
Mitigation potential in $MtCO_2e$/year	**100**		**150**	

4.4 Manure management

If animal manure is stored, especially in liquid form, significant amounts of CH_4 and N_2O are emitted, but the extent of these emissions varies. When storing the manure in tanks or lagoons, methane emissions can be diminished by cooling, use of solid covers, mechanically separation of solid and sludge or by capturing the emitted methane. Optimally, manure is anaerobic treated with a subsequent utilization of produced biogas. By composting manures and thus handling it in solid form, CH_4 emissions can be suppressed with the negative effect of increased N_2O formation. Also a fast output of manure to croplands may mitigate nitrogen emissions and restore soil fertility which leads to increasing crop yield and food security. Finally, CH_4 and N_2O emissions of manure can be partially influenced by altering feeding practices: Manure containing a lot of nitrogen will emit more methane than manure with lower nitrogen contents. Accordingly increasing the C:N ratio in feeds will reduce nitrogen emissions from cattle in all types of management systems (IPCC 2007, p. 510).

Assessment of mitigation/ adaptation potential and food security

According to the IPCC, the technical mitigation potential of manure management lies at a level of 50 $MtCO_{2e}$/year. The economic potential at mitigation costs of up to 20 US$/$tCO_2$ would meet a mitigation potential of about 10 $MtCO_2e$/year which is doubled (20 $MtCO_2e$/year) if mitigation costs rise up to 50 US$/$tCO_2$. Compared to current emissions from manure of approx. 413 $MtCO_2e$/year, the overall mitigation potential of manure management does not seem very high. But improved manure management and in this context the spreading of manure on the fields, will certainly increase soil fertility having some positive impacts on food security (IPCC 2007/ Woodfine 2009, p. 41).

Activity	Mitigation potential	Adaptation	Productivity	
			short term	long term
Manure management	Low	+	↑	↑
Mitigation cost in US$/$tCO_2e$	**Up to 20**		**20 to 50**	
Mitigation potential in $MtCO_2e$/year	**10**		**20**	

Source: IPCC 2007

4.5 Fossil fuel reduction

Apart from emissions of soil and livestock management, agriculture also contributes to GHG emissions through fossil fuel use in farm operations, the production of agrochemicals and the

conversion of land. Greenpeace estimates the total amount of indirect emissions from fertilizer production, farm machinery and irrigation systems at approx. 940 $MtCO_2e$/year which roughly meets the annual GHG emissions of Germany in 2010 (Greenpeace 2008, p. 7).
In terms of irrigation there can be made a distinction between surface irrigation that does not require energy to pump water and hence emits no CO_2 and irrigation using pumps (Foucherot and Belassen 2011, p. 33). If irrigation pumps are applied in agricultural systems, most of them are operated with diesel or electricity emitting approx. 369 $MtCO_2e$/year (Greenpeace 2008, p. 7). In order to reduce CO_2 emissions due to fuel consumption efficient water pumps or renewable energies could be utilised. Thus, pumps could be run with photovoltaic or wind power which avoid CO_2 emissions and additionally overcome problems regarding the lack of rural grid connection. But as from the farmers' perspectives the costs for such systems are often very high compared to conventional irrigation systems acquisitions cost are a key barrier to the implementation of efficient water pumps (Pallav 2005, p. 4).

Considering agrochemicals the production of one tonne of nitrogen fertilizers uses 1-1.5 tonnes of fossil fuel. Consequently, using organic fertilizers such as manure, legumes and other natural sources of nitrogen could avoid not only direct emissions from nitrogen in soil but also CO_2 emissions from fertilizer production (FAO 2007, p. 10). But as the allocation of indirect emissions from upstream processes is usually not determined, the mitigation potential of fertilizer production has to be considered carefully and depends on the individual methodology and project boundaries. Nevertheless, it definitely contributes to GHG emissions and therefore should be considered in the future.

Furthermore, in order to substitute fossil fuel, residues and manure can directly combusted or be used to gain biogas and transform it to electrical and/or thermal energy for heat and/or electricity generation. By replacing fossil fuel with biogas , CO_2 emissions are mitigated which otherwise would have come from fossil fuel. What has to be considered in the calculation of the net benefit are GHG emissions deriving from growing and processing the bioenergy feedstock (GTZ 2008). Besides, it is still uncertain how fast, to what extent and how efficient such techniques can be realized in developing countries (IPCC 2007, p. 511).

Finally, some emission reductions can be achieved by the implementation of adequate management practices which have already been mentioned before, like for example reduced or no-tillage. Reducing tillage also means a reduction in machinery and tractor use and therefore has a minor mitigation potential.

Assessment of mitigation/ adaptation potential and food security

The evaluation of mitigation potential and costs considering fossil fuel displacement seems to be very complex due to several interactions between management practices, technology applied and emissions of upstream processes. However, according to Smith et al. (2008, p. 807) the overall technical mitigation potential of improved energy efficiency in agriculture is estimated at 770 $MtCO_2e$/

year by 2030. Experience also shows that multiple low- or zero-emission technologies exist which can provide benefits for adaptation. However, at the core is the adaptation technology as such, and when it can be provided e.g. with renewable energy solutions such as solar or wind than there is a synergetic potential. The case of bioenergy is of course more complex, since large-scale exploitation of bioenergy resources as a means to reduce fossil fuel emissions on the consumption side (e.g. for fuelling cars) may in some calculations reduce emissions but can of course undermine ecosystem and agriculture system sustainability contributing to maladaptation. However, this cannot be elaborated here more in detail (see also 4.6).

Activity	**Mitigation potential**	**Adaptation**	**Productivity/ Food security**	
			short term	long term
Fossil fuel reduction	High	+	↓	Depending on interaction of mgmt. practises and applied technology
Mitigation cost in US$/$tCO_2e$	**Unknown**			
Mitigation potential in tCO_2e/year	**Up to 770**			

Source: GTZ 2008

4.6 Carbon sinks and the issue of land conversion

There is a tremendous potential for reducing carbon emissions by restoring, protecting and conserving soils in agricultural systems. Thus, increasing carbon sequestration by land conversion is highly required to mitigate emissions and adapt to climate change (FAO 2009, p.5).

According to a study carried out by Greenpeace International, croplands contain the lowest concentration of soil carbon apart from deserts and semi deserts. By converting cropland to grassland or forest, soil disturbance (tillage) and carbon removal (harvesting) are reduced while carbon sequestration (plant growth) is increased. Hence, the conversion of cropland into another land cover (most suitable are land covers which are similar to the native one), has the greatest effects on emission reductions respectively the establishment of carbon sinks. An even greater effect has the conversion of former wetlands which have been drained for crop-growing back into wetlands, but may also stimulate methane emissions due to water logging.

But also the conservation of current natural vegetation shows high mitigation potentials, as for example land use change from natural land cover to cropland contributes by approx. 20 % to global anthropogenic emissions. Mangroves for example build a coastal buffer and are able to lower impacts of rising sea levels and increasing storms and in this why are helping to adapt to climate change (Greenpeace 2008, p. 32). Preserving or restoring mangroves can therefore be an important and effective adaptation measure (Tri et al. 1998). But otherwise, land conversion can have significant trade-offs regarding food security since converting cropland into another non-arable land also means a reduction in yields. Consequently, such measures should be considered for areas which are not threatened by food insecurity (Woodfine 2009, p. 52).

Assessment of mitigation/ adaptation potential and food security

Generally activities that create carbon sinks through land conversion or restoration of degraded land are not actively linked to agricultural activities – with the exception of replacing agriculture. Therefore we do not focus on such activities within the following chapters of this report. When calculating potential emission reductions of land conversion one has to properly consider the balance between the benefits (e.g. in terms of carbon sequestration) and release of other emissions (CH_4), particularly for wetlands. Further, the establishment of carbon sinks by restoring land can have fundamental impacts on climate adaptation but also some severe influences on food security (Woodfine 2009, p. 52). Whether this has positive or negative implications largely depends on the adaptedness of the ecosystems as well as on the approaches applied.

Activity	**Mitigation potential**	**Adaptation**	**Productivity/ Food security**	
			short term	long term
Land conversion	High	Depends	↓	↓
Mitigation cost in US$/t$CO_2$e	**Up to 20**		**Up to 50**	
Mitigation potential in MtCO_2e/year	**100**		**350**	

Source: Woodfine 2008, IPCC 2007

4.7 Conservation agriculture

Conservation Agriculture (CA), an expression used by the FAO, is a term encompassing farming practices which have three key characteristics: (1) minimal mechanical soil disturbance (i.e. no tillage and direct seeding), (2) maintenance of a mulch of carbon-rich organic matter covering and feeding the soil (e.g. straw and/or other crop residues including cover crops) and (3) rotations or sequences

and associations of crops including trees which could include nitrogen-fixing legumes (FAO 2010a). There are a number of less strict tillage regimes that find wide acceptance and basically use the same concept , e.g. in the United States and Brazil.

Conservation Agriculture contributes to adaptation to climate change by reducing crop vulnerability. The protective soil cover of leaves, stems and stalks from the previous crop shields the soil surface from heat, wind and rain, keeps the soil cooler and reduces moisture losses by evaporation. In drier conditions, it reduces crop water requirements, makes better use of soil water and facilitates deeper rooting of crops; in extremely wet conditions, CA facilitates rain water infiltration, reducing soil erosion and the risk of downstream flooding. Conservation Agriculture also contributes to protect crops from extreme temperatures. Crop rotation over several seasons also minimises the outbreak of pests and diseases (FAO 2010b).

4.8 Synthesis of agricultural mitigation options

As a conclusion we highlight the main results regarding mitigation and adaptation potentials in the agricultural sector. First we demonstrate why methane emission reduction should be focused under consideration of time pressure to mitigate GHG releases substantially until 2020. Second we focus on mitigation and adaptation measures with highest mid to long-term efficiency: improved cropland management.

4.8.1 Methane avoidance as a short term solution for successful mitigation?

Due to the closing window of opportunity for successfully reaching a two degree path – total emission peaking needs to be reached before 2020 according to the United Nations Environment Programme (UNEP) (Alcamo et al. 2010, p.12) - some experts highlight the importance of focusing on the short-term GHGs, most notably methane. Watson and El-Ashry argued that “we need to get moving to cool the planet's temperature. Methane is the most effective place for us to start.” (Watson and El-Ashry 2009). Such approach would directly aim on agriculture as it is responsible for about 50% of global methane emissions. Depending on the individual abatement costs for reducing agricultural methane emissions it might be a favourable approach to intensify the debate about short-term solutions in the context of the agricultural sector. Besides manure management and avoidance of methane production from biomass decay especially rice farming and livestock management have significant mitigation potential while also offering synergies with adaptation and food security. For instance improving rice cultivation through the introduction of a controlled irrigation system can reduce methane emissions which are significantly higher when continuous irrigation/flooding occurs. In terms of adaptation this reduces water demand and safeguards food security as a reduction of irrigation water by 16-35% does not decrease yields. Of course this should not come on the expense of initiatives which try to reduce

CO_2 emissions e.g. by avoiding harmful land conversion activities. Regarding livestock, improved feeding practices provide synergies for both mitigation and adaptation.

4.8.2 Improved cropland management for efficient long-term carbon storage

Chapter 4.1 assessed the mitigation potential of improved cropland management practices to 700 Mt CO_2-eq/year at a price level up to 20 USD/t. This equals roughly the combined annual GHG emissions of France and Spain in 2009. Worthwhile to note, most practices that increase the soil carbon sequestration also have significant positive long-term effects on climate change adaptation and food security as they improve soil conditions. However the short-term and sometimes mid-term impact on productivity is often negative for activities such as reduced tillage, improved agricultural practices or agroforestry. Both the international funding instrument and the national/local gatekeeper institution (see chapter 9) would have to provide solutions mitigating decreased yields in the short-term.

5 International funding opportunities

Based on the review of agricultural mitigation activities this study assesses what project types have been applied in the context of international climate change financial assistance. We analysed common sources of funding such as international funds administered by multilateral organisations and other UNFCCC instruments, e.g. Nationally Appropriate Mitigation Actions (NAMAs). Furthermore we evaluated the suitability of carbon markets for (co-)financing of agricultural mitigation activities. With regard to adaptation, focus was laid on the three multilateral funds Adaptation Fund (AF), Least Developed Countries Fund (LDCF) and the Pilot Programme for Climate Resilience (PPCR) and the agriculture-related projects that have been approved. The particular advantage of these international funds compared to e.g. bilateral activities is the availability of standardised information regarding the specific projects. This does of course not mean that activities e.g. of bilateral agencies may not leverage important lessons learnt. The section is concluded by an outlook what one can expect from new post-2012 instruments such as the Green Climate Fund (GCF) or sectoral mechanisms.
Despite the fact that some agricultural activities received funding already, some project types are excluded yet. These shortcomings will be identified and approaches for reforms or adjustments are developed in order to enable climate compatible activities access to funding. This key chapter also interrelates with the second main chapter dealing with adaptation shortcomings (see also 10).

5.1 Overview of agricultural mitigation funding

5.1.1 The carbon market

International carbon markets have been established both under and outside of the Kyoto (see Figure 4). The flexible Kyoto mechanisms offer most notably the Clean Development Mechanism and Joint Implementation (JI). As JI has mostly relevance for economies in transition but these countries are hardly challenged by food insecurity, we focus on the CDM.

Outside Kyoto, several other carbon market mechanisms evolved within the last decade. Among these are voluntary systems such as Verified Carbon Standard (VCS), the Alberta Protocol (AP), the Climate Action Reserve (CAR), the American Carbon Registry (ACR) or the Carbon Farming Initiative (CFI) in Australia. Even though most of these schemes have not achieved substantial investments and emission reductions yet, some offer innovative concepts and methodologies for the agricultural sector. Finally we also outline the upcoming Bilateral Offset Crediting Mechanism (BOCM), established by the Japanese Government. It will be operational within the next year and partly targets agricultural activities.

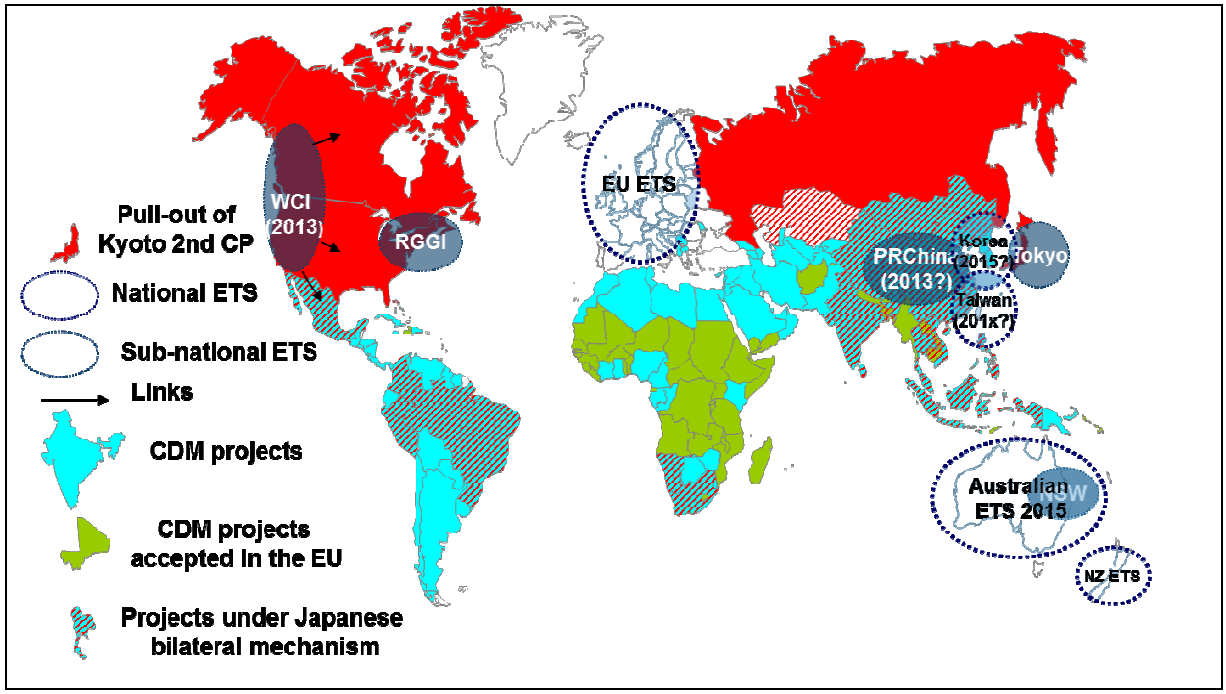
We briefly analyse suitable methodologies, registered and implemented projects, achieved emission reductions and future potential, MRV requirements and environmental integrity of agricultural mitigation measures for all schemes. The assessment will summarize the schemes' overall suitability for promoting mitigation in the agricultural sector of developing countries while having a potential to improve food security.

