THE Rockefeller Foundation

EVALUATION OFFICE

SYNTHESIS REPORT

Lessons and Challenges in Building Climate Resilience and Promoting Carbon Markets for Poverty Reduction in African Agriculture

September 2011

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This synthesis report was written by Paula Silva Villanueva and peer reviewed by Lars Otto Naess with financial support provided by the Rockefeller Foundation

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Preface

Throughout its history, the Rockefeller Foundation has supported agricultural development as a means of achieving poverty reduction and food security. Today this work is concentrated in Africa where the vast majority of poor people are dependent on small-scale, rain-fed farms for their livelihoods. These farm families are arguably the most vulnerable people in the world to the negative consequences of climate change.

Thus, when the Foundation's Board of Trustees approved a new Initiative in 2007 on Building Climate Change Resilience, a significant portion of the work was focused on African Agricultural Resilience (AAR). Emphasis was placed on establishing greater capacity within Africa's own agricultural research and development organizations so they could draw upon the best knowledge and practices available locally and worldwide to enhance traditional and to generate new resilience-building strategies.

In 2008, the Foundation began supporting a complementary Initiative on Carbon for Poverty Reduction (CPR). Its goal was to test whether the Foundation could influence the design of climate funds and carbon markets that were being established primarily for climate change mitigation, such that they would also contribute to improved livelihoods in rural communities. It was hoped that farmers in Africa and elsewhere would receive financial incentives for using improved land and forest management practices that increase the amount of carbon stored in trees and soils. These practices not only enhance the productivity, profitability and sustainability of land management systems, they simultaneously help mitigate global warming. In Africa the combined work under the two Initiatives was renamed Climate Smart Rural Development (CSRD) reflecting its potential to achieve three goals simultaneously: i) more resilient farming and land use systems, ii) mitigation of climate change and iii) reductions in rural poverty.

In 2011 the Foundation awarded a grant to ITAD Ltd to evaluate the progress of the AAR, CPR, and CSRD Initiatives, particularly in Africa. In order to understand the evaluation findings in a broader context, the Foundation also asked ITAD to synthesize lessons from similar or related programs in Africa. The result is the following Synthesis Report. The lessons and insights gleaned have been very helpful to us and we hope they will be useful to others as well.

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Acronyms

AAR	African Agriculture Resilience
APEC	Asia-Pacific Economic Cooperation
CA	conservation agriculture
CAADP	Comprehensive Agriculture Development Programme
CC DARE	Climate Change Adaptation and Development Initiative (UNEP)
CDM	Clean Development Mechanism
CIF	Climate Investment Fund of Christian Aid
COMACO	Community Markets for Conservation
CPR	Carbon for Poverty Reduction
CS	carbon sequestration
CSRD	Climate Smart Rural Development Initiative
DEFRA	Department for Environment, Food and Rural Affairs (UK)
DKKV	Deutsche Committee for Disaster Reduction
DRR	disaster risk reduction
EPA	Environmental Protection Authority (Ethiopia)
EW/EA	Early warning and early action
FAO	Food and Agriculture Organization of the UN
FARA	Forum for Agricultural Research in Africa
GHG	greenhouse gas
GTZ	German Agency for Technical Cooperation (now GIZ)
HARITA	Horn of Africa Risk Transfer for Adaption
ICRAF	World Agroforestry Center
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IPACC	Innovative Products for Adaption to Climate Change
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
M&E	monitoring and evaluation
MRV	monitoring, reporting and verifying
NGO	non-governmental organization
NTFP	non-timber forest product
OECD	Organization for Economic Co-operation and Development
SCC	Swedish Cooperative Centre
SEI	Stockholm Environment Institute
SP	social protection
TIST	International Small Group and Tree Planting Programme
UNDP	UN Development Programme
UNFCCC	UN Framework Convention on Climate Change
UNISDR	UN Office for Disaster Risk Reduction
USAID	US Agency for International Development
VER	voluntary emission reduction
WFP	World Food Programme of the UN


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Executive Summary

This synthesis review, prepared with financial support from the Rockefeller Foundation, is a companion report to the evaluation of the Foundation's work on African Agriculture Resilience (AAR) and Carbon for Poverty Reduction (CPR). The synthesis review seeks to identify lessons from a broad range of efforts to build climate resilient agriculture and reduce poverty through carbon markets in Africa. The Rockefeller Foundation and its grantees and partners are interested in learning not only from the Foundation's work but from the work of others, in order to gain a better understanding of what constitutes successful activities for building climate resilient agriculture and what works and does not work in carbon projects for poverty reduction in the agricultural sector.

Agriculture continues to play a key role in the formal economies and in sustaining local livelihoods in Africa. Climate change, in combination with widespread levels of poverty and food insecurity, could potentially have large impacts on the well-being of smallholder farmers and economic growth in the region. Climate resilient agricultural development and carbon markets for poverty reduction are rapidly emerging as key issues for development policy and practice. In ensuring that African agriculture is resilient to the changing climate, it has become imperative to protect livelihoods and to reduce food insecurity. At the same time, the emerging market for carbon may offer new possibilities for agriculture to benefit from land use management practices that sequester carbon, which could, in turn, contribute to poverty reduction.

The report first briefly introduces current debates surrounding AAR and CPR. In spite of wide agreement about the need for AAR and CPR efforts in the region, determining the best ways to approach them remains a contentious and uncertain challenge. The report also examines ongoing AAR- and CPR-type work in the region, based on a rapid desk-based screening of existing programs and projects, and on analyses available in the public domain. Tables 1 and 2 summarize reviewed practices, key findings and early lessons for reviewed adaptation and carbon activities, respectively.

TABLE 1: **Summary of adaptation activities reviewed and common key findings and early lessons**

FOCUS	TYPE OF ACTIVITY	COMMON KEY FINDINGS AND EARLY LESSONS
Protecting farmers and reducing risks	Early warning systems	Farmer adaptation takes place in the context of multiple stressors
	Index-based weather insurance	
Adapting farming practices	Climate information for improvement of farming practices	Focus on long-term change and uncertainty not just short-term risk
	Technological innovation to protect and improve agricultural production	Need to go beyond locally relevant technologies towards an understanding of determinants of adaptation
Supporting livelihoods	Social protection	
	Livelihood diversification	

TABLE 2: **Summary of carbon sequestration approaches reviewed, common challenges and early lessons**

<table>
<tr><th>FOCUS</th><th>TYPE OF ACTIVITY</th><th>COMMON KEY FINDINGS AND EARLY LESSONS</th></tr>
<tr><td>Land-use management</td><td>Crop management, agroforestry, livestock management, biotechnology</td><td rowspan="2">Institutional reforms to reduce transaction costs are critical to enable smallholder participation

Carbon sequestration is a long-term issue, but the poor are often forced into short-term responses

Different local geographies, institutional arrangements and cultural issues are highly influential

Potential trade-offs with adaptation efforts are under-addressed</td></tr>
<tr><td>Water management</td><td>Irrigation systems, water storage, water harvesting</td></tr>
</table>

Based on the review, there appears to be a large potential for synergies between AAR- and CPR-type efforts. However, the inter-linkages and potential trade-offs between these are not well understood. Table 3 shows key crosscutting issues identified in the report that are likely to underpin the success of AAR and CPR, and a set of recommendations for future practice.

TABLE 3: **Crosscutting lessons and recommendations for AAR and CPR**

CROSS-CUTTING LESSONS	RECOMMENDATIONS
Lack of understanding of AAR and CPR work in practice	Support long-term processes and not just projects, including building and partnering institutions and platforms for multi-stakeholder engagement Integrate AAR- and CPR-type efforts with an understanding of potential co-benefits, synergies and trade-offs Ensure that enough flexibility is embedded in program planning and periodically review activities to avoid pathways leading to maladaptation Develop M&E systems and tools to build an evidence base on the contribution of AAR- and CPR-type activities for building resilience, improving food security and reducing poverty
Many non-climatic factors determine the success or failure of AAR and CPR	Focus on understanding local realities and support discussion fora for open negotiation about available and potential trade-offs, expanding smallholders' involvement in planning and policy processes at an early stage Understand underlying causes of people's vulnerability and ensure those are an integral part of programs Support institution-building, partnering and reform to ensure that smallholders have access to markets Work with and support development partners to ensure AAR and CPR activities are integrated within ongoing development efforts
A focus on food production neglects the dynamics that characterize the agricultural sector	Move from a focus on food production to an understanding of the socio-ecological and political dynamics and uncertainties involved Take into account the impact of a variety of innovations in places that have particular ecological and socio-economic conditions Analyze the wider political economy – including actors, interests and policy processes – to understand its potential impact on AAR and CPR efforts Engage with multiple stakeholders policy dialogue and support multi-and trans-disciplinary research

The literature emphasizes that both AAR and CPR need to go beyond the current emphasis on reducing short-term risks, protecting and enhancing food production, and relying on carbon markets as a "silver bullet" for poverty reduction. AAR and CPR efforts need to take a systems approach that integrates biological, technical, institutional and social dynamics. A key concern and gap in existing programs is that AAR and CPR must address access to resources, governance questions, land rights, institutional structures and other dimensions that are root causes of poverty and vulnerability, if they are to be successful in the long term. AAR and CPR thus need to be integrated into broader development processes.

While analysis tends to focus on individual farmers' constraints, it is important to recognize that the choices available to them are dependent on, and shaped by, political processes at all scales. The understanding of such inter-dependencies and the integration of local, national and regional AAR and CPR efforts into the wider context remains limited, yet the long-term success of AAR and CPR efforts in Africa will be highly dependent on their being pursued elsewhere.

The challenges related to climate change, food insecurity and poverty reduction in Africa are ever more closely linked. This report provides a compilation of promising efforts, lessons learned and key challenges ahead. As the importance of AAR and CPR becomes more apparent, it is essential to take a holistic vision of food security, agricultural mitigation, climate change adaptation and agricultural pro-poor development. In an era of rapid change and growing risks, the challenge remains in dealing with a complex and uncertain dynamic landscape where any decisions made today will have significant implications for future choices. AAR and CPR are not a one off-solution but a long-term process of change.


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Introduction

Scope of the report

This report was prepared with financial assistance from the Rockefeller Foundation to synthesize lessons from ongoing efforts related to the Foundation's programs on African Agriculture Resilience (AAR) and land-based Carbon Markets for Poverty Reduction (CPR) in Africa. It aims to identify key aspects and lessons available in AAR- and CPR-type work and determine which could potentially be integrated into a new initiative on Climate Smart Rural Development (CSRD). The report is based on three activities:

- literature review of current approaches and practices in relation to building climate resilient agriculture and carbon sequestration practices that aim to reduce poverty in Africa
- identification of good practices and lessons learned from related programs available in the public domain
- analysis of key aspects and recommendations for the Rockefeller Foundation.

Background

The potential negative impacts of climate change on agriculture have been well documented in recent assessments and reports (Smith *et al.*, 2007; Knox and Hess, 2011). According to the Intergovernmental Panel on Climate Change (IPCC), reductions in greenhouse gas (GHG) emissions today will only have an effect on climate patterns after about 2030 (IPCC, 2007c). Thus to address the challenges of climate change, both mitigation and adaptation actions are essential. In this report,

- *adaptation* is defined as the ability to respond and adjust to the actual or potential impacts of changing conditions in order to reduce harm or exploit opportunities (IPCC, 2007a), and
- *mitigation* refers to actions to reduce GHG emissions and enhance carbon sinks (IPCC, 2007b).

This review derives from the need to gain a better understanding of what constitutes successful efforts to improve the resilience of agriculture to climate change, as well as what works and does not work in projects to reduce carbon emissions in the agricultural sector. Although the question of what constitutes successful adaptation to climate change still does not have a clear answer, the review shows that there are numerous promising agricultural practices for climate change adaptation and mitigation in Africa, including crop diversification, conservation agriculture, agroforestry development, and improved water harvesting. To help policymakers build on their potential, the review assesses the strategies and identifies key lessons learned to date.

Limitations

The scope of this report is limited to the resources available in the public domain, where only a limited number of formal evaluations are available. This is particularly so for monitoring and evaluation of adaptation activities (Silva-Villanueva, 2011). The feasibility of evaluating AAR- and CPR-type efforts is hampered by factors such as the high levels of uncertainty in relation to future climate scenarios and their associated socio-economic impacts, a lack of conceptual agreement on successful adaptation, as well as the choice of proxies to be used for its evaluation. Resources to aid future programming are therefore drawn not only from specific climate change resources, but also from development projects focusing on vulnerability to climate variability.

Structure of the report

The report is structured as follows.

- **SECTION 1.5** outlines the research approach.
- **SECTION 2** presents a literature review of current knowledge on resilience and adaptation in agricultural development, including case studies, lessons learned to date, and common challenges and key issues from current practice.
- **SECTION 3** presents a brief literature review of current knowledge on mitigation through carbon sequestration in land management followed by case studies, lessons learnt to date and common challenges and key issues from current practice.
- **SECTION 4** presents a synthesis of lessons learned and cross-cutting issues that underpin the success in AAR- and CPR-type activities, and proposes key recommendations for future practice.

Research Approach

The review was based on an online search of, *inter alia*, academic papers, meta-analysis reports, conference papers, online discussion fora, and available program documents and publications. The search focused on evaluations, cross-sectoral studies, and policy and research papers covering issues related to interaction among agriculture and climate change and variability; interaction between land management and climate change mitigation and agriculture and climate risk management; how and to what extent carbon sequestration practices help mitigate climate change and variability and reduce poverty; and how and to what extent adaptation and carbon sequestration practices can be considered as integrated in policy and practice.Criteria for selection of literature

The report focuses on the interactions and linkages among climate variability and change, agriculture development, land management and carbon sequestration practices. The review does not claim to cover all literature in the area. Rather, the literature search was done according to the following selection criteria.

- **ARTICULATED LINKAGES AMONG CLIMATE CHANGE ADAPTATION, MITIGATION AND AGRICULTURAL DEVELOPMENT.** The document analyzes the links between agriculture and climate variability and change. It also focuses on how and to what extent adaptation and mitigation strategies have the potential to reduce vulnerability and poverty reduction.
- **AGRICULTURAL AND LAND MANAGEMENT PRACTICES FOR CLIMATE MITIGATION AND ADAPTATION.** The document analyzes what is considered the land management practices "best suited" to i) mitigate climate change and variability, or ii) adapt to and cope with current climatic conditions or maintain carbon stocks and enhance carbon sequestration, while achieving the overarching objectives of poverty reduction.
- **EVALUATIONS.** The document provides detailed information on program results allowing researchers, policymakers or development partners to improve their understanding of successful interventions, the reasons behind them and the characterization of the elements of project design.
- **CASE STUDIES FOCUSED ON LINKAGES AMONG ADAPTATION, MITIGATION AND AGRICULTURAL DEVELOPMENT.** The document analyzes cross-cutting issues on agriculture and climate for specific projects. Selected case studies are about carbon sequestration practices or adaptation strategies to climate change and variability with a strong land management component.
- **GEOGRAPHICAL FOCUS.** The document focuses primarily but not exclusively on Africa.


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Building Climate Resilient Agriculture in Africa

Agricultural development has historically played a central role as a driver of poverty reduction in Africa. Agriculture is a key sector in the formal economy and also provides access to resources to support rural subsistence-based livelihoods. Impacts associated with climate change may therefore be particularly severe for many African countries, as losses associated with extreme periods of climate stress, such as droughts and floods, can result in major impacts on GDP (Boko *et al.,* 2007; Knox and Hess, 2011).