It has to be noted that certain structural parameters apparent in many developing countries may lead to adverse effects with regard to carbon markets as this has in part been the case in past CDM projects. Among these might be difficulties for smallholder farmers to monetarily benefit from such schemes, which can lead to potential intensification of structural marginalisation in the market or imbalance regarding co-benefits beyond GHG mitigation. Further, opening up carbon markets to the agricultural sector might also clear the way for including methodologies such as biochar sequestration and genetically modified crops, which both bear a risk with regard to social and environmental integrity (Jha 2012). In addition, a number of publications (e.g. Gaia Foundation 2011, African Biodiversity Network et al. 2011, PAIRVI 2012, PCFS 2012) have outlined potential negative impacts of including the agricultural sector into the carbon markets.

Also, carbon markets can only provide a substantial environmental benefit if the mitigation ambition in developed countries which drives the carbon price is adequate compared to the global needs – which is currently not the case. Even though we provide recommendations to avoid, mitigate and solve such challenges in chapter 10.1, the whole picture cannot be addressed here in detail.

Apart from these very important aspects we assume that the development and application of certain elements used in the carbon market - such as methodologies for assessing mitigation benefits - can provide important lessons learned for a variety of funding approaches within and outside carbon markets.

Figure 4: Geographic overview of international and domestic carbon markets (including envisaged schemes)



Explanation of abbreviations: EU ETS: EU Emission Trading System; WCI: Western Climate Initiative; RGGI: Regional Greenhouse Gas Initiative; NSW: New South Wales ETS; NZ ETS: New Zealand Emission Trading System; Kyoto 2nd CP: Second Commitment Period of the Kyoto Protocol

5.1.1.1 Clean Development Mechanism

The CDM is both in terms of investments and volume of credit supply by far the largest international carbon market covering developing countries. More than 5,600 registered projects have mitigated about 1,155 Mt CO_2-eq until end of 2012 (see CDM Highlights 2013). In its function as an offset scheme, the generated Certified Emission Reductions (CERs) may be used by industrialized, "Annex-B" countries that have signed the Kyoto protocol for compliance of their emission commitments. The EU-ETS is the main market currently purchasing most credits. Due to the low carbon price of European Emission Allowances (EUAs) primarily as a consequence of low-ambition mitigation targets of the EU and less demand because of the recent economic crisis, the global CER price has also dropped to a very low level of less than 0.5 EUR/CER in June 2012. According to Thomson Reuters this price level might increase to an average value of about 7.5 EUR in the period until 2020 (see Thomson Reuters 2012). Depending on the individual price levels of the agricultural mitigation activities assessed above, several project types could be covered by the CDM.

So far, the CDM Executive Board has approved 8 methodologies in the agricultural and related sectors, three of them covering methane avoidance. These small and large-scale methodologies have

been applied by more than 90 registered projects. Furthermore about 160 registered activities make use of two methodologies tackling manure management and biogas production. Overall they have reduced about 0.75 Mt CO_2-eq until mid of 2012. One approach for improved cropland management, improved rice production management and for fertilizer avoidance has triggered further mitigation activities. Two additional methodologies for CH_4 reduction through ruminant feed supplement in the dairy cattle sector and N_2O mitigation by use of natural nitrification inhibitors are under elaboration and not approved yet (see also Annex 1).

Despite the fact that the CDM has covered the manure management and biomass decay/methane avoidance sector through established methodologies and implemented project activities successfully, the rest of agricultural mitigation potential is almost untapped. Mostly the complex procedures and substantial transaction costs for smaller projects play a role while several mitigation activities might also lead to decreased short- and even long-term yields, such as improved agricultural practices, tillage, reduced fossil fuel consumption or land conversion (see chapter 4). Furthermore smallholders have only limited potential to participate individually as their particular emissions are comparably small. For example a soil carbon management comprising 50 kt $CO_{2\text{-eq}}$ annually, which would be at the lower end of profitability, requires an area of 25 thousand hectares. Such project might involve thousands of farmers that require coordination and that have no knowledge about and access to the methodological nitty-gritties of the CDM.

Hereby new methodological opportunities like Standardized Baselines (SBL) and Programme of Activities (PoAs) offer potential for additional project types, in particular for small-scale ones. So far only 4 PoAs have been registered under the methodologies described above: 1 in China, Brazil, Uganda and Indonesia each. About 30 further PoAs mainly in the methane recovery and methane avoidance sector are at validation. The requirements for successful validation and registration are even more complex than standard CDM hence a coordinated approach for the application of such schemes will be necessary. Hereby the envisaged gatekeeper institution (see chapter 9) might play a central role enabling broader applicability of the CDM in the agricultural sector and overcoming the market entry barrier for smallholders.

5.1.1.2 Joint Implementation

Joint Implementation (JI) is the second flexible mechanism under the Kyoto protocol besides the CDM. It enables projects in industrialized, Annex-B countries. Hence the system itself is not applicable for developing countries however one can learn from some applied project types and methodologies that create JI credits, so called Emission Reduction Units (ERUs), for the carbon market.
Besides activities built on some of the CDM methodologies described in the chapter above, JI also offers two additional approaches elaborated by French project developers:

- N_2O emission reduction through denitrification of agricultural soils with legumes insertion in agricultural rotation
- Methane avoidance through feeding additives for dairy cattle

The N_2O methodology covers a similar approach than the CDM AMS-III.A about fertilizer avoidance. The second methodology is comparable to one of the not-approved CDM methodologies under development. As the requirements for approval/registration of JI-project methodologies are not as strict as under the CDM it is doubtful whether these approaches would be applicable in the CDM framework.

5.1.1.3 Voluntary schemes and non-Kyoto carbon markets

Besides the flexible mechanisms of the Kyoto Protocol several voluntary and regional offsetting schemes have been implemented the last years. Some of them also cover agricultural mitigation activities:

- **The Verified Carbon Standard (VCS)**

  Under the VCS scheme developers particularly make use of CDM/JI methodologies but also create own approaches. For instance, an approach for sustainable agriculture and land management is already available and three methodologies covering improved grassland management are under elaboration. Currently the VCS scheme mainly covers waste handling/methane recovery projects in industrialized countries (that are not eligible to participate in the CDM) and emerging economies like Brazil or Thailand that likely faced additionality challenges under the CDM (see also VCS 2012).

- **American Carbon Registry (ACR), Alberta Protocol (AP) and Climate Action Reserve (CAR)**

  The three North American offsetting schemes ACR, AP and CAR issue verified offset credits. For agricultural activities, several methodologies complementary to the CDM are available. Among these are a methodology for tillage management systems improving cropland management with more than 60 registered projects, and five livestock feeding approaches under the Alberta Protocol. Even though these livestock methodologies, mainly focusing on cattle feeding procedures, have no registered projects yet, the CDM might get inspired from the innovative approaches. ACR provides one fertilizer management methodology and CAR one manure management and one improved rice production approach. Under the CAR methodology “US & Mexico livestock project protocol” a significant amount of 79 projects have been registered.

5.1.1.4 Japanese Bilateral Offset Crediting Mechanism (BOCM)

Even though international recognition for the Japanese BOCM under the UNFCCC is still pending, the government has already signed bilateral agreements with dozens of countries and more than 100 feasibility studies have been conducted. The mechanism particularly focuses on potential so far not tapped by other schemes as the CDM. Eligible project types are expected to be e.g. energy efficiency, transport, avoided deforestation, likely nuclear and agriculture. The latter has been investigated in e.g. Indonesia with a feasibility study on "Avoidance of Peat Aerobic Degradation by Peatland Rewetting and Rice Husk-based Power Generation Associated with Rice Production Increase in Jambi Province" (see METI 2012). Two further feasibilities for "abatement of N_2O emissions from pig excreta by utilizing low-protein feed" and "conversion of disposal management system for livestock excreta" are under elaboration. Final requirements and criteria for the BOCM project types are not completed yet. However as the scheme shall start in 2013 we expect the first applicable approaches at the end of 2012.

Overall Japan might have a tremendous offsetting demand that shall be primarily covered through BOCM due to lack of domestic mitigation progress. GHG emissions in 2010 have been on a similar level as in 1990 hence Japan mainly fulfils its Kyoto target already through offsets (see Japan 2011, p.5). Its Copenhagen target of a 25% emission reduction until 2020 will be unlikely achieved domestically only, in particular under consideration that the nuclear power plant park has been shut down after the Fukushima accident in early 2011. Even though increasing discussions on policy support schemes to boost renewable energies may have a positive impact on fulfilling parts of the pledges domestically, there will likely be demand for BOCM credits.

A positive element of BOCM regarding a climate-compatible development integrating mitigation, adaptation and food security might be that the methodologies for the BOCM project activities will be developed cooperatively by the host country and Japan and therefore can include tailor-made, individual and innovative characteristics. Hence if the host country focuses on food security, such elements can easily be included into the methodology. This provides opportunities to test new approaches. Therefore we recommend that developing countries follow the further emergence of the BOCM scheme and test waters as soon as suitable opportunities that combine mitigation and food security seem to be available. At the same time it has to be ensured that the bottom-up nature of these approaches does not undermine the environmental integrity of the whole system. Therefore it is important that results of such collaboration comply at least with minimum standards of international recognition under the UNFCCC.

5.1.1.5 Australian Carbon Farming Initiative

The Australian Carbon Farming Initiative (CFI) is a domestic scheme generating offsets for the Australian Emission Trading System established in 2011 and operational since July 2012. It focuses on agricultural activities and reforestation in Australia only. However the developed methodologies might be useful for mitigation in the agricultural sector worldwide.

So far four methodologies have been approved and eight are under consideration. Several of the proposed activities have not been covered by other carbon market instruments so far. Among these are innovative approaches such as a "measurement-based methodology for farm forestry projects" (see Government of Australia, p.7ff).

The Australian government distinguishes between Kyoto and non-Kyoto CFI credits. The first are compatible to UNFCCC requirements and can therefore be traded internationally. Australia may potentially allow credits that fulfil the eligibility criteria and validation and verification requirements from outside Australia. This would offer possibilities for developing countries to generate such CFI credits and sell them to Australian businesses or the Australian government. The non-Kyoto CFI methodologies might inspire project developers worldwide to elaborate similar UNFCCC compatible approaches. Governments and/or gatekeeper institutions should follow the development of the Australian CFI and see whether Australian policy makers decide to acquire internationally generated agricultural credits, most likely CERs, within the Australian trading scheme. Precondition in this case would be the transformation of CFI methodologies into CDM methodologies.

5.1.2 Carbon funds

Since the foundation of the UNFCCC in 1992 several funds with the objective of reducing GHG emissions have been established. Most of them are tapping mitigation potentials in the energy sector however some of them also fund reduction projects in the agricultural sector. Among these are:

Table 1: Overview of carbon funds

Fund title	Main focus	Financial volume, maximal support and lifetime
The World Banks' BioCarbon Fund	Based on a public/private partnership model which aims to deliver cost-effective emission reduction and support biodiversity conservation and poverty alleviation. The concept is to promote methodology development and purchase CDM credits from Afforestation, Reforestation, REDD, Agriculture projects.	The BioCarbon Fund consists of two Tranches with two parallel Windows, with a total capital of $90.4 million.

Fund title	Main focus	Financial volume, maximal support and lifetime
International Climate Protection Initiative (ICI) of Germany	- promoting a climate-friendly economy, - promoting measures for adaptation to the impacts of climate change and - conserving biodiversity with climate relevance (carbon sinks, especially of forests and other ecosystems such as wetlands).	The initiative has been working since 2008, is still ongoing and disburses annual funds of 120 million Euros. All projects run one to five years. Financial support is usually between € 500,000-€ 2,500,000 per project.
GEF Small grants programme Climate Change	Removal of barriers to energy efficiency and energy conservation; promoting the adoption of renewable energy by removing barriers and reducing implementation costs; conservation and restoration of arid and semi-arid areas; efficient stoves and biogas to reduce forest loss; integrated watershed management; soil conservation; afforestation; prevention of forest fires; and organic farming.	The maximum grant amount per project is US$50,000, but averages around US$20,000. Grants are channelled directly to Community Based Organisations (CBOs) and NGOs.
ECO Enterprises Fund (Nature Conservancy and InterAmerican Development Bank)	Works mainly in Latin America and the Caribbean. Invest in small and growing environmentally- and socially-responsible ventures in sustainable agriculture (including apiculture, aquaculture and community-based energy), sustainable forestry, ecotourism and non-timber forest products, as well as carbon, biodiversity offsets and climate change mitigation and adaptation. Investee companies must be incorporated commercial entities that employ sound environmental and social practices in their operations, provide positive benefits to communities, and meet rigorous environmental, social, and financial criteria.	Investment size ranges from $500,000 to $3 million, with an average investment of $2.5 million.
Carbon Farming Initiative non-Kyoto carbon fund	The ongoing Australian Carbon Farming Initiative non-Kyoto Carbon Fund will increase incentives for activities that are not counted towards Australia's emissions target under current international carbon accounting rules. These include soil carbon, revegetation and cessation of logging in native forests.	Funding of $250 million over six years will be available from 2012–13. The Carbon Farming Initiative non-Kyoto carbon fund will be administered by the Department of Climate Change and Energy Efficiency and will commence in July 2013.

Source: Table demonstrates a selection of funds, based on FAO 2010 and World Bank 2010

The overview of selected funds shows that there are several opportunities for financing agricultural mitigation activities. However the scarce resources within the funding institutions are not exclusively for agriculture; a significant share of resources has been disbursed for other project types. **Generally**

agriculture is rather a niche than a focus. This of course challenges funding in the context of agriculture, especially as direct access to the resources is the exemption. Only the GEF small grants program offers such direct transfer of finance, the other four funds are rather indirect sources that need an accredited implementing institution as an intermediary. Hereby farmers or the gatekeeper (see Chapter 9) would need to install/win the implementing institution before finance could be transferred.

5.1.3 Nationally Appropriate Mitigation Action under the UNFCCC

Since its foundation in 1992, the UNFCCC has established several instruments to promote mitigation activities in developing countries. Besides the flexible instruments CDM and JI under the Kyoto protocol, outlined in chapter 5.1.1, the UNFCCC has introduced the concept of Nationally Appropriate Mitigation Measures (NAMAs) that allows individual policies to enable emission reduction activities. Hereby developing countries can choose appropriate sectors and several have identified agriculture to be suitable for NAMAs.

Generally the UNFCCC has defined two different concepts of NAMAs: Unilateral NAMAs that are developed and implemented by the country without assistance from the international community and supported NAMAs that require international finance, technology or capacity support. According to country submissions under the Copenhagen Accord and the Cancún Agreements there exist an unverified number of more than hundred unilateral NAMAs, many of them in early developing stages (see UNFCCC 2011a). About 50 NAMAs are seeking international support so far (see Ecofys 2012). Among both approaches we identified NAMAs targeting the agricultural sector (for a full list see also: Annex II). In the following we will list the furthest developed ones as well as concepts that complement the carbon market and fund priorities listed above:

- **NAMA in the Costa Rican coffee sector (supported NAMA):** Costa Rica's coffee sector is responsible for a majority of the countries fertilizer induced GHG that constitute for 20% of the countries emissions. The objective is a reduction of GHG emissions of the agricultural sector by up to 15% through the implementation of GHG mitigation technologies in coffee production and processing. The Costa Rican Coffee Institute organises about 50,000 producer families (smallholders), such institution might be suitable to act as a gatekeeper institution. In 2020 the project proponent expects annual GHG emission reductions of about 0.5 $MtCO_2$-eq.

- **Sustainable peat land management in Indonesia (supported NAMA):** The objective is to raise the water table in the peat layer by installing water gates and improved management of existing water gates in order to inhibit aerobic decomposition of peat and thus limit carbon dioxide emissions. Worthwhile notice, an envisaged co-benefit of the NAMA will be increased food security through additional crop yields as a result of improved farmland management. Total costs are estimated to 15 million USD.

- **Eritrea (unilateral NAMA):** Develop and elaborate appropriate and integrated plans which are supportive of both adaptation and mitigation actions for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas affected by drought and desertification, as well as floods.