It is projected that crop yields in Africa may fall by 10–15 percent by 2050 due to climate change (Knox and Hess, 2011), particularly because African agriculture is predominantly rainfed and hence fundamentally dependent on climate patterns. Climate change exerts multiple stresses on the factors that underpin agricultural production (Boko *et al.,* 2007). At the same time, it is clear that the actual impacts on agriculture will depend on the interaction of climatic changes with socio-economic factors, international competition, technological development and, importantly, policy choices (Thompson *et al.,* 2007). As the people of Africa strive to overcome poverty and advance economic growth, there are concerns that climate change will exacerbate existing vulnerabilities, erode hard-won development gains and significantly undermine development prospects (Boko *et al.,* 2007). Because agricultural production remains the main source of income for most rural communities in the region, adaptation of the agricultural sector is imperative to protect the livelihoods of the poor and to ensure food security (World Bank, 2010a).

Review of key concepts and current approaches

Framing adaptation and resilience

ADAPTATION is broadly defined as adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (Adger *et al.,* 2007). Farmers have been adapting to climate variability and change from time immemorial. However, given the projected unprecedented pace of change, adaptation to future climate change will mean altering livelihood strategies faster than ever. One key difference with past adaptation lies in the increased need for proactive as opposed to reactive adaptation (Adger *et al.*, 2009b). Most adaptation policies and programs are therefore focused on proactive, planned adaptation and building adaptive capacity. Adger *et al.* (2005) proposed three objectives of planned adaptation:

- reduce the sensitivity of communities to climate change through activities such as increasing water storage capacity, diversification of crops or new types of buildings
- reduce the exposure to climate events through, e.g. disaster preparedness activities or shifting infrastructure away from exposed areas such as floodplains
- increase the adaptive capacity and resilience of communities to cope with changes, through activities that may include actions to enhance livelihood assets and measures such as insurance schemes, to improve populations' ability to recover from loss.

RESILIENCE refers broadly to the capacity of a system to absorb disturbances and still retain the same structure and function, while maintaining options to develop (Folke, 2006) (see also 2.1.2 below). As agriculture relies upon key ecosystem services such as water, energy and carbon sequestration, loss of resilience in ecosystems that maintain these services is a concern. In this context, adaptation and adaptive capacity can therefore be understood as, respectively, the processes and resources that contribute to building resilience in a manner that does not lead to the loss of future options (Nelson, 2011).

Approaches to adaptation and resilience

Research and design of adaptation policies and programs have primarily been defined by two key questions: i) who is vulnerable? and ii) what are they vulnerable to? Answers to these questions have translated into different approaches to adaptation. Each approach puts emphasis on certain aspects of adaptation, but they are all interlinked and to some extent complementary.

Impact approaches: managing and reducing risk

An impact approach understands adaptation as the need to reduce risk and exposure of communities and/or agricultural systems to particular hazards or climate impacts (O'Brien *et al.,* 2004). From this perspective, the vulnerability of the agricultural sector to climate change can be understood as the sensitivity of agricultural production and its resources. Since the large majority of rural populations depend directly on agriculture as the main source of their livelihoods, climatic changes adversely affect not only agricultural production and productivity but also household food security. Thus, considerable attention is given to protecting and increasing agricultural production in a changing climate. From an impact approach to adaptation, most forms of adaptation involve some form of technology, such as new irrigation systems or drought-resistant seeds, or "soft" technologies such as insurance schemes or crop rotation patterns. Adaptation strategies to support smallholder farming communities tend to promote livelihood protection and increase preparedness to extreme events. Activities include infrastructure, early warning systems and the provision of safety nets.

Social science approach: addressing underlying causes of vulnerability and risk

Recent research has demonstrated that attaining food security is more complex than protecting and producing more food (Eriksen *et al.,* 2009). Beyond climate predictions and impacts, understanding why people are vulnerable to impacts of climate change is the key to adapting to negative impacts and to taking advantage of new opportunities that may arise (Adger *et al.,* 2007). A more socially oriented approach towards adaptation has therefore emerged, suggesting that communities have to adapt to multiple shocks and stresses, and that there is a need to address the underlying causes of risk and exposure. In the context of agricultural development, for example, this means that adaptation measures should not only be focused on reducing farmers' exposure and increasing the capacity to tackle droughts, but also secure access to resources, assets and land tenure (Brooks, 2003). From this perspective, the key issues relate to access to food rather than food production

Socio-ecological system approach: building climate resilience

Resilience thinking emphasizes that the vulnerability of agricultural systems is best understood by linking social and ecological systems. Therefore, reducing vulnerability requires an integrated understanding of both systems (Folke, 2006). Resilience is widely seen as a desirable property of a system, particularly in a changing climate. Adaptation strategies within this approach involve fostering systems that can cope with uncertainties and surprises, for example through "learning by doing", flexible planning, and approaches fostering social learning, self-organization and collective action (Bahadur *et al.,* 2010).

Measuring success and failure in adaptation

Attempts have been made to identify key principles of successful adaptation (Adger *et al.,* 2005; Hedger *et al.,* 2008; Doria *et al.,* 2009; DEFRA, 2010). This type of research is still in its early stages of development, and empirical research to support the theoretical understanding of success is still needed. However, some common principles have been identified in the literature, including effectiveness, efficiency, equity, legitimacy and sustainability (see Table 4). While some researchers also identified flexibility and robustness, they saw them as indicators to measure efficiency of adaptation programmes rather than as principles (Adger *et al.,* 2005; Silva-Villanueva, 2011).

TABLE 4: **Principles of successful adaptation**

PRINCIPLES	DESCRIPTION
Effectiveness	An "effective" adaptation is flexible to change in response to altered circumstances and therefore robust against uncertainty.
Efficiency	Efficient adaptation actions involve deciding on acceptable levels of risk in a collaborative way. Efficiency refers to the cost-effectiveness of a particular project, comparing the cost of alternative ways of producing similar results. However, efficiency alone may not justify the intervention itself, as trade-offs may arise when balancing risk with resource investment.
Equity	Successful adaptation actions should not reinforce existing inequalities among communities, sectors or regions. The aim of adaptation programmes is to reduce vulnerability to climate shocks and stresses. However, as mentioned above, vulnerability also depends on a wider-set of socio-economic factors.
Legitimacy	Decisions must be accepted by participants and non-participants that are affected by those decisions.
Sustainability	Sustainability of adaptation intervention refers to looking beyond project duration and its immediate impact. "Those activities that are effective and equitable are more likely to be sustainable" (Hedger et al., 2008:28).

SOURCE: Modified from Adger *et al.*,2005; Hedger *et al*., 2008; and Silva-Villanueva, 2011.

Efforts to define successful adaptation recognize that adaptation can also be unsuccessful. Known as *maladaptation* (Barnett and O'Neil, 2010), it refers to adaptation actions or processes that increase vulnerability to climate change-related hazards or increase the vulnerability of other systems, sectors or social groups. Issues of scale (place and time), and the dynamics and interdependencies involved in adaptation are therefore critical. While an adaptation action can be successful or beneficial for a particular actor or system at a given time, it could have negative effects or externalities on other systems or in the long term.

What is considered successful, effective or legitimate adaptation also depends on what people perceive to be worth achieving and protecting (Silva-Villanueva, 2011). There is a growing body of research and evidence indicating that people's values play a critical role in individual decision-making of adaptation options (O'Brien, 2009; Grothmann and Patt, 2005; Adger *et al.,* 2009a; Carr, 2008; Heyd and Brooks, 2009; Patt and Siebenhuner, 2005; Weber, 2010). Finally, there is a growing awareness of the limitations – both biophysical and cultural – to adaptation, and that regardless of best efforts, losses will occur due to a changing climate.

Uncertainty about weather predictions and their socio-economic impacts are unlikely to decrease in the near future. For policy and practice, the challenge is to find adaptation options in spite of such uncertainty. Limited work has been developed to help policymakers and practitioners manage with such uncertainty beyond the development of "robust" decision-making strategies. The challenge thus remains in dealing with a constantly changing and dynamic landscape. Adaptation is therefore a process of change, not a one-off solution.

Review of current practice and lessons learned

This section reviews existing efforts to support farmer communities in adapting to the changing climate and in building a resilient agricultural sector. As mentioned in previous sections, the number of program evaluations specifically designed to contribute to climate resilient agricultural development is limited. This section provides results from evaluations or lessons learned in the course of program implementation. A summary of the reviewed focus areas and types of activities is given in Table 5.

TABLE 5: **Summary of reviewed adaptation practices**

FOCUS	ACTIVITIES
Protecting farmers and reducing risks	Early warning systems Index-based weather insurance
Adapting farming practices	Climate information for improvement of farming practices Technologies to protect and improve agricultural production
Supporting livelihoods	Social protection Livelihood diversification

Protecting farmers and reducing risk

A growing body of literature demonstrates the correlation between disaster risk, poverty and food insecurity (UNISDR, 2011). Key features of the reviewed programs include reducing risk in order to protect farmers, their crops and livelihoods, and to ensure that farmer communities are prepared to respond to extreme weather events such as floods and droughts. Many incorporate an explicit focus on early warning systems and establishment of emergency funds. Risk transfer approaches, including index or weather insurance, are also receiving increasing attention.

Early warning systems

The ability to implement early warning systems has become increasingly important for improving the capacity to adapt to climate change (IFAD, 2009; UNISDR and DKKV, 2010). For example, the Red Cross/Red Crescent has implemented the Early Warning and Early Action (EW/EA) framework in 14 countries in West Africa. One key feature of the EW/EA framework is dissemination of appropriate information to communities using low-cost communication networks ogy includes identifying the communities at risk and building a dialogue with the communities' leader/management structure, training local volunteer committees in translating meteorological information into intelligible messages and actions, and linking early warning to action through contingency planning (Red Cross, 2010, cited in Clements *et al.,* 2011).

BOX 1

Index-based insurance – Lessons to date from available evaluations

- **Location-specific** encompasses multiple factors; the climatic risks of a region must be well understood and well modeled
- **Local culture** must be considered when assessing the demand for the product;.
- **Community partnership** should be sought from the initial stages of program design.
- **Two-level integration – local and international level – is needed.** At the local level, it must be used with other strategies to improve farmers' resilience to climate variability and change. At a higher level, pooling of risk at the international level will reduce risk to local insurers who are reticent to offer agricultural insurance because of the high risk that it carries.
- **Access to improved inputs and extension services** and to well-managed farms must be paired with agricultural insurance for it to be effective.
- **A long-term strategy** is essential in order to enable farmers' adaptation to climate change. The strategy must be flexible, however, given the changing climate and often-unstable social and political environments.

Index-based weather insurance (Box 1)

Agriculture is an inherently risky economic activity. A large array of elements can affect output production and prices, resulting in highly variable economic returns to farming households. In recent years, there has been a shift away from insuring against poor crop yields and towards insuring directly against bad weather. Index-based agricultural insurance programs have been growing in popularity among NGO and international organizations as well as in developing country governments seeking to reduce farmers' vulnerability to weather extremes (Arnold, 2008; IFAD, 2010). These programs are advocated on the grounds that they can provide timely and predictable payouts following an extreme event, enable greater access to credit, technology and livelihoods inputs, incentivize risk reduction activities and provide space for longer-term development planning (Hazell *et al.,* 2010; Vermeulen *et al.,* 2010). However, it may not be suitable everywhere, and needs to be seen as part of broader agricultural investments. According to Hazell et al. (2010:95), "Index insurance can enhance existing agricultural supply chains and businesses. However, it would not be the most appropriate tool everywhere in the country – some crops are more weather-resistant than others – and is best suited to drought-prone areas. It can help support expansion in rural finance and agriculture, but must go hand-in-hand with investments in related areas such as extension services and irrigation." The potential of index insurance to help manage climate variability is being tested in a growing number of African countries. For example, the GTZ Innovative Products for Adaptation to Climate Change Programme (IPACC) works with insurance companies to analyze the demand for innovative insurance policies that exists within specific value chains, such as maize, cacao, rubber or bananas, and to decide what products can be developed and sold. GTZ reports that the program is improving income and food security, as well as access to credit and employment opportunities for Ghana's rural population. The lessons learned have yet to be systematically processed and transferred to other countries in Africa and beyond (GTZ, 2010b).

Adapting farming practices

Approximately 80 percent of all Africans depend directly or indirectly on agriculture for their livelihoods and food security (FARA, 2010). It is expected that climate change will put increased pressure on agricultural production (Boko *et al.,* 2007). The following are some of the farming practices being promoted for adaptation to climate change.

Climate Information for improving farming strategies (Box 2)

It is widely recognized that seasonal climate information can help small-scale farmers reduce the negative impacts of climate variability. Providing localized weather and climate information to farmers can improve farming decision-making and opportunity management. Many adaptation programs incorporate elements of improving seasonal forecasts and their dissemination to vulnerable farmer groups. Observations from a number of programs reveal that efforts to improve access to relevant climate information are helping build farmers' confidence in the value of forecasting (Vermeulen *et al.,* 2010). For example, Christian Aid's Climate Investment Fund (CIF) initiatives look to innovate ways to increase livelihood resilience to projected climate change (Christian Aid, 2011). In Tanzania, farmers had a chance to analyze their own traditional indicators and combine these with scientific forecasts. Despite considerable skepticism beforehand, the initiative had successful outcomes. It led to a greater understanding of what scientific basis there may be to local knowledge and, at the same time, highlighted the uncertainty involved in meteorological forecasts, which in turn motivated farmer field-schools to establish rain gauges. In their words, the initiative is "enabling a two-way communication on meteorology and rainfall that can be used for further training and livelihood decision-making" (Christian Aid, 2011).

The experience of projects that aim to bridge the gap between scientific and indigenous forecasting methods suggests that working with traditional knowledge providers can extend the reach of climate information

BOX 2

Climate information at the local level – Lessons to date from available evaluations

- The limitations of seasonal forecasts demand **farmers test a robust range of options**
- **Forecasts alone are insufficient** – they must be accompanied by decision aids and complementary information that is updated over the season
- Farmers need information in **languages and forms** they understand and trust
- Working with **indigenous forecasters builds community trust** and can widen dissemination and uptake of forecasts

to more rural farmers, and in languages and forms that are useful to them (Ziervogel and Opere, 2010). The value of these efforts may lie as much in the trust and increased uptake they engender as in any potential increases in forecasting accuracy. Farmers are strongly motivated to use good climate information if it is in forms and languages they can use, especially if it includes relevant advice and decision-making tools (Ziervogel and Opere, 2010).

Technological innovation to protect and improve agricultural production

Farmers have always carried out adaptive changes to their practices based on observed weather patterns. In the short term, farmers respond by altering crops, cropping patterns and farm management practices. With likely long-term changes in rainfall patterns and shifting temperature zones, climate change is expected to significantly affect agricultural production, which could be detrimental to the region's food security and economic growth. Many of the technologies proposed for adapting farming practices are not new to agricultural production practices (see Annex 2), but they are implemented based on the assessment of current and possible future impacts of climate change in a particular location. Many of the projects reviewed focus on supporting agricultural practices such as soil conservation, efficient use of water resources through improved irrigation systems, land management, or introduction of new technologies such as drought-resistant crops. A wide variety of different approaches have been found, including conservation agriculture (FAO, 2011), agro-ecology, evergreen agriculture (Word Agroforestry Centre, 2009), organic agriculture (IFOAM, 2009) and climate smart agriculture (FAO, 2010) (see also Section 3). Most of these interventions attempt to increase agricultural productivity while increasing resistance to climate variability and change.