Besides these NAMA examples, up to 40 additional unilateral NAMA concepts exist in the agricultural sector in more than 15 countries. These approaches cover a broad range of activities outlined in chapter 4 such as no-tillage farming (Brazil), promotion of nitrogen-fixing species or improved farming seeds (Central African Republic), implementation of agro-forestry systems (Ethiopia), uncontrolled burning practises (Ghana) or irrigation efficiency (Indonesia). Hence the approaches are going beyond the activities enabled through the carbon market and carbon funds. However almost all NAMA concepts are in an early stage and lack secured funding from both national and international sources. Furthermore just a rudimentary framework regarding NAMAs has been approved by the COP yet. This means that details regarding e.g. MRV are not precisely defined so far. As a consequence not a single supported NAMA has yet been implemented; unilateral NAMAs are also not formally registered by the UNFCCC. Nevertheless the international community considers flexible NAMAs as potentially powerful instruments to trigger international mitigation cooperation in developing countries. NAMAs are also expected to play a decisive role in enabling agricultural mitigation activities in future. The bottleneck will be the availability of substantial funding for large-scale implementation of the various concepts that have been developed so far.

5.1.4 Bilateral development cooperation

Bilateral development cooperation running not under dedicated climate funds already plays an important role in addressing climate-related aspects in areas relevant to food security. Obtaining an overview of the activities here is however much more difficult than in the case of specific climate funds (multilateral and bilateral) and the carbon market. The OECD climate markers have been an attempt to "mark" projects which are seen as having their principal or at least significant objective in addressing climate change mitigation and adaptation (see OECD, 2012). Recent research suggests that the credibility of the application of markers by donor countries has its clear limitations (see Michaelowa and Michaelowa, 2010; Junghans and Harmeling, 2012) and that there is the significant risk of over-coding. While these limitations need to be addressed, however, the figures reported will increasingly play an important role in the climate-finance debate because of its overall size. For example, the OECD reports that donors committed more than US$ 20 billion in 2010 for climate-related activities. A more substantive debate of the pros and cons of the climate markers cannot be undertaken here. However, it is useful to see that a substantial share of the projects contained in the OECD database are assigned to the agricultural sector. According to the OECD Rio Marker on climate change, Official Development Assistance (ODA) aid in the agricultural sector was at 175,4 million USD

in 2009. While this share sounds fairly low, the OECD reports that overall spending on agriculture was much higher, 7,8 billion USD, when not only considering agricultural development in response to climate change but all ODA.

While the information available on the projects is very limited and does not allow for a more substantive analysis of the methodologies and assessment of the mitigation potential, they show options which may address food security and climate concerns at the same time.

5.1.5 New post-2012 opportunities

Currently international climate negotiations under the UNFCCC involve the discussion about new mitigation schemes that shall be established within the next years. They are historically based on the Bali road map and are negotiated under the Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-*LCA*). COP17 has agreed on a framework to establish a new market mechanism (NMM) and also non-market mechanisms (see UNFCCC 2012c). Currently only a couple of very general characteristics have been defined for the NMM, such as avoided double counting or MRV requirements. More details are formally due at COP18. The EU tries to promote sectoral trading and sectoral crediting. Hereby developing countries' sectors that stay "significantly below" Business-as-Usual thresholds would receive credits. These might be traded domestically and/or internationally to finance the mitigation activities. Hereby the agricultural sector could be suitable for participation as the sectoral approach aims to decrease transaction costs significantly. Japan does to promote the BOCM as a blueprint for a NMM. Apart from this, detailed concepts are yet lacking.
Besides the NMM, there will likely be opportunities by the Green Climate Fund that has been agreed on at COP16 in Cancun and has been further operationalized in Durban at COP17. The GCF is expected to become the biggest multilateral climate fund and to function as an important channel investing a certain share of the international long-term climate finance (overall up to 100 billion USD annually in 2020 mobilised from industrialized countries to the developing world) supporting both mitigation and adaptation. With regard to adaptation, it was agreed that the GCF would channel "a significant share of new multilateral adaptation funding". However, the specific size remains open as of now. Significant delays in its further operation in 2012 have hampered progress and it must be expected that it will not be able to disburse significant amounts of resources before the end of 2013 or even later. Even though its detailed characteristics are not defined yet we likely expect potential for agricultural activities if developing countries decide to apply with such programmes. Hereby policy makers might influence characteristics towards promoting synergies of mitigation and adaptation (see also chapter 10.2 for aspects related to funding climate-compatible development.

5.2 Evaluation of funding opportunities

Based on the assessment of financial support instruments we are able to highlight all agricultural mitigation activities that have received or are likely to receive funding from specific financing instruments in the following. We also compile the geographic distribution, the overall expected mitigation potential and the future potential of the funding opportunities.
It is crucial to take into account here that the established methodologies can help assessing mitigation benefits of agricultural approaches and provide lessons learnt apart from the often controversial question whether the actual funding would and should come from the carbon market, or from other sources such as the GCF or bilateral finance. Benefits and risks of different funding options are therefore not necessarily associated with the methodologies applied for assessing the mitigation benefits directly.

During COP18 in Doha discussions on the general integration of mitigation activities in the agricultural sector emerged. Although the funding opportunities outlined below seem to bear a huge potential for reducing CO_2 emissions in the agricultural sector, their applicability is still highly debated among some developing countries under the UNFCCC. Among these are India, Brazil, and Argentina, which all have, during COP18 in Doha, expressed their reservation towards discussing agricultural mitigation aspects in general. This is due to the following reasons:

Argentina, Brazil and India are actively trying to prevent discussions on mitigation in the agricultural sector because they want to keep up the developing vs. developed country firewall. No matter if through carbon markets or other means, most countries in transition do not want to agree on any mitigation targets for their countries. This argument comes with the general mistrust towards developed countries wanting to impose CO_2 emission targets on developing countries.

A second aspect that developing countries are concerned about is losing their sovereignty when it comes to reducing GHG emissions. While they strictly oppose any legally-binding reduction targets at the moment, they also disapprove any patronization with regard to which sectors should be prioritized.

Lastly, moving mitigation aspects in the agricultural sector under UNFCCC window will harm developing countries that are currently benefitting largely from the absence of any GHG emission targets in their countries. Brazil for instance hugely profits from soy bean production as demand for meat around the world is growing ever more. If those practices would be subjected to any mitigation targets, Brazil's large-scale farmers are likely to lose out on their profits.

Table 2: Evaluation funding opportunities

	Project based Carbon Market	Carbon Funds	NAMAs	New Instruments
Main Mechanism/ Instrument	Currently CDM VCS, BOCM in future	GEF small grants, BioCarbon Fund	Supported and Unilateral NAMAs	Sectoral Crediting
Main mitigation activity	CDM: Manure management and biogas production; methane avoidance.	BioCarbon Fund: Mainly forestry projects are sponsored. Agriculture is involved in only a minority of projects.	Agriculture rarely used as supported NAMA. Plenty of different unilateral mitigation activities announced.	Not yet defined
Geographic distribution	The applied CDM manure/biogas projects have a strong focus on Latin America (Mexico, Brazil) and Southeast Asia (Philippines). Most methane avoidance projects are located in Southeast Asia (Malaysia, India)	BioCarbon Fund: Globally but due to focus on forestry many funds have disbursed to countries with rainforests.	Most agricultural NAMAs are located in Africa, some are announced for Latin America and two are in Indonesia.	Not yet defined
Current expected mitigation potential (Mt CO_2-eq) up to 2020	CDM: 80-85 Mt (UNEP Risoe 2012)	Only agriculture projects: ~ 3 Mt	Supported NAMAs: 3.6 Mt (Ecofys 2012)	N.A.
Future mitigation potential	BOCM: Might be substantial but depends on specific design of scheme. VCS might rather offer innovative methodologies instead of being a suitable mechanism itself.	Tranche two of the BioCarbon Fund is currently running. If international donors would initatite a third tranche minor mitigation potential via CDM could be generated.	Unilateral NAMA potential is significant however the concepts are not detailed enough for a quantitative estimation.	Theoretically significant. Requires more precise framework decisions by COP18.
Food security and adaptation component	Not explicitly considered. However DNAs as well as institutions like the Gold Standard might introduce food security as a sustainable benefit criterion required for registration of carbon projects.	The BioCarbon Fund does not consider food security. Other funds directly promote adaptation and have a framework that allow inclusion of food security as criterion.	Some NAMA concepts precisely take food security into account. If further COP decisions do not explicitly exclude certain co-benefits we see high chances to create synergies.	Not yet defined

Source: UNEP Risoe 2012, Ecofys 2012, assessment in chapter 5.1.

5.3 Activities lacking financial support

This chapter compares the analysed funding opportunities with the mitigation potential assessed in Chapter 4. Shortcomings will be described and recommendations for improvement are given.

5.3.1 Assessment of shortcomings in agriculture mitigation funding

Table 3 demonstrates whether agricultural mitigation activities receive sufficient financial support from the main mitigation instruments Carbon Market, Carbon Funds and NAMAs. Doing so, both existing opportunities but also the prospective options are evaluated.

Table 3: Assessment of suitable funding instruments for selected agricultural practices.

	Carbon Market (CDM, CAR, VCS etc.)	Carbon Funds	NAMAs
Improved agricultural practices	1 CDM meth appr; 1 CA meth u.d.	BioCarbon Fund might purchase CERs	Enhance soil carbon stocks (Eritrea)
Nutrient use	several CDM projects; 1 ACR meth appr.; 1 CAR, 1 VCS meth u.d.	BioCarbon Fund might purchase CERs	Organic fertilizer utilization (Indonesia)
Residue management and tillage	66 AP tillage projects	-	No-tillage (Brazil);
Water management	-	GEF provides funds	Sustainable peat land mgmt. (Indonesia); Irrigation efficiency (Indonesia)
Rice management	1 CDM project, 1 ACR/VCS meth u.d.	BioCarbon Fund might purchase CERs	Low methane rice variety (Indonesia)
Agro-forestry	1 CFI meth appr.	-	Agro-forestry systems (Ethiopia)
Grazing intensity and rotational grazing	2 VCS meth u.d.	-	Integrated crop-livestock system (Brazil)
Increased productivity	-	-	Coffee processing (Costa Rica)
Fire management	1 VCS meth u.d.	-	Burning practices (Ghana)
Species introduction	-	-	Nitrogen-fixing species (CAR)
Improved feeding practices	3 AP meths appr.	-	-
Specific agents and dietary additives	1 AP meths appr.	-	-
Longer-term management changes and animal breeding	1 AP methodology	-	Limit livestock increase (Mongolia)

	Carbon Market (CDM, CAR, VCS etc.)	Carbon Funds	NAMAs
Manure management	Successful under the CDM; several meths appr.	BioCarbon Fund might purchase CERs	Installation of CH4 recovery and flaring system (Macedonia)
Fossil fuel reduction	Fossil fuel reduction methodologies exist but have not explicitly applied for the agricultural sector	-	Programme that harness potential of renewable energy (Macedonia)
Carbon sinks and land conversion	-	GEF provides funds; ICI has theoretical potential;	-

Explanation: Green: Successful funding (expected); yellow: successful funding potential; red: no funding expected. appr:: methodology approved; u.d.: methodology under development

Comparing available funding instruments with the range of assessed agricultural mitigation practices (see chapter 4) shows significant gaps. This does not necessarily mean that the untapped options are necessarily uneligible, but they have not been explicitly addressed so far. Regarding the carbon market only nutrient use and manure management are sufficiently covered whereas most potential is untapped. Attempts to also access rice management, residue management and tillage would require the transformation of non-CDM related methodologies towards the Clean Development Mechanism. However, as pointed out above, an integration of those sectors requires a precise and adequate methodology of measuring the CO_2-eq savings, which to date is not yet entirely possible.

The Carbon Funds complement the CDM in some cases by purchasing CERs from agricultural projects which currently lack funding. Furthermore improved agricultural practices, water management and carbon sinks could profit due to fund support.

Announced NAMA ideas have been identified for almost all agricultural practices however it is unlikely that all of them will be successfully implemented. We expect that the supported NAMAs in Indonesia and Costa Rica have higher chances due to donor support such as capacity building and financing than the unilateral ones.

6 An overview of key adaptation funds

After chapter 5.3.1 has outlined a number of international funding opportunities for mitigation activities in the field of agriculture and food security, this chapter identifies and evaluates currently available and/or key funding instruments for adaptation in that sector. Due to their specific importance the following three instruments receive special attention: the Adaptation Fund (AF), the Least Developed Countries Fund (LDCF), and the Pilot Program for Climate Resilience (PPCR)[2]. Of course, other channels such as bilateral cooperation are important as well. For example, the first application of the OECD-DAC adaptation marker also list a large number of projects in the agricultural sector which are marked as adaptation. However, there is only few information available on the variety of projects, and for the purpose of this research the analysis of funded activities in the three funds is regarded sufficient and generally representative of many other activities.

All three funds provide funding for adaptation through different approaches. The LDCF funds urgent and immediate climate change adaptation needs through development and subsequent implementation of National Adaptation Programmes of Action (NAPAs) of LDCs. The AF finances concrete adaptation projects and programs in developing countries and the PPCR funds programs that integrate climate resilience into development planning in a selected group of pilot countries and regions. The three adaptation funds differ in their governance, the roles of Mulilateral Development Banks (MDBs) and UN institutions play within them, efficiency of operations, and synergies and cooperation among them. Some official documents acknowledge that the funds have overlapping goals, yet other official documents make an effort to avoid overlap. The Global Environment Facility (GEF) generally acknowledges that the three adaptation funds are relatively distinct in their purposes and functions, but it recognizes the risk of overlap (WWF 2011). What they have in common is that they are not prioritising a specific sector - e.g. agriculture - in a top-down manner on a global level. This is consistent with the principle of country ownership where each country has to identify its own priorities, in accordance with the principles and provisions agreed in the Cancun Adaptation Framework (Decision 1/CP.16 under UNFCCC). However, this bottom-up approach and the analysis undertaken here show that agriculture and food security are important for many developing countries when seeking to increase their resilience and adaptive capacity.

For reasons of limited resources, the project-based analysis in this chapter does not seek for overall completeness of analysing all projects that have ever been submitted to the funds. It focuses on

[2] In this context there is also the Special Climate Change Fund (SCCF) that finances long-term adaptation measures that increase the resilience of national development sectors to the impacts of climate change. Build up very similarly to the LDCF, as it is also managed by the Global Environment Facility (GEF), we concentrate our examination on the LDCF as the demand and approval of projects within this fund is currently much more vivid.

projects which in some form have been identified as meeting the criteria established by the governing boards of the three funds. For example, in the case of the Adaptation Fund only projects have been taken into account which have been approved by the Adaptation Fund Board.

In terms of these funds and their relevance for climate change adaptation projects in the field of agriculture and food security it can be noted that 52% of the projects approved by the Adaptation Fund in fact relate to one or both issues. For the LDCF the ratio is 28% while the PPCR only approved 11% of agriculture and food security relevant projects (status July 2012).

Table 4: Overview of key adaptation funds

Adaptation Fund	LDCF	PPCR
Uruguay Helping small farmers adapt to climate change	**Lao PDR** Improving resilience of the agriculture sector to climate change impacts	**Bangladesh** Promoting climate resilient agriculture and food security (IFC)
Turkmenistan Addressing climate change risks to farming systems in Turkmenistan at national and community level	**Senegal** climate change adaptation project in the area of watershed management and water retention	**Mozambique** Enhancing climate resilient agricultural production and food security
Ecuador Enhancing resilience of communities to the adverse effects of climate change on food security, in Pichincha Province and the Jubones River basin	**Central African Republic** Integrated adaptation programme to combat the effect of climate change on agricultural production and food security	
Eritrea Climate change adaptation programme in water and agriculture in Anseba Region		
Solomon Islands Enhancing resilience of communities in Solomon Islands to the adverse effects of climate change in agriculture and food security		
Nicaragua		

Reduction of risks and vulnerability based on flooding and droughts in the Estero Real River Watershed		

6.1 General features of the three funds

This section will briefly describe some general features of the three funds**.**

6.1.1 Adaptation Fund

The Adaptation Fund finances concrete adaptation projects and programmes and offers the opportunity of direct access. A concrete adaptation project is defined as a set of activities that aim to address the adverse impacts of and risks posed by climate change. All developing countries which are Parties to the Kyoto Protocol are eligible for application. Adaptation projects can be implemented at the national, regional, or local level. In fact, the AF also promotes projects at a transboundary level to enlarge the scope of the project. There are two types of interventions financed by the AF (Adaptation Fund n.d.):

1. Adaptation project: it concerns discrete activities with (a) collective objective(s) and concrete outcomes and outputs that are rather narrowly defined in scope, space, and time.
2. Adaptation programme: this is defined as a process, a plan, or an approach for addressing climate change impacts that is broader than the scope of an individual project.