Conservation Agriculture (CA) (Box 3)

CA aims to foster natural ecological processes to increase agricultural yields and sustainability by minimizing soil disturbance, maintaining permanent soil cover and diversifying crop rotations (FAO, 2011). It is a farming approach that is being taken by several organizations. For example, the UN World Food Programme (WFP) (Urquhart, 2010) and the UN Food and Agriculture Organization (FAO) (Silici, 2010) support conservation agriculture (e.g. in Lesotho and Zambia), and appropriate cropping systems and drought-resistant crops. In Malawi, for example, early maturing crops are promoted in combination with building capacity on small-scale irrigation (Urquhart, 2010).

In Africa, numerous studies have documented yield increases associated with a shift to CA practices, across a range of geographies and crops (Mloza-Banda and Nanthambwe, 2010). Yet empirical evidence is not clear or consistent on many of the positive claims

BOX 3

Conservation Agriculture – Lessons to date from available evaluations

- Vulnerable smallholders in Africa are particularly **unlikely to adopt CA spontaneously**
- **Long-term support is required** due to the complex, knowledge-intensive nature of CA. The process of CA adoption in rural communities may take 3–5 years, while it may take even longer to build the capacity and confidence of farmer and community groups to become self-sustaining after the project ends.
- **Need to build local capacity** to facilitate future adaptability to climate change.
- Increased **project flexibility** is a must for responding to climate change or other perturbations as they arise.
- **Large-scale perspectives** are critical, and programs should be designed to balance the potential benefits, trade-offs and costs.

of CA in relation to increased yields, improved soil fertility and reduced erosion points (Giller *et al.,* 2009). There are emerging critiques which question such claims. Concerns include decreased yields often observed with CA, increased labor requirements, an important gender shift of the labor burden to women and a lack of mulch due to poor productivity and the priority given to feeding of livestock with crop residues (Giller *et al.,* 2009). Giller *et al.* (2009) called for a critical assessment to determine under which ecological and socio-economic conditions CA is best suited for smallholder farming in sub-Saharan Africa.

A study by Milder *et al.* (2011) reviewed evidence on the practice, outcomes and potential of CA in sub-Saharan Africa as an approach to increasing food security, alleviating poverty, conserving biodiversity and ecosystem services, and supporting climate change adaptation and mitigation at local to global scales. The study focused on answering the key question: *Are CA projects significantly increasing farmers' ability to adapt to current climate variability and future climate change?* The study acknowledged that none of the existing CA frameworks were designed specifically to assess the climate change adaptation benefits of CA. However, the evaluation concluded that some of the most important adaptation benefits of CA projects and programs arise not from site-scale agronomic practices but from associated investments to improve local knowledge, capacity, social capital, market access, seeds and financial service.

Agro-ecology

Agro-ecology is a common approach that encompasses concepts of sustainable production and biodiversity promotion, and therefore provides a useful framework for identifying and selecting appropriate adaptation technologies for the agriculture sector. Analyzing farm practices highlights the close link between climate change adaptation and mitigation in the agricultural sector (Speranza, 2010) (see Section 4). Newsham and Thomas (2009) found that agro-ecological knowledge in North-Central Namibia has historically served farmers as a source of adaptive capacity to considerable climate variability, permitting settled agriculture in areas prone to recurring episodes of drought and flood. The authors suggested that local knowledge may also strengthen resilience to future climate change impacts. Newsham and Thomas found instances of "knowledge co-production" that occur through interactions between this body of knowledge and the science that informs agricultural extension policy and practice as especially promising, and called for a focus on "hybrid knowledge" for sustainable farming.

Supporting livelihoods

This section briefly describes a few examples of adaptation programs that include livelihood components.

Social protection (SP)

There is an emerging recognition of the role of social protection as a response to the multiple risks and short- and long-term shocks and stresses associated with climate change (Davies *et al.,* 2009) leading Stern (2006) to argue that social protection could become one of the priority sectors for adaptation in developing countries (Stern, 2006, cited in OECD, 2009). As this is an emerging field of practice, there is limited evidence on what role social protection schemes may play in adaptation to climate variability and change. However, there is ample evidence that SP plays a role in helping reduce food security and protect livelihoods (Davies *et al.,* 2011). One example, the Horn of Africa Risk Transfer for Adaptation (HARITA), supports poor farmers and landless rural households who are participating in food and cash for work projects in Ethiopia to pay for their insurance with their own labor through insurance-for-work (Oxfam, 2010). HARITA combines community disaster risk reduction with support to enable households to take "smart risks", i.e. allowing them to build more sustainable and resilient livelihoods that are protected through insurance and savings (Oxfam, 2010). An evaluation of the HARITA project found that the vast majority of each cash transfer was spent on food, mainly maize. People made other small but at times crucial non-food expenditures, including spending on health and educational resources and agricultural subsidies. However, food prices in Ethiopia rose much more than anticipated which made items less affordable. Key lessons from the evaluation included:

- cash transfers require effective targeting and delivery in the context of climate change
- markets and prices need to be better monitored in order to understand the impact of cash transfers and to determine whether they are appropriate mechanisms
- cash transfers can help alleviate poverty in the longer term and reduce the impact of periodic shocks (Oxfam, 2010).

Livelihood diversification (Box 4)

Livelihood diversification as an adaptation strategy is another area receiving increasing attention (Chuku and Okoye, 2009). Livelihood diversification can spread risks temporally and spatially, thus reducing the vulnerability of livelihoods. However, critics argue that it may translate into individuals moving to low-value activities and falling further into so-called "poverty traps" (Dercon and Christiaensen, 2007). It is therefore argued that when promoting livelihood diversification activities, adaptation policy needs to facilitate diversification simultaneously into higher-value activities and low-carbon development (Newsham and Thomas, 2009). As an example, the Climate Change Adaptation Program of the International Union for Conservation of Nature (IUCN) concluded that many of the diversification activities identified for the pilot sites were typical "business as usual" livelihood improvement activities (Swennenhuis, 2010). Although this finding was in itself a valuable lesson, it also raised the question of the potential of these activities to contribute effective lessons for adaptation. One area with potential for lessons is analyzing how climate proof the proposed activities are. In other words, how far can they be expected to provide viable livelihoods in the long term?

BOX 4

Livelihood diversification - Lessons to date from available evaluations

- **Analyze potential negative impacts on vulnerable groups and ecosystems** and adjust design and implementation of the activities.
- Identify and, where possible, **address economic, financial and socio-cultural factors hampering adoption** and scaling-up.
- **Engage expertise from development partners.**
- **Ensure an effective mainstreaming of the ecosystems approach** and give priority to activities with strong ecosystems aspects
- **Promote diversification into higher value activities and low-carbon development** simultaneously

Analysis and discussion – Key issues emerging from current practice

Several common characteristics have emerged from the case studies above.

- **FARMER ADAPTATION TAKES PLACE IN THE CONTEXT OF MULTIPLE STRESSORS.** Agricultural production systems are embedded in economic, social, environmental, political and cultural contexts. However, many of the adaptation programs maintain a sectoral and technical focus on the climatological, physical and biological aspects of climate change impacts without taking into account the socio-economic aspects of vulnerability. Recent research (Silici *et al.,* 2010) highlighted that change in land use and livelihood strategies was driven by adaptation to *a range* of factors of which climate appeared not to be the most important. Bryan *et al.* (2009) identified factors influencing farmers' decision to adapt, which in Ethiopia included wealth, access to extension, credit and climate information and in South Africa, included factors such as wealth, government farm support and access to fertile land and credit. Along similar lines, Enete *et al.* (2011) found that the major factors constraining farmer's adaptation options in southeast Nigeria were poverty, farmland scarcity, inadequate access to more efficient inputs, lack of information and poor skills, and land tenure and labor constraints.

- **FOCUS ON LONG-TERM CHANGE AND UNCERTAINTY, NOT JUST SHORT-TERM RISK.** The dominance of impact and hazard-based approaches can be seen in most of the programs adopting disaster risk reduction practices and interventions. Many calls have been made for the integration of climate change adaptation and disaster risk reduction (DRR) policies and practice. However, as pointed out by Mitchell *et al.* (2010), adaptation does not equal DRR, and effective disaster risk management in a changing climate is more than "business as usual". Adaptation to a changing climate must entail the long-term adjustment to changes in mean climatic conditions, including the opportunities that this can provide. In addition to the temporal scale differences, attention is now turning to the ability and capacity of risk managers to deal with uncertainty, surprise events and variability in climate patterns. While adaptation may consist of the process of adjustment of practices to respond to long-term climate variability, Eriksen and Kelly (2007) refer to coping with actual climate stresses, where the actions performed are often of short-term nature. The factors that facilitate long-term adjustments may differ from the ones that enable effective responses to short-term hazards.

- **LOCALLY RELEVANT TECHNOLOGIES AND BEYOND.** While technologies can play a key role in promoting and facilitating adaptation, lessons learned from the case studies reviewed point to the need of i) supporting adaptive capacity beyond technological improvements and ii) developing locally relevant technologies. Kato *et al.* (2009) investigated the impact of different soil and water conservation technologies on the variance of crop production in Ethiopia to determine the risk implications of the different technologies in different regions and rainfall zones. They found that soil and water conservation technologies had significant impacts in reducing production risk in Ethiopia, and could be part of the country's climate-proofing strategy. The results, however, also showed that one-size-fits-all recommendations are inappropriate given agro-ecological and social differences. The performance of these technologies is location specific, and soil and water conservation measures should therefore take these differences into account in adaptation strategies (Kato *et al.,* 2009).

Research by the International Food Policy Research Institute (IFPRI) (2007) highlighted land ownership as an important determinant of farm-level adaptation. Farmers who own their land are more likely to invest in adaptation options, including crop and livestock management practices and water conservation. The type of farming system also determines farmers' use of adaptation strategies: those engaged in mixed crop and livestock farming or in subsistence farming are more likely to adapt to changes in climatic conditions than those engaged in specialized farming systems. Recent studies also highlighted the importance of understanding the factors influencing farmers' decisions to adapt beyond the availability of technologies and climate information (Chuku and Okoye, 2009; O'Brien, 2009; Grothmann and Patt, 2005). The studies argued that drought-resistant varieties alone are unlikely to ensure successful local adaptation to climate change. Farmers are reluctant to adopt certain drought-resistant species, in part due to low market and consumption values, and in part due to the high labor investment associated with cultivating these species (Eriksen, 2001).

The message from these examples is not to avoid adoption of technologies such as high-yielding seeds or inorganic fertilizers, but rather to adopt only those technologies that are appropriate in a given context, and in conjunction with strategies that help build natural capital. This can then be relied upon in the event that the technologies become ineffective or unaffordable. A recently published FAO report (Dejene *et al.,* 2011) highlighted the need for developing value chains for agricultural inputs and outputs and creating a market economy at district and ultimately national level. FAO encouraged doing this while at the same time focusing on community-based adaptation strategies to ensure that science-based responses are embedded in local knowledge, practices and circumstances (both biophysical and socio-economic). The authors argued that this will ensure that responses are understood, wanted and implemented by the farmers participating in the project (Dejene *et al.,* 2011).


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3

The role of carbon markets in mitigating climate change and reducing poverty in Africa

The mitigation potential of the agricultural sector has rapidly become an area of increased attention and interest in policy and practice. The key motivation is the argument that mitigation, especially when integrated with the global carbon market, has the potential to improve food security and reduce poverty.

Africa's contribution to climate change through GHG emissions is insignificant compared to developed countries. The exception is emissions generated through land use changes, such as land clearing and degradation of biodiversity. Land use changes comprise 17 percent of total GHG emissions, of which Africa contributes roughly 20 percent (Boko *et al.*, 2007). According to 2007 statistics, 43 percent of Africa's total CO_2 emissions come from clearing land for agricultural use, including shifting cultivation. The share of emissions from land clearing is set to increase rapidly through land degradation, which could lead to a release of 316 billion tons of CO_2 equivalents currently stored in Africa's topsoil. It is claimed that a range of cropland practices could reduce GHG emissions by 2.0–3.5 million tons of CO_2 equivalents per hectare per year (Shames and Scherr, 2010). Thus, one of Africa's primary means of mitigating climate change lies in agricultural carbon. It is said that the positive socio-economic benefits of mitigation, known as co-benefits, could contribute to improved food security as well as poverty alleviation in Africa (Scherr and Sthapit, 2009; Streck *et al*, 2010; Lal, 2011). As financial incentives provided through the global carbon markets can provide incentives for both emission reduction and carbon sequestration, this section starts with a brief overview of potential benefits, challenges and trade-offs with carbon markets before moving into a more detailed look at carbon sequestration and land management practices and lessons learned.

Agriculture and carbon markets

Given the current and future challenges for the African continent's future food security due to climate change, it may be of little surprise that given the potential and the size of mitigation markets – the value of global carbon market reached $144 billion in 2011, up from $135 billion in 2008 and $63 billion in 2007 – carbon markets are seen by some as the "silver lining" of climate change for Africa's smallholder farmers (Shames and Scherr, 2011). According to the IPCC (2007b), up to $30 billion could be obtained annually in non-OECD countries through agricultural mitigation from the estimated total annual value of crops, grazing land improvements, organic soil and degraded land restoration. FAO suggests that this is only 15 percent of the overall agricultural investment required for global food security (FAO 2011). The World Bank/FAO estimates that agricultural investment can leverage five times its value in carbon revenues (FAO, 2011).

Placing a price on carbon emissions has the potential to deliver emission cuts more efficiently than direct regulation. However, it is arguable as to whether the global markets have actually delivered. It is worth noting that there are concerns that they are "being used for rich countries to get away with not doing anything and inevitably weaken the necessary action in developed countries" (Whittington 2009: 5). A major concern is that companies participate in the Clean Development Mechanism (CDM) while simultaneously engaging in activities that worsen climate change and aggravate socio-environmental destruction (Whittington, 2009). The energy sector is a clear example of where this has occurred. Within the terrestrial system, most international experience with carbon markets has been more closely associated with forestry than with agriculture.

Climate change mitigation fiscal instruments include carbon pricing through, e.g. carbon markets, taxes and emission trading schemes, and technology-based policies. Carbon markets can help provide the funding and additional financial incentives for the endeavours that provide opportunities to reduce GHG emissions while increasing community income. Poverty reduction is estimated to occur in two primary ways, carbon offsetting and improved agricultural practices. With "carbon offsetting", poor people receive payments through carbon markets to engage in carbon sequestration. These are essentially cash transfers but carbon payments also have been used to support revolving funds for technical carbon expertise, such as Malawi's Trees of Hope project. "Improved agricultural practices" refers to increased revenue through improve yields (Scherr and Sthapit, 2009). Other ways include general livelihood diversification, including increased biodiversity. Bass (2000) suggests that there is a spectrum between strictly carbon-offsetting projects that can have benefits for poverty reduction and rural livelihood programs that can have carbon benefits. The former is typically long-term, while the latter is more orientated towards short-term livelihood needs. Lipper and Cavatassi's (2004:382) review of several case studies suggests that the most important role for carbon sequestration payments is "facilitating the adoption of land-use systems that have higher returns even without sequestration payments, but which were inaccessible due to financial or social barriers."

While carbon markets are the largest form of environmental market in the world, in 2006, Africa's share was less than 3 percent. As of February 2010, only 19 projects had been registered in Africa through the CDM. Given that soil carbon sequestration is not eligible for the CDM, most agricultural projects are excluded. However, carbon sequestration is included in voluntary markets, such as the World Bank's BioCarbon Fund (Shames and Scherr, 2011). Agricultural projects are slowly emerging in these voluntary markets. Most of these have involved project-based transactions, in which the buyer invests directly in emission reductions and get credits in return (Jindal, 2008). Thus far, carbon markets have not worked well for agricultural and terrestrial carbon, as markets have been biased toward industrial emissions and "buyer's short-term compliance needs rather than long-term mitigation potential" (Streck *et al.,* 2010:3).