6.1.2 Least Developed Countries Fund

The Least Developed Countries Fund finances projects with a country-driven approach that supports the implementation of urgent and immediate activities identified in national adaptation programmes of action (NAPAs), as a way of enhancing adaptive capacity. Only Least Developed Countries are eligible. Further, the LDCF supports the implementation of activities identified in NAPAs and of other elements of the LDCs' work programme identified in decision 5/CP.7, in order to promote the integration of adaptation measures in national development and poverty reduction strategies, plans or policies, with a view to increasing resilience to the adverse effects of climate change. On a general note the LDCF pursues a learning-by-doing approach. (UNFCCC 2005).

6.1.3 Pilot Program for Climate Resilience

The PPCR aims helping countries transforming to a climate resilient development path that is on the one hand consistent with poverty reduction goals and on the other hand aims at sustainable development. As a pilot program that supports a learning-by-doing process, PPCR interventions ultimately aim to result in an increased application of knowledge on integration of climate resilience into development. The PPCR complements, yet goes beyond, currently available adaptation financing in providing finance for programmatic approaches to upstream climate resilience in development planning, core development policies, and strategies. The PPCR is designed to provide lessons over the next few years that can be taken up by countries and regional groupings, the development community, and the future climate change regime, including the UNFCCC's Adaptation Fund. The PPCR only supports a number of selected countries (see Table 5)

Table 5: Countries funded by Pilot Program for Climate Resilience

Country	Disbursement in million USD
Bangladesh	1,558
Bolivia	4,725
Cambodia	24,55
Dominica	31
Grenada	16,68
Haiti	45
Jamaica	51
Mozambique	2,989998
Nepal	10,854
Niger	65,34
Papua New Guinea	5
Samoa	1,1
St Lucia	1,07
St Vincent & Grenadine	11,414
Tajikistan	16,38
Tonga	25
Yemen	1,5
Zambia	4,38

6.2 Access to the funds: criteria and pursued activities

This sections summarises the key criteria for accessing the funds. It furthermore contains summaries of activities proposed by project proponents regarding adaptation in the area of food security. These summaries contained in tables below do not constitute a list of recommended activities by the authors nor the funds themselves. However, since the analysis is based on approved projects these can be regarded as generally eligible to the funds.

6.2.1 Adaptation Fund

As pointed out earlier, concrete adaptation projects and programs are eligible for funding. The following list provides some insights into the guidelines that are applied by the Adaptation Fund Board when assessing project proposals. The list is compiled on the basis of the Operational Policies and Guidelines, the Strategic Priorities and other subsequent decisions of the AFB. They do not provide an order of significance.

On the level of the funding criteria:

(1) Consistency with national sustainable development strategies, including, national development plans, poverty reduction strategies, national communications and national adaptation programmes of action and other relevant instruments
(2) Economic, social and environmental benefits from the projects with particular reference to the most vulnerable communities, including gender considerations
(3) Meeting of national technical standards
(4) Cost-effectiveness of projects and programmes
(5) Existence of arrangements for management, including for financial and risk management
(6) Arrangements for monitoring, evaluation as well as impact assessment
(7) No duplication with other funding sources
(8) Application of a programmatic approach

On the level of the concrete project proposal guidance:

(1) Clarity about the problem and the objective(s) that are being addressed (incl. what the project will deliver when, how and by whom)
(2) Clear baselines, milestones, targets and indicators to ensure the measurability of progress and results
(3) Existence of a learning and knowledge management component to capture and feedback lessons
(4) A consultative process during the development of the project proposal that involved all stakeholders (incl. vulnerable communities and women)

(5) Justification for the funding requested on the basis of the full cost of adaptation
(6) Aligned with the AF results framework (at least one core outcome indicator from the Fund's results framework and sex-disaggregated data, target and indicators)
(7) Existence of concrete adaptation actions to assist the country in addressing adaptive capacity to the adverse effects of climate change and build climate resilience
(9) Ensuring access to the fund in a balanced and equitable manner
(10) Securing regional co-benefits
(11) Maximization of multi-sectoral or cross-sectoral benefits
(12) Sustainable design of the project
(13) The project funding to be within the cap of the country
(14) Existence of a detailed budget including budget notes
(15) Arrangements for M&E to be clearly defined (incl. budgeted M&E costs)

The currently approved projects with relevance to agriculture and food security have been analysed with regard to certain concrete practices they use in order to advance adaptation in the target regions. These can also serve as inspiration for potential activities to be pursued by other project proponents, in case they are judges as adequate to the specific challenges and circumstances of a target region. A generally important feature is the strategic priority of the AF which requires project proponents to pay particular attention to the specific needs of the most vulnerable communities. In the area of agriculture, these are often poor and vulnerable smallholders and farmers.

Table 6: Overview of activities pursued by projects approved under the AF

Concrete approaches	Planning considerations
- facilitate technology and knowledge transfer to local cultivators, using existing institutions to accelerate the rate of uptake of sustainable practices (where needed strengthen existing institutions) - modify ongoing practices at all stages (from plating to harvest) - development of new water mobilization and management techniques that take into account future predicted rainfall patterns - promote groundwater recharge and implement flood water harvesting measures as well as water storage facilities - more efficient use of available resources through the demonstration of climate resilient demand and supply side techniques	- address the short and long term climate risks that jeopardize food security and related development objectives - develop a vertically and horizontally integrated approach to address climate change risks involving many stakeholders at different levels - develop a project management structure that guarantees that climate considerations will begin to be practically integrated into national and provincial government agencies' planning and decision making processes and into the work of agricultural field staff - develop a programme that will simultaneously stimulate the implementation of new national agro-ecological policies, helps institutionalize the results of earlier programmes, and facilitates the acquisition of appropriate knowledge, attitudes and promotional

	behaviour by the extension staff of the national government agencies responsible for rural and agricultural development - develop a combined strategy that integrates community based adaptation with an ecosystem approach

Source: documents on approved projects (list countries), available at [AF-website]

6.2.2 Least Developed Countries Fund

LDCF activities must focus on additional costs imposed by climate change on the development baseline, meaning that activities that are part of the baseline are not considered for funding. For example, projects that target the improvement of public health and the education system are not eligible. Funding is provided only to address impacts of climate change above and beyond the baseline in a vulnerable socioeconomic sector. Unlike GEF, projects financed by the LDCF do not need to generate global environmental benefits. Local benefits can be generated as long as the case for additionality can be made (WWF 2011)).

On the level of the funding criteria:

(1) Only the additional costs will be financed that imposed on vulnerable LDC countries to meet their (urgent and immediate) adaptation needs

(2) To receive funding for NAPA implementation under the LDCF, the country should be an LDC Party to the UNFCCC that has completed its NAPA.

(3) Country "driven-ness": The project proposal should be identified as a priority activity in the country's NAPA, it should show evidence of stakeholder consultation and support, and it should take into account other relevant local, national or regional studies and projects

(4) Program conformity: Demonstrate that the proposal has been developed in compliance with the NAPA rules and procedures and represents a response to an urgent and immediate adaptation need

On the list of the concrete project proposal guidance:

(5) Project design: The proposal should include a list and description of project components as well as an additional cost calculation that demonstrates what would be done in a development baseline in the absence of climate change and the alternative scenario including measures that meet urgent and immediate needs that justifies the request for LDCF resources

(6) Sustainability: The benefits of the project should continue after project completion

(7) Stakeholder involvement: The project should provide for multi-stakeholder consultations and participation—which have proven pivotal to the NAPA preparation process—to continue during project implementation

(8) Development and inclusion of a financing plan: The proposal should provide a summary of financing contributions to the project, including an assessment of the baseline financing being included in the project. Co-financing may include utilization of existing resources, in the form of bilateral grants, IDA loans, or other in-cash and in-kind contributions. These co-financing contributions may include existing budget lines of the core development sector under consideration. The total project cost will be the sum of the LDCF contribution and all co-financing

(9) Assessment of cost-effectiveness: The project proposal should include a discussion of the various options considered to achieve the project's goal in a way that demonstrates that the adaptation measures and activities selected represent the most cost-effective approaches

(10) Institutional coordination and support is required of all projects to ensure that any potential duplication of activities is minimized and that coordination, collaboration, and consistency of approaches to other activities in the country is maximized. It is important that NAPA implementation builds upon other ongoing and upcoming activities.

(11) Monitoring and evaluation requirements for the project are the same as for all GEF projects. By the time of project approval, all projects should have developed a detailed monitoring and evaluation plan that includes provision and arrangements for annual monitoring reports and independent mid-term and final evaluations. In addition, indicators for tracking the achievement of project goals and objectives should be provided, including targets for mid-term and project completion. The baseline year or "pre-project" values for these indicators should be estimated at the time of project approval.

Altogether, three projects (the one's listed in above in Table 7) with relevance to agriculture and food security have been analysed with regard to certain concrete practices they use in order to advance adaptation in the target regions. These can also serve as inspiration for potential activities to be pursued by other project proponents, in case they are judges as adequate to the specific challenges and circumstances of a target region.

Table 7: Overview of activities pursued by projects approved under the LDCF

Concrete approaches	Planning considerations
- introducing appropriate and resilient agricultural practices at the local level - integrate climate risk projections and low-cost adaptation actions into the training programs for agricultural extension workers and local farmer groups - a functional system for the systematic collection, distribution, and internalisation of climate-related risk information at the national, district, and local levels to promote the sharing of project knowledge both within the country and the region - the introduction and demonstration of diversified agricultural production for farmers dependant on rain-fed crops and the development of sustainable production checklists to strengthen capacity at all levels and to increase the resilience of agricultural production systems - support of communities to forage associations, drip irrigation, awareness raising on water use and irrigation management	- a systematic integration of climate risk considerations into major agricultural sector policies - strengthening of institutional, organizational and individual capacities to understand the link between climate change and future food security - build capacity of sectoral planners with respect to projected climate change impacts on agricultural production - work towards a transition of agricultural systems from vulnerable to resilient by introducing new agro-ecological techniques and the sustainable use of
- introduction of critical water retention and watershed management infrastructures (incl. maintenance in the long run) - creation of retention basins to offer opportunities for non-crop based income diversification - build up capacities of national researchers and farmers to pro-actively identify, evaluate and share adaptive technologies that increase the overall resilience of the agricultural sector by reducing the risk to it from institutional failures to deliver promised support - support the development of tools (guidelines and manuals), methods and practices addressing climate change and targeting land managers, local government agencies, extension services, and farmer associations - invest in climate resilient technologies and practices and in income-generating activities that are resilient to more frequent and intense climate security threats	- plant genetic resources - perpetuate best practices and incorporate them in a scaled up, long term adaptation strategy for food security and agriculture

6.2.3 Pilot Program on Climate Resilience

The PPCR is funded by the Strategic Climate Fund (SCF), one of the two Climate Investment Funds (CIF). It is designed to demonstrate ways that developing countries can make climate risk and

resilience part of their core development planning. It helps countries build on their NAPAs and is committed to help funding public and private sector investments identified in climate resilient development plans. With pledges of approximately USD 1 billion, PPCR is active in nine countries.

Official guidelines to access funding

(1) Projects should be country led, build on National Adaptation Programs of Action and other relevant country studies and strategies, and be strategically aligned with the Adaptation Fund and other donor funded
(2) Activities to provide pilot finance in the short term so as to learn lessons that will be useful in designing scaled up adaptation financing
(3) Projects should be consistent with poverty reduction and sustainable development goals
(4) ODA-eligibility (according to OECD/DAC guidelines)
(5) Existence of active multilateral development bank (MDB) country programs
(6) Priority will be given to highly vulnerable Least Developed Countries eligible for MDB concessional funds, including the Small Island Developing States

6.3 Indicators applied by selected projects

It is common practice to identify indicators by which a project proponent can track its results. Any indicator in adaptation projects usually includes at least two parameters, the target that should be achieved through the project and the value of the indicator at the start of the project (or its first assessment). Such indicators are also important to develop a baseline study or scenario to highlight important aspects that would be neglected without the project. The collection of baseline data allows for:

- comparing the situation after the project (with adaptation) with the initial characterization (initial conditions prior to project implementation) and the envisaged results; or
- compare the situation after the project with a baseline (control site) that describes how the system would have performed in the absence of each implemented adaptation action (non-adaptation scenario or "business as usual").

This exercise is extremely useful in order to provide feedback with respect to the efficacy of adaptive measures promoted by the project, and to provide information about the desirability of scaling up or modifying specific activities. Of course, this can only be done after the completion of the projects which naturally result in quite a delay in time. In the next chapter, some aspects relevant to baselines are elaborated further. Indeed, many recent projects that aim to mainstream adaptation emphasize 'learning-by-doing' and sharing lessons learned as central elements of the M&E framework, which can be newly defined as monitoring, learning and evaluation. To support applicants in their project

proposals and enrich their ideas the subsequent table provides an overview of potential indicators that might be useful to describe expected results of a project, including the progress compared to the baseline. This table has been developed on the basis of the analysis of the different projects addressed in the funds.

Given the bottom-up nature of international adaptation funding it is difficult to draw conclusions similar to those in the mitigation sector, in particular since none of the funds requires the approval of specific methodologies on the global level. No specific sectoral priorities are set on the global level for good reasons, but countries identify bottom-up their priorities, ideally in a participatory manner involving also those who are most vulnerable. The above therefore provides more an inspiration of potential activities based on "successful" project applications in existing funds.

Table 8: Examples of indicators from adaptation projects related to food security

General agricultural management	Water management	Soil, seed, and forest management	Awareness raising and informational management
- increase the number of post harvest storage facilities - increase the number of agricultural associations that are operational - increase hillside terracing - increase the number of nursery sites and tree planting - improve famine/drought warning system - increase the number of integrated crop-livestock production systems - increase the number of provincial and community level food banks - raise the number of farm families implementing agro-ecological farm transformation plans - increase the number of farmers adopting improved storage practices - reduction in difference between farm gate and market price - increase the identification of resilient elements in existing farming systems - increase the number of national and provincial government stakeholders that are using the knowledge base for sectoral planning - improve seasonal forecasts - increase the percentage of non-timber products used	- increase kilometres of irrigation canals cured, dredged, and maintained - increase of water availability in all seasons - increase the number of reservoirs and water retention structures drained - increase the access to quality and stable water supplies for direct participants and indirect downstream users - increase the number of micro dams constructed - increase in water quality - increase the hectares of land changed from subsistent rain-fed production to irrigated production - raise the groundwater table by x centimetres - improve on- and off-farm water conservation structures - increase the number of farming households adopting adaptive water management technologies and practices - raise the number of people that have access to irrigable water resources - increase the number of water retention basins - increase silting-up (colmatage) operations on existing water retention basins - increase the hectares managed for sustainable irrigation - increase the number of installation of improved wells for small-scale irrigation - increase drip irrigation	- increase in the number of rice varieties tested and proven resilient in laboratory and field testing conditions - increase of kilogram resilient seeds produced and disseminates to multipliers - increased number of resilient rice and non-rice varieties - increase the percentage of native and adapted crop species - increase in drought and disease-resistant as well as early-maturing seeds varieties - increase of the total area of cropped land under adaptive varieties - increase of the number of farmers adopting improved (e.g. stress tolerant) cropping patterns - increased use of certified seeds grown by farmers - increase the use of sustainable fertilizer - increase the number of farmers practicing sustainable/efficient use of soil inputs based on soil test recommendations - increase the hectares reforested around project sites - increase the number of multipurpose trees	- increase the number of technicians trained on maintenance and silting-up - increase the number of communities that have an adaptation plan in place - have more farmers trained in Integrated Pest Management - have farmers and land/forest users trained (50% women) - reach an increase proportion of people with awareness raising campaigns - increase the percentage of women benefiting from intervention - increase information dissemination for adaptable agricultural practices - increase the number of associations and communities sensitized

7 Baseline principles for mitigation and adaptation activities in the agricultural sector

7.1 Baseline principles for mitigation activities

In the precedent chapters we have identified a variety of applicable methodologies for mitigation projects in the agricultural sector. In particular, the carbon market mechanisms, most notably the CDM, CAR and AP provide advanced baselines for mitigation activities in the fields of manure management, methane avoidance and livestock feeding.

Major principles that have been applied for the baseline scenario are:

- Methodologies often contain **default values** that facilitate the development of the baseline and project scenario and lead to reduced transaction costs (e.g. common from palm oil production methodologies under the CDM). These values have to be derived in a **conservative** way that guarantees environmental integrity;

- **IPCC Guidelines** for National Greenhouse Gas Inventories (IPCC 2006) are often applied as a helpful tool for baseline calculations;

- **Parameters** for **organic material** have to be justified;

- Proper definition of **base year** for performance standards is required;

- **Baseline boundary** should include all relevant emission sources related to the envisaged mitigation activity;

- **Land conversion** has to be reflected in some baselines, especially if a conversion that leads to reduced emissions has been planned before the mitigation activity takes place.