Tools to measure these interventions rigorously are growing, aided by remote sensing, sampling techniques and modelling tools that help create models for annual crop soil management, avoiding deforestation; forestation/reforestation; agroforestry; livestock management changes; and biochar incorporation into soil.[1] Further investment into research and capacity building continues to be needed (Negra and Shames, 2010). Monitoring, reporting and verifying (MRV) systems to support nationally appropriate mitigation actions benefit not only from higher technical capacity but also from procedural and institutional arrangements that are transparent, accountable and include provisions for quality control. Wherever possible, it is important to consider existing MRV systems and assess the extent to which they are reliable (Wilkes *et al.,* 2011).

It is clear that carbon markets, like technological options, should not be considered a "silver bullet" and must be integrated with appropriate incentives and energy policies at local, national and international levels. Carbon markets are highly uncertain and unlikely to provide significant benefits to smallholder farmers in the short term (Bryan *et al.,* 2011). However, livelihood options that produce mitigation co-benefits, and carbon finance schemes that provide additional incentives could help farmers meet both livelihood and environmental objectives. Nonetheless, as elaborated below, structural reforms and institutional and community capacity building remain of upmost importance (FAO, 2011; Jindal *et al.,* 2008).

Carbon markets are not the only market-based solutions to finance mitigation. Payment for ecosystem services (PES), which compensates land managers for soil conservation and ecosystem restoration, could provide significant livelihood benefits to poor people at the household or community level. It is estimated that by 2030, markets for biodiversity conservation could benefit 10–15 million low-income households. This could be in the form of cash payments or non-cash benefits such as establishing secure land tenure or strengthening social capital. Such a system in Latin American PES programs showed significant benefits, as payments comprised 10–50 percent of household incomes. In China's sloping land conversion program, this was more variable (Milder *et al.,* 2010). As in carbon markets, pro-poor partici-

[1] The validity of these models is still being debated (Negra and Shames, 2010).

pation, influenced by eligibility, desire and ability to participate, is a critical factor. Thus far, smallholders have largely been excluded, as engagement in these markets requires complex technical, scientific, financial and negotiation skills (Lal, 2011; Whittington, 2009).

Carbon sequestration through land management

This section briefly integrates the current knowledge of carbon sequestration and land use practices into the scientific and technical knowledge – which seeds, land management practices and other efforts are suspected to be or have been proven successful – and the larger socio-political and institutional aspects of climate change mitigation in agriculture.

Carbon sequestration in agriculture involves various methods of reducing and sequestering emissions. While the majority of methods focus on land management, water management is also of crucial importance. Water shortage is projected to become a significant challenge in the future, and current irrigation rates are extremely low throughout the continent. The Comprehensive Africa Agriculture Development Programme (CAADP) recommends country-wide irrigation systems – including water storage and water harvesting – to enhance both mitigation and adaptive agricultural capacity throughout the continent (CAADP, 2010). Similarly, farmers will be better able to reduce emissions when better energy systems reduce their need for wood (CAADP, 2010). Agronomy, nutrient management, tillage and residue management, and agroforestry are considered primary ways to reduce GHG emissions, increase carbon sequestration and maintain below-ground carbon stocks (Smith *et al.,* 2007). Reducing emissions occurs via:

- soil management, including conservation tillage, increasing soil biodiversity, enriching soil carbon
- water management, including micro-irrigation, reduction of loss from rainfall and evaporation, water harvesting and recycling
- crop management, including improving varieties, high biomass protection and resilient residues, which can also help reduce deforestation and restore degraded soils and ecosystems
- climate-friendly livestock production and rangeland management systems, including increasing feed quality that will i) decrease methane production and hence carbon emissions but also ii) improve milk production and, in turn, yield higher incomes (Lal, 2011).

Sequestering emissions occurs through capturing CO2 from the atmosphere, for example, via:

- changing land use, including restorative perennial systems which maintain and develop woody biomass
- supporting ecosystems through multiple ecosystem services, increasing the ecosystem gene pool, conserving soil, water and nutrients, and planting species with wide adaptability

- changing farming systems, including lay farming, agroforestry and cover cropping
- soil, water and crop management, including conservation tillage, fertilization and soil amendments (Lal, 2011)
- increasing sustainable agriculture and land-use through protecting natural habitats and restoring degraded watersheds and rangelands (Scherr and Sthapit, 2009).

The following table estimates the economic mitigation potential of various management practices in the major African regions by 2030, with carbon prices at \$20/t of CO2e, emission reductions.

TABLE 6: **Economic mitigation potential of various management practices in African, by region**

	CROPLAND MANAGEMENT (MtCO2e/yr)	GRAZING LAND MANAGEMENT (MtCO2/yr)	RESTORATION OF ORGANIC SOILS (MtCO2e/yr)	RESTORATION OF DEGRADED LAND (MtCO2e/yr)	OTHER PRACTICES (MtCO2e/yr)	TOTAL (MtCO2e/yr)
East Africa	28	27	25	13	15	109
West Africa	16	15	14	7	8	60
Central Africa	13	12	11	6	7	49
North Africa	6	6	6	3	3	25
South Africa	6	5	5	3	3	22
Total	69 (26%)	65 (25%)	61 (23%)	33 (12%)	37 (14%)	265

SOURCE: Streck et al., 2010

Soil conservation has been described as the "foundation" of agrarian societies. According to Lal (2011), soil restoration through sustainable management is the "engine of economic development, eliminating poverty, enhancing political stability and transforming rural communities." Conserving resources more generally via sustainable practices in agriculture generally increases yields (Pretty *et al.,* 2011; Lal, 2011; Scherr and Sthapit, 2009). Carbon sequestration through afforestation and reforestation can also benefit the local ecology. For example, degraded rangelands in Sudan could benefit from a carbon reforestation project that is working to improve local rangelands through planting trees and grass to stabilize sand dunes (Jindal, 2008). However, carbon sequestration projects do not always benefit the local ecology. It is quite common for projects to focus on single species plantations, in part because they have institutional set-ups that are easy to manage. However, such plantations can harm the local environment, such as through increasing salinization and acidification, destroying native species and contributing to a loss in stream flow. Sequestration projects must therefore be carefully planned to benefit the local socio-ecology (Jindal 2008). This calls for an integrated, systems approach to both the ecology and the social dynamics of mitigation projects.

Review of current practice and lessons learned

There has been a recent increase in projects for carbon mitigation in Africa, some of which are highlighted in Table 7 below.

TABLE 7: **Carbon mitigation projects in Africa**

COUNTRY AND PROJECT NAME	KEY INSTITUTIONS	CLIMATE-FRIENDLY PRACTICES PROMOTED
Ethiopia Humbo Assisted regeneration	The community has developed 7 cooperative societies The Ethiopian Forestry Department, and the Ethiopian Agriculture, Rural Development and Forestry Coordination Office, in collaboration with World Vision, jointly implement the project	Farmer-managed natural regeneration (FMNR) approach, in which existing trees and shrub root material in the soil is identified, selected, pruned and managed to enable re-growth, using only native species
Kenya Green Belt tree-planting project	Community Forest Association plant trees NGO Green Belt Movement manages projects, aggregates credits and sells to the World Bank Kenya Forest Services owns the land and gives the carbon and NTFP rights	Tree planting with a long term goal to use the re-grown forest in a sustainable manner for a variety of products
Kenya Smallholder coffee carbon project	Project developer is Ecom Agroindustrial Corp. which is working with Komothai smallholder farmers' cooperative to aggregate	Transitioning from full sun to shade grown coffee
Kenya Western Kenya Smallholder Agriculture Carbon Project	Project developer is VI-Swedish Cooperative Centre (SCC) Farmer associations aggregate the credits	Farm enterprise approach adopting sustainable agricultural land management practices and planting fruit and fuel wood trees
Tanzania Uchindile and Mapanda Forest Project	Green resources developed reforestation project validated and registered according to the VCS standard	Tree planting
Uganda Trees for Global benefits	Farmers receive carbon payments directly Ugandan NGO Ecotrust manages projects and acts as aggregator USAID supports baseline costs	Trees planted provide for soil conservation, food (cashews), fodder for livestock and medicinal values
Zambia ICRAF	ICRAF project focused on intercropping in maize farming systems	Gliricidia-maize intercropping system with application of gliricidia prunings to soil

SOURCE: Streck *et al.*, 2010: 11.