Regarding the project scenario, additionally the following principles have been considered in most agricultural methodologies:

- **Leakage emissions** due to shift of pre-project activities, competing use of biomass that might have been produced on the agricultural area;

- Additional **environmental impacts** of projects are partly considered (e.g. AMS-III.D. requirements define how the final sludge has to be handled in animal manure management);

- **The project boundary** should include all relevant activities and emission sources without creating unacceptable transaction costs. This should be in line with the baseline boundary.

7.2 Adaptation baseline principles

As highlighted in the previous chapter the formulation of baseline parameters is required when applying for adaptation funds. The subsequent list gives an overview of the types of data which use is recommended depending on the specific circumstances of a project either from available data and assessments or through the collection of new ones. (World Bank n.d.)

- **Climate data** (temperature, seasonal precipitation, start and length of the rainy season, etc.)
    - Climate change can affect the performance of the project either in a positive or negative manner. Therefore selecting adequate indicators for project performance is important for the implementation. The use of several proxies may be useful, for instance measuring how well non-climate dependent factors of agriculture were improved through the project. As these factors measure the vulnerability to disruptions caused by climate events, they are central for this process. For example, does the improvement of non-climate related factors reduce vulnerability to agronomic (management induced) or meteorological drought? Is soil conservation being promoted?
    - The collection of climate data can help communities to revise their climatic expectations and integrate traditional knowledge, and hence constitute an important measure for building adaptive capacity by itself.
    - Correlations between climate data and other types of data can help refine projections of climate change impacts at the local level (i.e. on agricultural productivity, coastal erosion, migration, etc.).
- **Socioeconomic data** (including measures of "well-being," demographics, access to basic services, migration, etc.)
    - To evaluate the "well being" of communities before and after the project a suitable set of variables is essential that go beyond annual income. For instance, "perception" or "hope" indicators could help measuring the degree of confidence that a drought won't disrupt local people's life. Also, an indicator could measure the strengthening of collective action and social networks.
    - In addition data should be collected on possible local effects of climate change that are not directly targeted by the project. Examples include health issues, social turmoil and conflict, internal and international migration, etc.

- **Ecosystem services, including productivity of natural resources** (i.e., agricultural yields, water salinity, coastal erosion, etc.)
    - When the measurement of an actual climate impact is difficult proxies should be developed For instance, the productivity and well-being of mangrove forests can be used as a proxy for the strength of beach erosion defence against storm surges.
- **Data on institutional and policy processe**s (i.e., number of existing national agriculture policies that incorporate adaptation issues, level of enforcement of policy on land and water rights, level of knowledge regarding climate change within local institutions, etc.)
    - Simple process indicators (ege.g. new water policy including adaptation approved, interdepartmental committee set up, etc.) and more complex outcome indicators (ege.g. to measure enforcement of policy on land and water rights) should be included.
- **Coping strategies**
    - Changes in the available set of coping options available to local communities are perhaps the most representative changes in adaptive behaviour and adaptive capacity. Examples include: changes in crop selection within cropping season; change in planting dates; income diversification; distress selling of lands, crops, and livestock; share cropping the land, food storage per family, etc.

8 How to link mitigation and food security

Several mitigation activities identified in chapter 4 have negative impacts on yields, at least in the short and mid-term. Among these are improved agricultural practices, residue management and tillage, agro-forestry and fossil fuel reduction. A reduction in yields may obviously pose a challenge to improving or maintaining food security, which is a main objective under this research project. Options to respond are exclusion of such activities, directly compensate for the lost harvest or provide rewards for other benefits (which result in an indirect compensation of lost harvest). Otherwise farmers, in particular smallholders, will likely not be willing to participate in the mitigation activities.
We discuss two options how to deal with the antagonism of reduced yields through mitigation on the one hand and the objective of improved food security on the other hand:

8.1 Exclusion of mitigation project types that reduce yields

One option for dealing with the dilemma would be to ban mitigation activities leading to reduced yields. As analysed above this would not even require complicated updates of existing regulatory frameworks of the carbon instruments. In case of the CDM, DNAs would simply define food security

as sustainable development criterion and exclude all projects that have a negative impact. An innovative CDM label such as Gold Standard could mark credits that have positive or negative impacts on food security. Such verified standard would facilitate the evaluation for DNAs as they could simply require that project activities in the agricultural sector fulfil the “food security standard” for issuing a LoA.
The carbon funds would need to slightly adjust their evaluation criteria and define projects with negative impacts on yields as non-eligible.

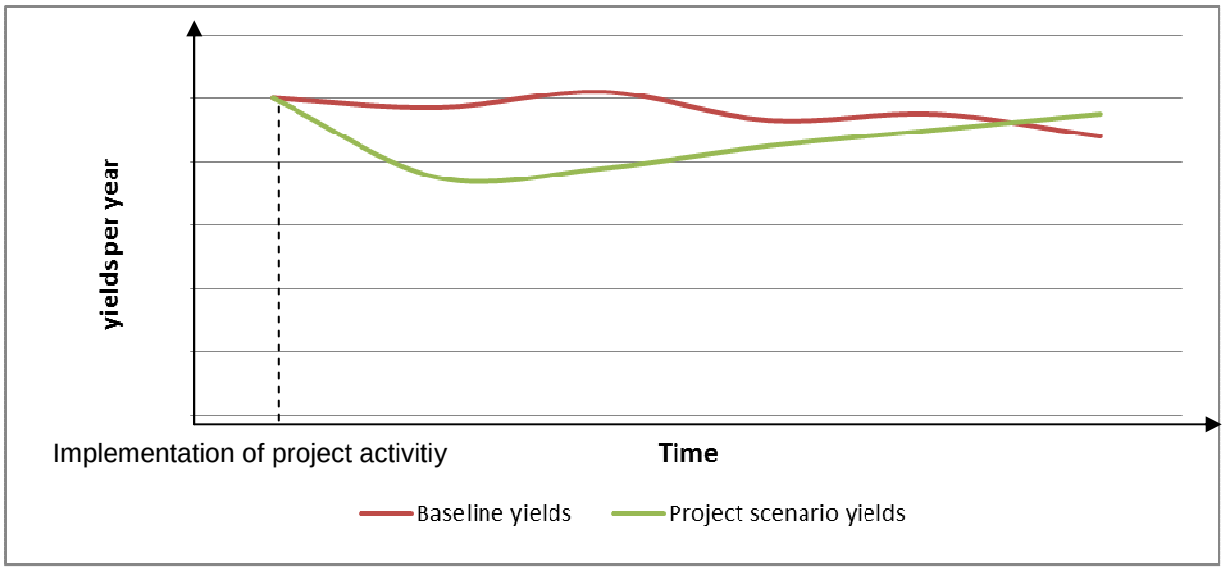
8.2 Compensation of reduced crop yields

The ban of projects reducing yields would significantly decrease the mitigation potential - in particular for improved cropland management. We have identified several cost-efficient mitigation activities in this field that would not be eligible. To tap this potential without jeopardising food security an innovative approach is required

Hereby one has to consider the yields over time for agricultural activities with negative food supply impacts. Improved cropland practices can reduce the harvest in the short and mid-term before the activity pays off in the long term (see example in

Figure 5). Even though they might be incentivized by financial revenues through the mitigation instrument, smallholders that rely on constant food supply might not be willing to risk current existential health and economic conditions for a more beneficial situation in the future (except they would be provided with certain safety nets, such as certain insurance instruments which of course contain their own complexities).

Figure 5: Hypothetical development of baseline yields and yields after implementation of a mitigation project activity



In order to overcome the barrier of decreased yields there is a need to compensate the failed yields in the initial phase of the project. Doing so, there exist two options:

- Direct compensation payments for failed yields: Decreased harvest is monitored and compensated with gatekeepers' funds. As the gatekeeper will receive finance for the verified emission reductions at a later point in time sufficient financial coverage of the gatekeeper is required. As soon as e.g. the soil has recovered and yields cross the baseline the gatekeeper can stop compensation payments. An innovative label such as Gold Standard "food security CERs" might enable premium payments by investors or donors. The risk for the farmers might be the elasticity of food market prices. They will not have own control over their food supply.

- Indirect compensation through food supply for farmers. Instead of disbursing money the gatekeeper could also purchase food products and deliver them to the farmers to substitute the reduced harvest. This might hedge the risk of rising food market prices for the farmers. However smallholders will still require participation at the mitigation revenues for their project implementation efforts.

9 The gatekeeper institution

From the above the question arises what kind of institutional set-up would be required and appropriate to better exploit the potential of synergetic approaches with a view to allowing a climate-resilient and low-carbon development as a means to providing continued investments into food security. The above analyses have shown that already a variety of funding activities from outside exist, which is categorised here as **external support fragmentation**. At the same time, agriculture is an economic sector which involves a large number of actors (both larger-scale ones as well as many, many smallholders) in developing countries. These can both be recipients of funds as well as important agents of change for a sustainable agriculture. This situation can be categorised as **internal implementation fragmentation.**

Therefore, there is clearly a need for some kind of **coordination mechanism** to bridge this fragmentation. As a first overview, the following functions seem necessary:

- ability to receive external funds;
- ability to coordinate funding proposals/decisions among a variety of stakeholders;
- ability to manage the disbursement of funds to a variety of scattered recipients, which includes aspects such as fiduciary standards, monitoring capacities and potentially reporting duties also to the funders

These will be elaborated on more in detail further below. In the following it will be discussed in how far such a gap could be filled by specific institutions or a set of institutions which we call "gatekeeper institution(s)", and what characteristics would be required to play this role.

In order to advance the conceptual thinking on such a gatekeeper institution it is necessary to look at relevant experience and issues from other processes. Therefore, this chapter will briefly summarise relevant aspects a) regarding the emerging trend of national funding entities, b) in the Adaptation Fund, in particular with regard to direct access and the National Implementing Entities and c) in the mitigation frameworks of the UNFCCC.

9.1 National Funding entities

Since more and more developing countries have identified climate change related actions as an area which increasingly affects their development pathways and objectives, an emerging trend is to establish specific funding institutions to address climate change. Partially, this is triggered by the expectation that international funding for climate change purposes will significantly increase in the next decade, as stipulated by the commitments made in Copenhagen and in Cancún. Furthermore, countries are motivated to have a greater ownership of funds and activities that concern their future than they would have by relying on multilateral institutions.

9.1.1 Overview of existing initiatives

National funding entities on climate change can be found in a number of developing countries, both in emerging economies and in LDCs. While their types and specific designs vary, "one common feature that emerges from all is the clearly stated or implied objective to link programs and projects approved for funding directly to some kind of overall climate change policy framework where they exist, and/or national development strategies and plans." (Gomez-Etcheverri 2010: IV). For example, in the case of Bangladesh, the country first developed the "Bangladesh National Climate Change Strategy and Action Plan" as its framework to guide mitigation and adaptation policies and then established the "Bangladesh Climate Change Resilience Fund". As the name indicates, this Fund will focus on the adaptation and resilience needs of the country and in particular vulnerable communities and the agricultural sector. A particularly interesting feature of the Fund's governance structure is that part of the funds will be disbursed through ministries and departments (on-budget activities), while the other part (off-budget) will be accessible for civil society organisations and the private sector.

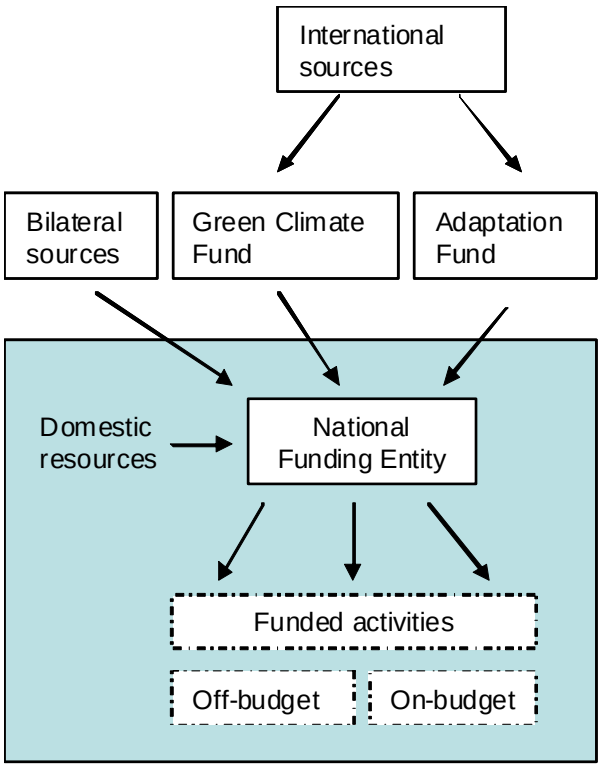
Numerous examples for such funds in different areas (adaptation, mitigation, REDD+, CDM) exist, such as the Amazon Fund of Brazil, the Indonesia Climate Change Trust Fund, the Maldives Climate Change Trust Fund or the Thailand Energy Efficiency Revolving Fund. Others are being set-up. The interesting and fundamentally important part of the development is indeed that these countries have taken their own initiative to assist the implementation of policy objectives, rather than following guidance established by a specific multilateral fund. This entails the prospect that these funds will play a much more important role as domestically invented structures.

9.1.2 Function and potential role in the international climate finance architecture

With the governing instrument approved under the Green Climate Fund (see 10.2), such funding entities for the first time receive an explicit recognition (UNFCCC, 2011). The AF of course provides an important starting point for discussing the potential role of such national funding entities in the international climate finance arena, notwithstanding the fact that these entities are also being used to allocate and disburse domestic climate change finance (see 8.2 for more details). Such national funding entities could for example perform the role of "national implementing entities (NIE)" under the AF, once they were accredited by the Accreditation Panel of the AFB. They would oversee the domestic implementation of projects funded and approved by the Board. An interesting example in that regard is the National Environment Fund of Benin, which originally was established to disburse funds acquired through a domestically imposed environment tax. In September 2011, it was accredited as an NIE by the AFB. This marks an impressive example of "devolution" of responsibility from the international level to an LDC institution.

Among the arguments for such a devolution of responsibility is the fact that national needs and requirements can best be identified and addressed at the national (or sub-national level), rather than on an international level. Depending on the funding purpose (adaptation, mitigation, REDD+ etc.) there are also very different needs regarding skills, knowledge and investment instruments, which can better be assessed locally. Also, such funds can attract and leverage funds from a number of sources, including bilateral climate finance, to fund strategies and plans in a coherent manner (see Etcheverri 2010).

Figure 6: Potential role of national funding entities in the overall climate finance set-up



Source: own illustration

Overall, there is the hope that the impact of funding will increase with such a devolution and thereby not only transform the current climate finance architecture, but also strengthen and improve efforts against the threats of climate change.

However, the case of the Bangladesh Climate Change Resilience Fund already implies one of the key challenges and potential areas of controversy. When developing country governments are setting up such funds to attract international climate finance, they have to apply certain fiduciary management standards and potentially environmental and social safeguards to ensure that developed country governments – the potential key donors – can trust the operations and integrity of the respective fund. Often it is also appreciated when such a trust fund is governed by some form of

multi-stakeholder body which, besides civil society, includes bilateral aid agencies or at least multilateral institutions such as the World Bank or UNDP. In the case of Bangladesh, the government initially wanted the World Bank to manage the fund, which led to strong resistance by civil society due to concerns over the sovereignty of decisions, and in turn to a significant delay in the implementation of the fund due to continued negotiations with donor country governments. In the end, agreement was reached on a model where a multi-stakeholder board governs the fund and where the World Bank plays a supporting role to ensure that due diligence requirements are being met.

Against this background, it is interesting that for example the Government of the Maldives chose the World Bank as Trustee for its Climate Change Trust Fund, which has been set up to inter alia build up adaptive capacity and develop renewable energy as a contribution to the Maldives' objective to become climate neutral by 2020.

It is obvious that meeting certain fiduciary management standards is crucial in order to provide sufficient trust for funders of any kind, but in particular of developed countries as the key providers of public climate finance to developing countries. Therefore, these aspects are also crucial to take into account for a concept of gatekeeper institutions. However, with increasing experience and capacity in developing countries to manage climate-related funds in a due diligent manner, fewer arguments will remain not to shift greater responsibility to developing countries. This is one of the reasons why it is expected that direct access under the new Green Climate Fund will play an even more important role than in the AF. Nevertheless, capacities among developing countries vary and the appropriateness of the institutional capacity to manage larger flows of climate finance will have to be examined from country to country. Where capacity is not yet sufficient and a developing country would like to move forward on the direct access road, providing capacity building is an important element (see also 10.2).

9.2 The Adaptation Fund and National Implementing Entities

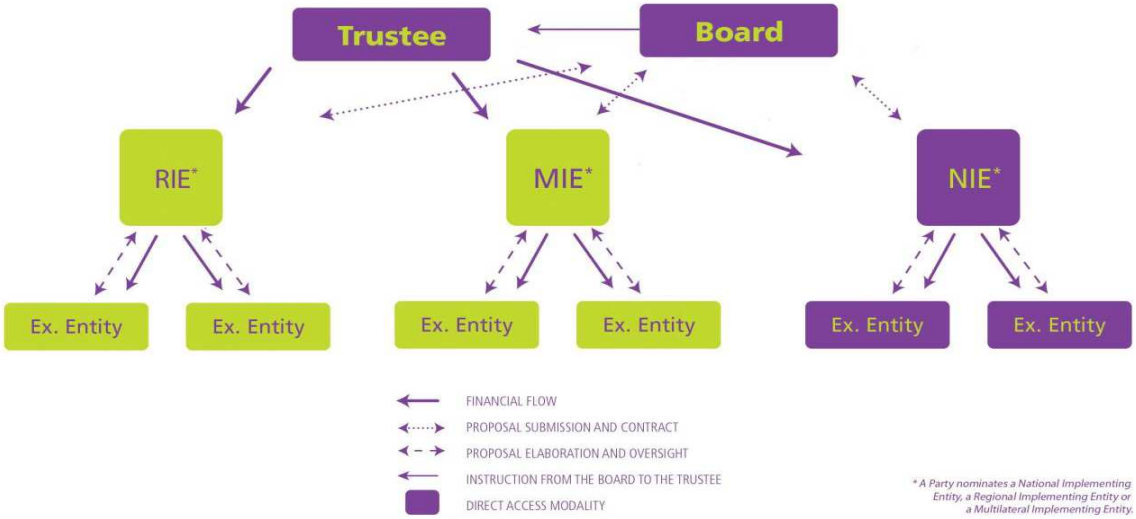
Some background to the Adaptation Fund has already been provided in previous chapters. This section will particularly look at institutional aspects relevant to the gatekeeper discussion.

The AF is the first international climate fund which provides the opportunity to developing countries to access finance directly, under certain conditions, instead of applying through multilateral agencies such as UNDP, UNEP, the World Bank or others.

9.2.1 National Implementing Entities and fiduciary management standards

Simply speaking, the so-called National Implementing Entities (NIEs)[3] have to fulfill a number of oversight functions in the implementation of projects. They serve as the recipient of the resources approved by the AFB for a specific project. Within the country, the NIE then has to coordinate the implementation process, release funds to the entities actually executing the projects on the ground and entering in contracts with them (see following figure). With regard to their relationship to the AFB as the governing body of the AF, "the NIEs will bear the full responsibility for the overall management of the projects and programmes financed by the Adaptation Fund, and will bear all financial, monitoring and reporting responsibilities." (Adaptation Fund, 2010, para 28). Therefore they have a central function which reflects some of the considerations of a gatekeeper institution, so far limited for the specific case of the AF.

Figure 7: Modalities for accessing resources of the adaptation fund



Source: Adaptation Fund 2012

Based on this approach, the AFB developed relevant criteria, with a strong focus on fiduciary management standards which are the following:

"**(a) Financial Integrity and Management:**

(i) Accurately and regularly record transactions and balances in a manner that adheres to broadly accepted good practices, and are audited periodically by an independent firm or organization;

[3] Parties can also nominate a regional or sub-regional entity as implementing entity, see Adaptation Fund 2010, para 29

(ii) Managing and disbursing funds efficiently and with safeguards to recipients on a timely basis;
(iii) Produce forward-looking financial plans and budgets;
(iv) Legal status to contract with the Fund and third parties

(b) Institutional Capacity:

(i) Procurement procedures which provide for transparent practices, including in competition;
(ii) Capacity to undertake monitoring and evaluation;
(iii) Ability to identify, develop and appraise project/programme;
(iv) Competency to manage or oversee the execution of the project/programme including ability to manage sub-recipients and to support project/programme delivery and implementation.

(c) Transparency and Self-investigative Powers: Competence to deal with financial mismanagement and other forms of malpractice." (Adaptation Fund, 2010, para 33).

Developing countries therefore nominate institutions to the AFB - or more specifically to the Accreditation Panel - and ask for accreditation, by providing documents which show the capability of the institution in meeting the set-up standards.

9.2.2 National Implementing Entities

So far, the AFB has accredited 12 National Implementing Entities from a diverse group of countries. Table 9 provides an overview of these institutions and key features. This overview as well as the experience of the AFB with the accreditation process allow fordrawing a number of interesting observations and conclusions:

- the AFB only asks for the fulfillment of certain fiduciary management standards; specific expertise in adaptation to climate change, related to the inclusion of stakeholders or the coordination of relevant actors in a specific policy field is not explicitly required;
- the identification of projects is usually the task of the relevant ministries in charge of the process, consistency with existing national policy frameworks has to be ensured;
- partially because of that, the institutions accredited vary significantly from each other, from specific ministries to non-governmental organisations under the authority of governments with adaptation expertise, from institutions experienced in managing large amounts of external funds to development banks;
- this also provided the governments with the opportunity to first look at the existing institutional set-up in their countries, resulting in the fact that not one institution was established just because of the AF process; thereby also concerns expressed early-on in the process e.g. by developed countries that this process would lead to further institutional fragmentation has not been justified;

- among the countries allowed to apply direct access are also LDCs, such as Benin, Senegal (as the first NIE), Rwanda;
- many more applications for NIEs are in the pipeline, but providing all the documentation required by the Accreditation Panel seems to be challenging, as well as sometimes identifying the most appropriate institution in a country (see Adaptation Fund, 2011)

With regard to the focus of this study, it is interesting that there are some institutions with a particular agricultural background, namely

- the Unidad para el Cambio Rural (UCAR) from Argentina;
- National Bank for Agricultural and Rural Development (NABARD) from India,

While the first is a government-like institution under the Ministry for Agriculture mandated to coordinate a range of activities related to external finance, the second is a large bank with USD 30 bn in assets, working through a large number of staff and many local offices.
Some other NIEs are experienced in a variety of environmental issues and therefore also possess relevant expertise, even if enhancing food security is not within their explicit mandate.

Table 9: Overview of National Implementing Entities accredited under the AF

Country	National Implementing Entity	Institutional location	Institutional history	Institutional character and mandate
Argentina	Unidad para el Cambio Rural (Unit for a Rural Change - UCAR)	a specific entity created under the Ministry for Agriculture, Livestock and Fishery	Through Resolution of Argentina's Ministry of Agriculture, Farming and Fishing (MAGyP) 45/2009 the Unit for Rural Change (UCAR) was created.	created to manage the planning, negotiation, formulation, administration, monitoring and evaluation of projects and programmes conducted in the areas under the mandate of the ministry with external financial support, also implementing projects in the area of natural resource management and biodiversity protection (own translation from Spanish); AF relation seems to be the first activity explicitly on adaptation. It also manages contacts to the Ministry of Economy and Public Finance, the Ministry of Foreign Affairs, International Trade and Worship, Lending Organizations and International cooperation agencies, and all those agencies of the National and Provincial Public Administration, in order to coordinate and implement Programs and Projects subject to external funding.
Belize	Protected Areas Conservation Trust (PACT)	Organization dealing with environmental questions in Belize	After several years of consultation and meetings with various government and non-government organizations, the private sector, and international organizations, PACT was formally established in January 1996 with the passing of the Protected Areas Conservation Trust Act, No. 15 of 1995, creating the institution as a Statutory Board	[To contribute to the sustainable management and development of Belize's natural and cultural heritage by providing effective funding support to protected areas.] PACT provides funds for supporting conservation and promoting environmentally sound management of Belize's natural and cultural resources to foster sustainable development. PACT is a bold and innovative strategy for non-traditional revenue generation.
Benin	National Environment Fund	Promotion of environmental governance under the guardianship of the ministry of environment	Unknown	The FNE is interested in all projects to protect, restore or enhance the environment

Country	National Implementing Entity	Institutional location	Institutional history	Institutional character and mandate
India	National Bank for Agricultural and Rural Development (NABARD)		NABARD was established under an Act of Parliament called the NABARD Act, 1981 which gives it the legal personality, capacity, authorization and the ability to directly receive funds and do the work required as an NIE.	NABARD is a development bank that provides and regulates credit and other facilities for the promotion and development of agriculture, small scale industries and other rural economic activities throughout India. It is a large bank with USD 30 billion in assets represented mainly by loans and credit support programmes. In 2009-10 NABARD gave almost USD 11 billion in refinancing and loans using other banks to reach a significant percentage of the rural Indian population. NABARD has 3000 officers who are supported by other staff that operates in the Head Quarters in Mumbai, 30 Regional Offices and it has 400 district development managers functioning at the district level. The German development bank KfW has executed a number of programmes through NABARD and the KfW officer in charge of the file was positive on the organization.
Jamaica	Planning Institute of Jamaica	An Agency of the Office of the Prime Minister	Established under the Planning Institute of Jamaica Act, 1984, but been in existence for over 50 years as the national planning agency	Operates under a Board, providing policy and planning advice to government and external cooperation management
Jordan	Ministry of Planning and International Cooperation	Ministry of Planning and International Cooperation	Started in 1952 as Council of Construction and became after several changes and modifications the Ministry of Planning and International Cooperation on Oct 25th 2003 (Law No. (68) for 1971)	Supporting and directing development initiatives aimed at raising the standards of living and improving the national economy. Strengthening and enhancing technical, financial and economic cooperation with donors, international organizations and financing institutions, while steering foreign assistance in line with socioeconomic priorities within the framework of the National Agenda.

Country	National Implementing Entity	Institutional location	Institutional history	Institutional character and mandate
Kenya	National Environment Management Authority (NEMA)	NEMA is a government agency established to exercise general supervision and co-ordination over all matters relating to the environment. The Authority is the principal instrument of Government in the implementation of all policies relating to the environment. Section 9(2) of EMCA details 17 statutory functions that NEMA shall undertake.	The National Environment Management Authority (NEMA) is established under the Environmental Management and Coordination Act (EMCA) No. 8 of 1999, as the principal instrument of government in the implementation of all policies relating to the environment. The Authority became operational on 1st July 2002	Mission: Safeguard and enhance the quality of the environment through coordination, research, facilitation and enforcement, while encouraging responsible individual, corporate and collective participation towards sustainable development; Coordinating the various environmental management activities being undertaken by the lead agencies, promote integration of of environmental considerations into development policies, plans, programmes and projects and others (...)

Country	National Implementing Entity	Institutional location	Institutional history	Institutional character and mandate
Mexico	Mexican Institute of Water and Technology (IMTA)	State-owned organization, with its own legal personality and assets, and coordinated by the Ministry of Environment and Natural Resources (Semarnat).	The IMTA was created by presidential decree, published in the Official Gazette of the Federation on August 7th, 1986, as an autonomous public organization linked to the former Ministry of Agriculture and Water Resources (SARH). As a result of modifications to the country's Public Administration, and by a presidential decree published on December 28th, 1994, IMTA became part of the Ministry of Environment, Natural Resources and Fisheries (SEMARNAP). Since October 30th, 2001, IMTA is a state-owned organization, with its own legal personality and assets, and coordinated by the Ministry of Environment and Natural Resources (Semarnat).	The main objective of developing technology and training the necessary qualified human resources in order to ensure the rational utilization and integrated management of water resources. Their vision is to be a leading, world-class institution that fosters the transformation of the water sector and furthers the sustainable management of water resources in the country. They understand their mission to produce, instillinstall, and disseminate knowledge and technology for the sustainable management of water in Mexico.

Country	National Implementing Entity	Institutional location	Institutional history	Institutional character and mandate
Rwanda	Ministry of Natural Resources (MINIRENA)	Ministry of Natural Resources (MINIRENA)	Started in 1989 as “Environment and Development Project” in the Ministry of Planning, which later became the National Environment Unit, a springboard for the establishment of the Ministry of Environment and Tourism (MINETO) in 1992, the duties of which included, among others, the coordination of all environment related activities carried out by different ministries (...) The Ministry is now called the Ministry of Natural Resources (MINIRENA) since May 2011.	Planning, Policy and Capacity Building Unit is placed under the supervision of the Secretary General, different visions and missions: environment protection; rational exploitation and efficient land management, Environment, Water Resources and evaluate their implementation; Promote research and exploit Rwandan underground natural resources, plan and follow up pure water distribution programme and basic health activities; initiate incentive measures and support programmes to private sector and civil society so as to invest in land protection activities, Water Resources and Environment; coordinate stakeholders activities and mobilise necessary resources, reinforce capacities of decentralised entities
Senegal	Centre de Suivi Ecologique	A non-profit association under the Ministry of Environment and Nature Protection	Created in 1986 to study desertification, CSE is an ecological monitoring institute that provides IT expertise	The Centre’s technical capacity focuses on environmental monitoring
South Africa	South African National Biodiversity Institute	SANBI is a public entity under the Department of Environmental Affairs. This relationship requires that the Institute works closely with the department in its activities including partnership projects and programmes.	The South African National Biodiversity Institute was established on 1 September 2004 through the signing into force of the National Environmental Management: Biodiversity Act 10 of 2004 by then President Thabo Mbeki.	SANBI leads and coordinates research, and monitors and reports on the state of biodiversity in SA. Providing knowledge and information, gives planning and policy advice and pilots best-practice management models in partnership with stakeholders. SANBI engages in ecosystem restoration and rehabilitation, leads the human capital development strategy of the sector and manages the National Botanical Gardens as 'windows' to South Africa's biodiversity for enjoyment and education.

Country	National Implementing Entity	Institutional location	Institutional history	Institutional character and mandate
Uruguay	Agencia Nacional de Investigacion e Inovation	A national research and innovation institute	Established in 2006 under law 18.084 to promote national innovation in Uruguay	Operates under a Board, the institute supports innovation in the public and private sectors through competitive funding calls

Sources: various documents related to the AF, websites

9.3 National institutions for mitigation activities

UNFCCC related mitigation activities have to be approved by national bodies. In the case of the CDM a Designated National Authority (DNA) is responsible to evaluate proposed projects regarding their contribution to sustainable development of the country. These institutions have built internal capacity, i.e. they have gained experience with various types of mitigation activities, depending on the submitted CDM applications. Furthermore DNAs have usually secured domestic funding from the government and are often sub-departments of the government. Often the Ministry of Environment or Ministry of Natural Resources has installed the DNA. This, on the one hand likely guarantees funding for staff, information campaigns and even the development of methodologies or carbon fund applications which would enable the DNA to take over gatekeeper functions. On the other hand an institution under direct governmental control is not necessarily the most favourable construction in all countries as e.g. the partial existence of a silo working style revealed by this project's case studies has shown (Adwera 2012, p.25).
Regarding agricultural CDM activities the host countries with registered projects are expected to have at least basic experience as they issued Letter of Approvals (LoAs) for such activities already. Among these are (numbers represent registered projects per country):

Methane avoidance through manure management (Methodology: ACM10 and AMS-III.D.)
Mexico 71, Philippines 36, Brazil 28, China 8, Thailand 4, India 3, Chile 2, South Africa 1, Indonesia 1, Cambodia 1, Vietnam 1

Avoidance of methane emissions (AMS-III.E. and AMS-III.F.)
Malaysia 36, Brazil 12, India 10, Indonesia 8, India 6, Uruguay 3, Argentina 1, Cambodia 1, Chile 1, Peru 1, Guatemala 1, Philippines 1

Methane reduction through co-composting and in agricultural activities (AM0039; AMS-III.R)
Indonesia 3, China 3, Malaysia 2, India 1

Overall 16 different DNAs in Asia and Latin America have been in touch with CDM projects from the agriculture sector yet. The African continent is underrepresented; just one project in South Africa has been registered so far.
Before issuing a LoA the project related sustainable development benefits need to be defined and assessed by the DNA. Among these are elements that can be interpreted as food security related ones such as "enhance access to local resources and services for vulnerable groups" (Philippines). The DNA is free in choice what kind of development or "contribution to provision of basic amenities to people" (India) it selects for determining sustainable development benefits. In case significant negative impacts of the CDM activity are identified the DNA is expected to reject the project. Although this approach has sometimes led to approval of questionable CDM projects in the past; e.g. in the

biofuel sector. To support the safeguards of the CDM and decrease risk of negative social and environmental impacts the Gold Standard has been developed. It requires additional impact assessments and stakeholder meetings.

In general, the DNA structure and related definition and assessment of development benefit criteria can be used as a basis for further improvements towards broader responsibilities in the context of a gatekeeper structure. Hereby the DNA might take over the function of coordinating the application of carbon markets. NAMAs concepts are often developed under the control of Government Agencies or Ministries - however a clear “focal point” is not required under the current UNFCCC regime (mid of 2012). Therefore DNAs that have gathered experience regarding agricultural emission reduction projects might take responsibility for further mitigation instruments such as NAMAs or applications for Carbon Funds.

9.4 Initial conclusions for the gatekeeper concept

The above analyses have provided a number of insights and lessons learnt which are relevant to the discussion of the gatekeeper concept. In the following we outline initial conclusions what requirements the gatekeeper institution needs to fulfill and what tasks it might take over.

Importance of high fiduciary standards to receive and manage funds

In particular the experience of the Adaptation Fund, but also that of the Bangladesh Climate Resilience Fund shows how crucial it is - from a donor perspective - that it there is sufficient trust that such an institution possesses the institutional capacity to manage the funds according to high fiduciary standards such as anti-fraud policies, independent audits etc. For the specific function of the **ability to receive external funds** this seems to be more important than particular expertise in climate change mitigation or adaptation or agriculture.

Ability to use different financial instruments

The flexibility of an institution may increase when it is able to manage different financial instruments. While it can be expected that much of adaptation finance will be distributed through grants, addressing both adaptation and mitigation as well as mainstreaming of these into the agricultural sector may also involve the management of more complex financial instruments such as loans, risk insurance etc. Therefore a certain experience to handle different instruments may be advantageous, like it is for example the case in the Indian bank accredited as NIE under the AF.

Complex nexus of agriculture and climate change mitigation and adaptation

As the above analyses have also shown, the socio-economic environment of agriculture is already complex even without addressing mitigation and adaptation, with a very fragmented target group. This in particular holds for the role of dispersed smallholders which often are among the most

vulnerable to climate change impacts as well as other external shocks that might impact on the food security situation. Therefore, it seems necessary that in the gatekeeper concept institutions are involved which have a good understanding and track record of dealing with agricultural sector and its diverse players, with a particular attention to smallholders. Furthermore, specific expertise related to climate change mitigation and adaptation and the international climate finance landscape should be acquired.

Build on existing institutions

The above experience has also shown that there is a tendency within developing countries to either build on existing institutions, or to set up institution which are explicitly envisaged to manage more or less all external funds from different sources. In the case of the AF NIEs existing institutions were identified. The second trend is constituted through the establishment of National Funding Entities independent of specific international provisions.

With regard to the content of this research this means that the starting point would be to screen the existing institutional portfolio in a given developing country in how far it meets required qualifications.

Ability to involve multiple stakeholders

Both from a food security as well as a climate change view point it is important that there is the ability to involve multiple stakeholders, taking into account there specifics as well as being able to prioritize certain target groups. One approach to deal with multiple stakeholders could be to set up different funding streams, like the on-budget (government) and off-budget (civil society) approach in the Bangladesh climate change fund which provides different avenues for different stakeholders.

Identification of projects and programmes

Generally, capacity would also be required to being able to identify good projects and programmes harnessing synergies between adaptation and mitigation and enhancing food security at the same time. This would on the one hand require expertise in the project types as such as well as the ability to manage such identification processes which should involve a broad range of stakeholders (see before), in consistency with national policy frameworks, and should not result in top-down approaches.

One institution or a set-up of different institutions?

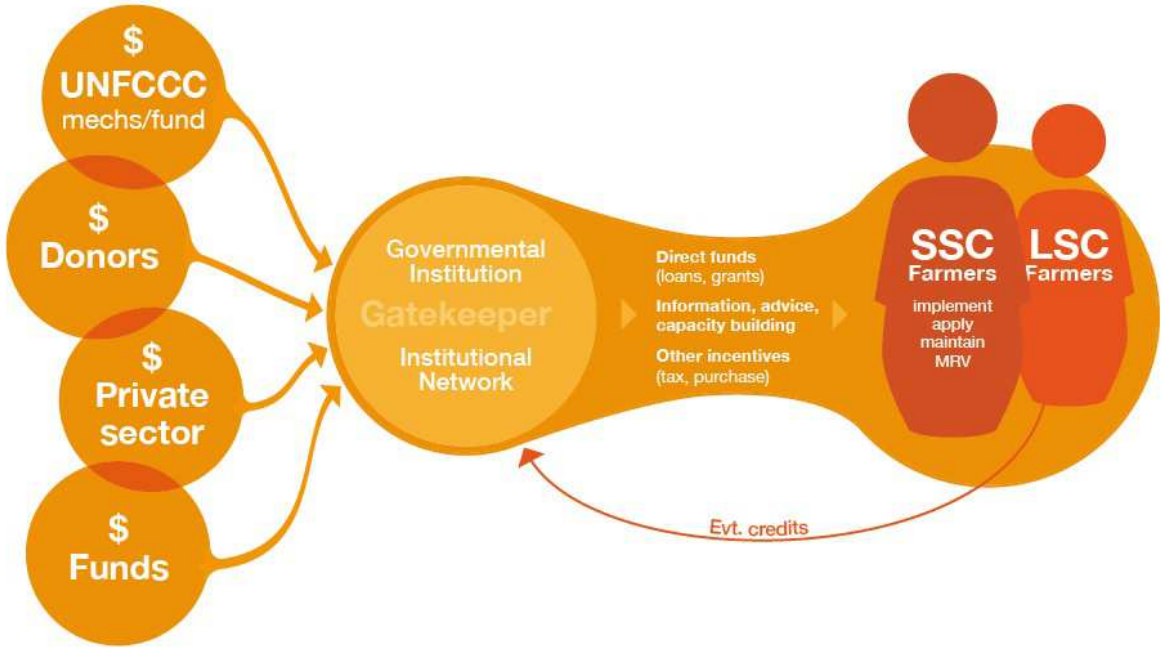
Reflecting all these important lessons learned and functions required, the question arises whether one institution would be able to perform all these functions, or whether a set-up of different institutions seems more reasonable. This cannot be answered in general, since it may depend a lot on the existing institutional set-up in a country as well as the chosen approach towards international climate and development finance. There are some general pros and cons that can be taken into account:

- One institution: the advantage of one institution comprising all these functions could be a more consistent and efficient performance since the functions are not scattered upon different institutions.

Responsibilities and decision-making procedures may be clearer. For receiving external finance, one specific institution might also be attractive to donors at long as it ensures good performance in key issues.

- set of institutions: a set-up of several institutions, like e.g. a network, where different institutions perform different of these functions, could be better able to harness the strengths and experience of different institutions. It would also reduce the risks since bad performance of one institution may not necessarily have adverse impacts on the overall gatekeeper performance. Separating the functions of financial management from issues such as identification of good projects and programmes and managing multiple stakeholder processes can also reduce potential conflicts of interests. What would be important is nevertheless a clear division of labor and responsibilities. Consistency could be ensured through an overall governance body which oversees the strategic performance and sets standards and provisions, but does not rule into the daily business of the performing institutions.

Figure 8: Illustration of the gatekeeper concept



Source: Own illustration

10 Proposals for adjustments of international funding

10.1 Improving mitigation funding instruments

Chapter 5.3 has revealed significant lacks for agriculture mitigation activities in today's funding instruments. In the following we outline options for improvement of these instruments. Hereby we focus on the three main options of Carbon Markets, Carbon Funds and NAMAs:

Carbon Markets

Generally the CDM has proven its suitability to open doors for new mitigation project types in developing countries. To provide further incentives for agricultural mitigation projects existing approaches have to be improved. The success of the manure management methodologies ACM10 and AMS-III.D and methane avoidance AMS-III.E/F/R show that the CDM has enabled CH_4 reduction project types. Under consideration that we identified methane avoidance as an important short-term solution (see chapter 4.8) this is a success and should be continued. Nevertheless all other mitigation options have not been tackled so far, including the important field of cropland management. We strongly recommend **developing innovative CDM methodologies** that provide the base for additional project types. Starting point might be the approved but not applied methodology AMS-III.A as well as the AP "Tillage System Management Quantification Protocol" methodology which led to more than 60 projects already. In addition, further simplification and standardisation of methodologies would help to increase the number of relevant projects.

To facilitate implementation and decrease transaction costs, innovative CDM options such as Programme of Activities and Standardized Baselines should be used. The local gatekeeper institutions, international development organisations and the CDM Executive Board could launch joint initiatives to elaborate additional agriculture methodologies.

Decisive factor for the success will be adequate demand for generated CERs. As the market price is on a historical low level (see chapter 5.1.1.1) that will not be sufficient for many project types, international funds and donors might pay premiums for agricultural credits. Hereby one could develop a new **sustainable benefit standard** that directly aims on food security. Comparable standards exist already: For instance the Gold Standard foundation has recently expanded its concept of validated premium credits to forestry and land-use projects (Gold Standard 2012). Alternatively the host countries' DNAs integrate food security standards in their requirements for approval of agricultural projects.

Carbon Funds

As demonstrated in Table 3 Carbon Funds are successfully financing CDM projects through purchase of CERs from selected project types. As soon as the CDM enables the application of additional agriculture mitigation activities the Funds can play a decisive role by buying CERs, eventually paying premium prices. Funds might also finance projects outside the flexible Kyoto

mechanisms. GEF and ICI provide already resources however most implemented projects are not directly related to agriculture but rather to REDD and carbon sinks. Nevertheless gatekeeper institutions should attempt to access such financial sources for agricultural mitigation activities.
In upcoming climate finance architecture the Green Climate Fund will play an outstanding role. It is the main vehicle to disburse a significant share of the 100 billion of climate finance from industrialized countries to the developing world in 2020. We suggest following and actively participating the debate about the design of "operational modalities, access modalities and funding structures" in order to allow the access of agriculture mitigation activities. Food security synergies might also be included as sustainable benefits that get financially rewarded.

NAMAs

Despite the fact that more than 40 NAMA concepts in the agricultural sector have been proposed, not a single one has officially been accepted or registered under the UNFCCC. One reason is that the approval and implementation of modalities and procedures for NAMAs is still on going on the international level. Detailed definition of MRV, baseline setting and further requirements is not completed yet which in turn hampers the implementation of NAMAs on the ground.
Our recommendation is to observe the development on international level, including the emergence of the UNFCCC NAMA registry and updated definitions and requirements by the COP in the first step. In the second step developing countries should make use of the instrument and its funding opportunities for promoting GHG reductions in the agricultural sector while considering food security benefits. Both developing countries and donor countries should be sensitized to require food security approaches. CDKN might play a mediating role for promoting cooperation of potential donors and implementing countries.

10.2 Improving adaptation funding - shaping the Green Climate Fund

10.2.1 An overview and interpretation of GCF provisions that have potential to promote adaptation funding for the agricultural sector

With the adoption of decision 3/CP.17, the Conference of the Parties to the UNFCCC last year approved the Governing Instrument of the Green Climate Fund. This contains key provisions for the design and further operationalisation of the Fund which were agreed after intense negotiations first in the Transitional Committee and then at COP17 in Durban. Procedurally, the Green Climate Fund Board is now in the driving seat to further elaborate the modalities of the GCF, and it will take some time before the first funding will be approved. By July 2012, unfortunately the process got significantly delayed due to outstanding nominations of GCF Board members from Asia, the Caribbean, and the Group of Latin American Countries. The first meeting of the Board, originally planned for end of April, had to be postponed two times and has not been confirmed yet.

This section will summarise the provisions in the governing instrument that seem relevant to the discussions of this paper. In particular these are the following:

2. [...] In the context of sustainable development, the Fund will promote the paradigm shift towards low-emission and climate-resilient development pathways by providing support to developing countries to limit or reduce their greenhouse gas emissions and to adapt to the impacts of climate change, taking into account the needs of those developing countries particularly vulnerable to the adverse effects of climate change.

From an agricultural viewpoint this mandates the Fund to support activities which contribute to a low-emission and climate-resilient transformation of the agricultural sector or aspects relevant to food security, if a country decides to suggest such initiatives to the GCF.

31. The Fund will provide simplified and improved access to funding, including direct access, basing its activities on a country-driven approach and will encourage the involvement of relevant stakeholders, including vulnerable groups and addressing gender aspects.

Aspects related to direct access will be discussed further, but the reference to a country-.driven approach provides also a justification for a country to determine its own institutional structure to implement activities supported by the GCF. The involvement of relevant stakeholders, including vulnerable groups and addressing gender aspects, is of particular importance in the area of agriculture where often poor smallholders are among the most vulnerable. Their needs and concerns have to be taken into account.

34. The Board will develop methods to enhance complementarity between the activities of the Fund and the activities of other relevant bilateral, regional and global funding mechanisms and institutions, to better mobilize the full range of financial and technical capacities. The Fund will promote coherence in programming at the national level through appropriate mechanisms.

The objective to enhance complementarity also requires to take on lessons learnt in other funds as well as a potential role for filling gaps, which partially have been identified in the above analyses. Furthermore, promoting coherence on the national level is a key objective of the idea of a gatekeeper institution.

36. The Fund will support developing countries in pursuing project-based and programmatic approaches in accordance with climate change strategies and plans, such as low-emission development strategies or plans, nationally appropriate mitigation actions (NAMAs), national adaptation plans of action (NAPAs), national adaptation plans (NAPs) and other related activities.

This mandates the GCF to particularly look at the support for the implementation of existing strategies. Since the starting point for the analyses contained in this paper and carried out in the overall project are the climate change strategies developed nationally, particular attention should be paid to designing the rules of the GCF in a way that they facilitate the implementation of existing plans.

37. The Fund will have thematic funding windows. Initially the Fund will have windows for adaptation and mitigation. An integrated approach to funding mitigation and adaptation will be used to allow for cross-cutting projects and programmes.

The explicit reference to supporting integrated approaches to funding mitigation and adaptation will pose a challenge for the GCF, since, as research in this paper has shown, there is little experience with funding such integrated approaches, or at least rewarding mitigation and adaptation at the same time. This makes it even more important to develop appropriate concepts. If institutions at the national level would be able to ensure such integration based on the needs identified in a country this could also help the GCF to develop appropriate modalities.

40. The Fund will provide resources for readiness and preparatory activities and technical assistance, such as the preparation or strengthening of low-emission development strategies or plans, NAMAs, NAPs, NAPAs and for in-country institutional strengthening, including the strengthening of capacities for country coordination and to meet fiduciary principles and standards and environmental and social safeguards, in order to enable countries to directly access the Fund.

This mandates the GCF to provide particular support to so-called readiness activities, both related to actual implementation of activities as well as to in-country institutional strengthening. Aspects which are also important to any discussion of a gatekeeper concept include country coordination, fiduciary principles and standards and environmental and social safeguards for direct access.

47. Recipient countries will nominate competent sub-national, national and regional implementing entities for accreditation to receive funding. The Board will consider additional modalities that further enhance direct access, including through funding entities with a view to enhancing country ownership of projects and programmes.

The last paragraph elaborates on the direct access modalities by indicating an accreditation process for appropriate institutions, with national funding entities mentioned as a particular type.

Since the GCF Board has not yet been able to start its work, the Governing Instrument of the GCF is currently the only starting point for a further discussion of a gatekeeper institution related to the integrated implementation of adaptation and mitigation in the area of agriculture.
Some key aspects are already enshrined in the instrument, in particular:

- the mandate to support integrated funding approaches;
- several provisions highlighting the need for country ownership;
- the possibility for direct access through national institutions, including national funding entities;
- and indication of aspects for which readiness support should be made available, and which therefore are regarded important from an institutional viewpoint, such as in-country coordination, fiduciary principles and standards, and environmental and social safeguards.

11 Conclusion and recommendations: Agricultural mitigation and adaptation in the context of CCD (trade-offs and synergies)

In the following we list the main conclusions that have been identified in the context of this report. The focus is particularly on synergies and trade-offs of mitigation and adaptation/food security in the agricultural sector and options how to overcome such barriers. Recommendations are derived for both developing country governments confronted with the challenge of food security but also for multilateral and international institutions such as CDKN.

Main conclusions regarding agricultural mitigation and adaptation activities:

Being responsible for about 50% of global methane emissions, **CH_4 reduction in the agricultural sector** has been identified to be an environmental and political priority. The carbon market instruments currently cover activities in this area so there is experience which can be drawn on. However increased food security is not reflected yet.

Recommendations:

- The successful application of the existing carbon market instruments (most notably the CDM) in terms of registered project activities and mitigated GHG emissions should be continued. Lessons learned should be disseminated and funds might provide ex-ante financial support and premiums to enable projects in more countries. Potential negative implications that might result from a carbon market extension into the agricultural sectors outlined in section 5.1.1 should be considered and mitigated.
- A new standard e.g. “Food Security Gold Standard” would guarantee that the project combines needs regarding mitigation and adaptation/food security at the same time. Minimum requirement is to either keep the current status of food supplies or improve it. Projects that do not fulfil such standard should not receive a LoA from the respective DNA. The same should count for other instruments such as NAMAs or carbon funds.
- The reduction of methane emissions offers a chance to capitalize synergies between mitigation, adaptation, and food security: Reducing chemical fertilizers both mitigates methane emissions and sustains healthy soils for long-term food security. Moreover, improving rice cultivation through the introduction of a controlled irrigation system can reduce methane emissions which are significantly higher when continuous irrigation/flooding occurs. In terms of adaptation this reduces water demand and safeguards food security as a reduction of irrigation water by 16-35% does not decrease yields.

Even though the mitigation potential is expected to be tremendous, **improved cropland management** has hardly been tapped by funding instruments yet. It bears several positive synergies

between mitigation, adaptation, and food security. Its mitigation potential lies at 700 Mt CO_2-eq/year at a price level up to 20 USD/t. Prospects for adaptation are significant as soil conditions are improved, most likely leading to stable food security conditions. High transaction costs, missing methodologies and the low carbon price are expected to be main challenges. Some activities lead to negative trade-offs in the short and mid-term which directly endangers food security.

Recommendations:

- Existing instruments need to be improved to successfully promote cropland management activities. Methodologies for carbon market mechanisms, support of pilot-NAMAs and shaping post-2012 mechanisms are suitable approaches.
- For agricultural practices that include **clear negative trade-offs** such as unpreventable reduced yields in the short and mid-term, compensation is required. Both international funding instruments and the gatekeeper institution will have to promote interim support otherwise practices like reduced tillage, improved agricultural practices or agroforestry will have no incentives for farmers.

According to the IPCC there is a huge potential for **agricultural adaptation options** in developing countries. Being rather cost-effective they can also directly reach the local level, for instance small-holders and farmers. Our analysis has highlighted a number of community based adaptation options: improving water management practices such as building infrastructure for more efficient irrigation systems and small-scale water capture, storage and use, using short-cycle varieties, introducing drought and flood tolerant varieties as well as crops and cultivars with disease resistance traits, adopting practices to conserving soil moisture, organic matter and nutrients, and setting up community-based seeds and grain banks. On top of that positive synergies between mitigation and adaptation are found when improving nutrient use, residue management and tillage (only in the long term), when combining agricultural and forestry technologies (agro-forestry), advancing fire management, when pursuing long-term animal breeding, as well as enhance manure management. Our research has shown however that awareness of potential synergies and trade-offs is often lacking, particularly among project developers and funding entities.

Recommendations:

- To close knowledge gaps and increase climate change resilience it is recommended that funding institutions thoroughly analyse funded agricultural projects and draw constructive and practical lessons from existing projects. Further, those institutions are advised to look at specific practices those projects have applied. This can support interested project developers from developing countries to gather ideas and align them to local specific conditions.
- Furthermore it is important to consider and apply traditional knowledge on different adaptation options (e.g. seed varieties, crops or land management) as most of these strategies have been long-standing, tested first-hand in many developing countries, and are in part also useful for mitigating climate change. In addition, the work of the Consultative

Group on International Agricultural Research (CGIAR), which is a global partnership that unites organizations engaged in research for a food secure future, should also be given consideration, as they take traditional landraces, identifying sources of desirable characteristics crossing them into higher-yielding varieties.

Main conclusion to overcome barriers: The gatekeeper institution:

The analysis of agricultural mitigation and adaptation funding instruments has revealed a significant **fragmentation** of both international support sources and domestic implementation. Homogenised approaches on the international support level are rare. A variety of adaptation and mitigation funds, carbon market mechanisms, NAMAs under the UNFCCC and bilateral finance provide support. They differ in terms of eligibility criteria, requirements, transaction costs, access procedures and MRV. On the domestic level sufficient agricultural area is required to successfully make use of mitigation approaches. As usually large numbers of smallholders farm the land, information, coordination and monitoring has been identified as a main challenge. To overcome these barriers the authors recommend "**gatekeeper institutions**" on the domestic level that are responsible for linking the international to the local level.

Recommendations:

- Gatekeeper institutions require **high fiduciary standards** to receive and manage funds – from a donor perspective but also from the point of view of domestic stakeholders interests' in social or environmental integrity. Knowledge of agricultural settings, climate change mitigation and adaptation expertise as well as the ability to manage large numbers of stakeholders are additional, important needs.
- Developing countries are recommended to build gatekeepers on operational existing institutions from the adaptation or mitigation sector. Identified candidates performing certain functions within such a gatekeeper concept might be NIEs, DNAs, related ministries or non-governmental organisations. In case such institutions are not suitable or do not exist new structures which are explicitly envisaged to fulfil the requirements described above have to be set up. Both from a food security as well as a climate change view point it is important that there is the ability to involve multiple stakeholders, taking into account there specifics as well as being able to prioritize certain target groups and project types. In regard to the number of gatekeeper institutions that are advised to be set up, the following arguments should be considered:
    - Establishing one gatekeeper institution has the advantage of less coordination effort and thus faster processing times for project proposals and implementations. One organization would also be effective as mandates are clearly defined and partners (funding institutions, farmers, associations, etc.) do not have to deal with getting in contact with a number of different institutions.
    - The second option is to compose a network of several institutions which would perform different functions of the gatekeeper and which jointly manage the whole

process. This option has the advantage of being able to draw knowledge and experience from a number of other institutions and thus increases the capacity of the set of institutions. In addition, the outreach of several institutions, especially to small-holders and rural farmers is likely to be higher as there are more links to external partners.

- Gatekeepers are recommended to **identify and provide options to resolve** the **trade-offs** between mitigation and adaptation/food security analyzed above.
- Main objective of the gatekeeper is to **overcome the fragmentation** of funding sources and domestic implementation options. The ability to manage the access to and disbursement of funds to a variety of scattered recipients requires a high level of organizational capacity. It is recommended to disseminate the identified results of this report among developing countries, initiate a discussion process that involves stakeholders from different domestic levels of society and finally support the set-up of gatekeeper institutions. Multilateral and international institutions such as CDKN are suggested to actively promote and support this process.

Main conclusion to stimulate a holistic approach in terms of financing mitigation and adaptation activities

To date, there is no adequate mechanism that particularly encourages funding institutions to focus on an integrated approach to address climate change mitigation, adaptation, and food security. Indeed, the dichotomy between mitigation and adaptation in the international climate arena is dangerous when considering realities on the ground.

Recommendations:

- The establishment of the Green Climate Fund bears a lot of potential as it will be the first multilateral funding instrument with the explicit mandate to fund an integrated climate change approach. However, as research in this paper has shown, there is little experience with funding such integrated approaches, or at least rewarding mitigation and adaptation at the same time. This makes it even more important to develop appropriate concepts. If institutions at the national level would be able to ensure such integration based on the needs identified in a country this could also help the GCF to develop appropriate modalities.
- It is important that international institutions on the one hand create an enabling environment for such integrated approaches, for instance though transferring the experiences made when addressing sustainable development - a prime example when it comes to applying the holistic approach. On the other hand there is the need to finding adequate financing instruments for on-the-ground application – adaptation and scaling up – of adaptation and mitigation measures. This is also means to ensure that relevant levels of financing will reach the application levels, in general, as specifically smallholders or farmers.

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Annex 1: Agricultural methodologies used in carbon market projects

I. Approved methodologies

Activity	Standard	Description	Registered Projects		Projects at validation	Credits issued (in ktCO2e)	Registered Projects		Projects at validation
			Number	Where			Number	Where	
Manure management and biogas production	CDM	ACM10: GHG emission reductions from manure management systems	6	China 4, Chile 1, Vietnam	10	52	-		
	CDM	AMS-III.D. : Methane recovery in animal manure management systems	154	Mexico 71, Philippines 36	56	616	1	Brazil 1	17
	VCS	uses UNFCCC and CAR Meths for manure management	2	USA	3	47	N/A		
	CAR	U.S.& Mexico Livestock Project Protocol	27	USA 26, Mexico 1	59	602	N/A		
Composting in combination with fertilizer avoidance	CDM	AM0039: Methane emissions reduction from organic waste water and bioorganic solid waste using co-composting	5	Indonesia 3, Malaysia 2	5	-	-		-
Improved cropland management	CDM	AMS-III.A. : Offsetting of synthetic nitrogen fertilizers by inoculant application in legumes-grass rotations on acidic soils on existing cropland	0	-	0	-	-		-
	AP	Tillage System Management Quantification Protocol - Updated February 2009	66	Canada, Alberta		N/A	N/A		
	VCS	VM0017 Adoption of Sustainable Agricultural Land Management v1.0	0	-	0	-	N/A		
Improved rice production management	CDM	AMS-III.AU Methane emission reduction by adjusted water management practice in rice cultivation	0	-	1	-	-		-
	CAR	Rice Cultivation Project Protocol v1.0: Dry seeding (DS) with delayed flood and/or Post-harvest rice straw removal and baling (Baling)	0	-	2	-	N/A		
Methane avoidance	CDM	AMS-III.E.: Avoidance of methane production from decay of biomass through controlled combustion, gasification or mechanical/thermal treatment	33	Brazil 11, Malaysia 10, In	21	4,976	-		1
	CDM	AMS-III.F: Avoidance of methane production from biomass decay through composting	42	Malaysia 26, Indonesia 7	33	56	2	Uganda 1, Ind	9
	CDM	AMS-III.R. : Methane recovery in agricultural activities at household/small farm level	4	China 3, India 1	29	32	1	China 1	7
Fertilizer management	ACR	N2O Emission Reductions through Changes in Fertilizer Management	0	-	0	-	N/A		
Livestock feeding management	AP	Including Edible Oils in Cattle Feeding Regimes Quantification Protocol - v3.0 July 2011	0	-	0	-	N/A		
	AP	Reducing Days-On-Feed of Beef Cattle Quantification Protocol - v2.0 July 2011	0	-	0	-	N/A		
	AP	Dairy Cattle Emission Reduction Quantification Protocol - v1.0 January 2010	0	-	0	-	N/A		
	AP	Innovative Feeding of Swine and Storing and Spreading of Swine Manure (Pork) Quantification Protocol	0	-	0	-	N/A		
Livestock lifecycle management	AP	Reduced Age at Harvest of Beef Cattle Quantification Protocol - v2.0 July 2011	1 with problems	Canada, Alberta		-	N/A		

II. Methodologies under development

Activity	Standard	Description				
Fertilizer management	CAR	Nitrogen Management Project Protocol				
	ACR/VCS	N2O Emission Reductions through Fertilizer Rate Reduction (ACR and VCS have same proposed meth)				
Improved cropland management	CAR	Cropland Management Project Protocol				
Improved grassland management	VCS	Methodology for Sustainable Grassland Management (SGM)				
	VCS	VCS Methodology for Agricultural Land Management: Improved Grassland Management				
	VCS	ALM Adoption of Sustainable Grassland Management through Adjustment of Fire and Grazing				
General soil carbon management	VCS	Methodology for Soil Carbon				
Improved rice production management	ACR	Emission Reductions in Rice Management Systems				
	VCS	Calculating Emission Reductions in Rice Management Systems				

Source: Own research based on ACR registry 2012, AP 2012, CAR 2012, UNFCCC 2012a, VCS 2012

Explanation of standards:
ACR: American Carbon Registry
AP: Alberta Protocol
CAR: Climate Action Reserve
CDM: Clean Development Mechanism
VCS: Verified Carbon Standard

Annex 2: NAMAs with agricultural components

Country	NAMA	Already listed in GW background paper?
Brazil	An integrated crop–livestock system (range of estimated reduction: 18 to 22 Mt CO2 eq in 2020)	
	No-till farming (range of estimated reduction: 16 to 20 Mt CO2 eq in 2020)	
	Biological nitrogen fixation (range of estimated reduction: 16 to 20 Mt CO2 eq in 2020)	
Central African Republic	The promotion of improved techniques by using nitrogen-fixing species	
	The multiplication and popularization of forage seed in grazing areas (Ouham, Ouham-Pendé and Nana-Mambéré)	
	The intensification of the production of improved farming seeds by farmers	
Chad	The multiplication and popularization of forage seed	
	The upgrading of farms	
	Composting and organic fertilizer-making	
Colombia	Elaboration of agriculture MACC	
Ethiopia	The application of compost on 80,000 km2 of agricultural land of rural local communities to increase carbon retention by the soil;	
	The implementation of agro-forestry practices and systems on 261,840 km2 of agricultural land to improve livelihoods and for carbon sequestration;	
Eritrea	Implement projects and programmes that enhance soil carbon stocks in agricultural soils	
	Develop and elaborate appropriate and integrated plans which are supportive of both adaptation and mitigation actions for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas affected by drought and desertification, as well as floods	
Gabon	Annual crop potential, from 3.5 million m3 in 2010 to 14 million m3 in 2020 (4 million m3 with own funds and 6.5 million m3 with the support of various international mechanisms);	
Ghana	Land preparation:	
	• Uncontrolled burning practised ('business as usual'): promote spot and zero burning practices;	
	• Mechanized land preparation practised ('business as usual'): promote minimum tillage and incentivize the use of biofuels for mechanized agriculture;	
	Cultivation:	
	• Use of nitrogen-based fertilizers ('business as usual'): promote the use of organic fertilizers and the integrated use of plant nutrients;	
	• Predominant cultivation of rice in low lands ('business as usual'): promote the cultivation of high-yielding upland rice;	
	Harvest to post-harvest:	
	• Burning of crop residues practised ('business as usual'): promote the recycling of crop residues;	
	• High post-harvest losses ('business as usual'): improve storage facilities and promote the use of post-harvest technologies	
Indonesia	Introduction of low methan rice variety	
	Irrigation efficiency	
	Organic fertilizer utilization	
Ivory Coast	Development of sustainable farming	
Jordan	Growing perennial forage in the Badia region	
	Best management practices in irrigated farming fertilization applications;	
	Use of CH 4 emitted from livestock and chicken production and slaughter houses	
Madagascar	Multiply forage seeds and popularize them in grazing regions	
	Intensify the production of improved agricultural seeds	
	Produce compost and high-quality organic fertilizers in rural areas in the Agricultural Investment Zones	
Macedonia	The transposition and implementation of the European Union Common Agricultural Policy legislation;	
	• The completion of institutional and legal reforms in the irrigation sector;	
	• Increasing institutional and individual capacities for the application of available European Union funds;	
	• The development of a system for the application of good agricultural practices;	
	• Financial support in order to motivate farmers to use mitigation technologies;	
	The introduction/development of GHG mitigation technologies in agriculture:	
	• The installation of CH 4 recovery and flaring systems at selected farms;	
	• A research support programme for the development of new mitigation technologies and the transfer of existing ones;	
	• A programme for the introduction of practices that harness the potential of the agriculture sector for the use of renewable energy and carbon sequestration;	
	Programmatic CDM projects:	
	Strengthening the national and local capacities for carbon financing:	
	• Training with regard to the CDM potential in the agriculture sector;	
	• Training with regard to the preparation of CDM documentation;	
	Education (of experts/farmers/decision makers) with regard to the application of mitigation measures/technologies in the agriculture sector:	
	• Upgrading the current curricula and syllabus with climate change mitigation issues;	
	• Training farmers with regard to the adoption of new technologies;	
	• Familiarizing the public and institutions with the problems of climate change mitigation;	
Mongolia	Limit the increase in the total number of livestock by increasing the productivity of each type of animal, especially cattle.	
Morocco	The improvement of the farm land yield. Mitigation potential: 2,025 kt CO2/year;	
Sierra Leone	The introduction of conservation farming and the promotion of the use of other sustainable agricultural practices (e.g. agroforestry)	
Tunisia	Increasing the areas devoted to biological farming, to reach 500,000 ha in 2014	
	Upgrading farms according to international standards, and promoting the use of new water-saving techniques in irrigated perimeters to cover at least 200,000 ha, compared with 120,000 ha in 2009	
	Reinforcing the programmes for brackish water desalinization and the reuse of treated wastewater, including in the framework of the implementation of the national strategy on water resource mobilization by 2050, using the best energy-saving and water-saving technologies to support agriculture, the fight against desertification, land protection, and forest and pastoral tree planting.	

Source: UNFCCC 2012b

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