USAID's literature synthesis report on carbon sequestration projects in Africa (81 cases) found almost no sequestration projects only on farmland. Most were some combination of forestry and agriculture. The case studies reviewed in the following illustrate a mix of agriculture and agroforestry programmes.

Community Markets for Conservation (COMACO) is a community-owned and run organization with a market-based approach to rural livelihoods, food security and biodiversity conservation in the Luangwa Valley of Zambia. COMACO has established the infrastructure, a network of extension services and the payment mechanisms necessary to bring markets to remote rural communities and value-added agricultural commodities into regional centres. With support from the World Bank's BioCarbon

BOX 5

Carbon Sequestration (CS) – Lessons to date from available evaluations

- Understand local risks and barriers to benefiting from carbon markets and address them on a context-to-context base, creating space to bring together the relevant stakeholders
- Aggregate small holders and small organizations facilitates long-term ownership and engagement
- Monitoring and evaluation systems can be high, but should not be compromised
- Integrate water management practices as a central part of CS efforts
- Promote and support long-term CS programmes and address key barriers for market access
- Support institution-building, partnering and reform to ensure that smallholders have access to markets
- Potential synergies and trade-offs between adaptation and mitigation must be carefully considered

Fund, the sustainable agricultural land management (SALM) methodology is at the first stage of the dual validation approval phrase. Pending approval, COMACO will have 27,000 farmers participating. The farmers will represent the participants in the initial phases of the initiative. They are planting a particular type of tree that is known for increasing carbon.[2] This is expected to lead to 148,999 voluntary emission reductions (VERs)[3] per year at maturity. The highly decentralized system is also expected to increase yields and lead to better food and income security. In this case, the inclusion of social and institutional development has been seen as critical to its success.

Western Kenya Smallholder Agricultural Carbon Finance Project. In Western Kenya, the NGO Swedish Cooperative Centre-Vi Agroforestry is promoting the adoption of sustainable agricultural land management practices, including cropland management, agroforestry, mulching and rehabilitation of degraded land. Economic benefits include i) increased yields and ii) increased income sources (Shames and Scherr, 2011). The project uses a participatory extension approach. The methodology relies on existing tools approved by the CDM and computer modelling "to deliver a streamlined protocol that may open up soil carbon projects" (Shames and Scherr, 2011:51). Soil carbon is measured using an activity baseline monitoring survey conducted annually. There are high costs of MRV and investment barriers. As of 2009, SALM practices were implemented on about 7,000 ha, sequestering about 10,500 tCO_2 (Shames and Scherr, 2011).

The Cocoa Carbon initiative in Ghana, established by the Katoomba Incubator and the Nature Conservation Resource Centre, provides Ghanaian cocoa farmers with the opportunity to benefit from carbon financing through the Reducing Emissions from Deforestation and Forest Degradation (REDD) mechanism. The project gives farmers the opportunity to collectively stop the expansion of farms into unprotected forestland. Cocoa farming is considered the main driver of deforestation. The forest area is currently being reduced at nearly 2 percent per annum, one of the highest deforestation rates in Africa. Monitoring and verification remains a significant challenge, as methodologies will need to be modified for small farms. The project also requires investment in appropriate satellite technology to assemble relative data, and it will have to be supported by a coordinating organisation. Success may also depend on whether

2 *Faidherbia Albida* trees have a particular pattern of leaf defoliation that provides additional fertilizer, improves soil fertility and protects against erosion (Shames and Scherr, 2010).

3 A type of carbon offset exchanged in the voluntary or over-the-counter market for carbon credits. VERs are usually created by projects that have been verified outside of the Kyoto Protocol. One VER is equivalent to 1 tonne of CO2e emissions.

farmers obtain increased rights over trees. *Forests, agroforests and REDD*. Most of what is described above is directly linked to agriculture and land use. However, there is also considerable potential in agriculture-forest linkages, notably agroforestry. Jindal *et al.* (2008) conducted a comprehensive review of 23 forest and agroforest carbon sequestration projects across 14 countries in Africa, most of which are carried out on a volunteer basis in East Africa. The projects, mostly in the initial stages of implementation, are expected to sequester about 26 million $tCO_{2,}$. The review identified several issues.

Timelines

Projects use different timelines to compute their respective sequestration potential. For example, the Forest Rehabilitation project in Uganda calculates its sequestration potential over 99 years, while the International Small Group and Tree Planting Program (TIST[4]) estimates its potential over 30 years.

Benefiting local communities – or not

There are often economic benefits for local communities, such as the Nhambita Community Carbon Project in Mozambique where, over a period of seven years, local households receive a cash payment of $242.60 per ha per year for carbon sequestered on their farms. This represents a significant increase in household income. However, projects seem to have mixed impacts on local communities. The project includes education and employment benefits for the local communities. There is no clear evidence that the communities themselves get a share of carbon revenue and, in fact, the project *may* adversely affect communities by moving local people out of their homes. Economic returns depend on quality of land, actual land use (dry lands sequester only 0.05–0.7 tons of carbon compared to 0.43tC/ha/year for Miombo woodlands). Other projects were found to directly harm poor households, such as the commercial plantations project in Uganda that barred local households from harvesting any timber, resulting in the entire community losing income (Jindal *et al.*, 2008). The Kyoto Protocol does not support avoided deforestation, nor do any of the currently known carbon projects in Africa. Thus far, there is little evidence from practical experience to support a claim that enabling farmers to earn carbon credits through avoiding deforestation could improve biodiversity conservation (FAO, 2011; Jindal, 2008).

By including carbon storage through forest restoration, rehabilitation and afforestation/reforestation, the REDD+ mechanism has created a policy foundation that the agricultural sector can build on. Briefly, these include recognizing the importance of early donor support for pilot projects to demonstrate feasibility, capacity enhancement, appropriate implementation mechanisms and creating appropriate monitoring, reporting and verifying systems (MRVs). Negra and Wollenberg (2011) suggest that agriculture would benefit from an MRV framework that is simple, streamlined and cost effective; accessible and affordable as well as global; balanced between precision of measurement and cost of measurement; and that provides independent and reliable standards and verification. They also encourage re-examining the concept of additionality (new and additional finance). Compared to the forest sector, agriculture has

[4] The International Small Group and Tree Planting Program (TIST) Scurrah-Ehrhart (2006)

higher levels of methane and nitrous oxide emissions, lower potential for carbon sequestration, higher reversibility and variability, higher transactions costs, and greater politically sensitive food security and trade issues. Arguably, it therefore requires different mechanisms and incentives than currently available through REDD (Negra and Wollenberg, 2011).

In REDD, civil society participation has been poor, which has hampered implementation. The agricultural sector can thus learn from REDD's experience and engage civil society earlier in the process (Negra and Wollenberg, 2011). REDD is still coming to terms with what it means to deliver the promised benefits to poor people (Corbera and Schroeder, 2011). Governance issues (politics, policies and socio-environmental outcomes) that have proven critical in REDD will also be critical for agriculture (Corbera and Schroeder, 2011). CAADP (2010) encourages the engagement of the private sector early in the process as well. An integrated approach to forestry, agriculture and land use change would enable better management of trade-offs and synergies among mitigation, food security and poverty reduction in rural areas (Negral and Wollenberg, 2011).

Analysis and discussion – key issues emerging from current practice

While some pilot projects offer promising results, at this stage there is not enough evidence to support the claim that projects funded by carbon markets can actually reduce poverty and enable adaptation, or even that this can contribute significantly to additional mitigation. Most projects are still in the inception phase. For example, in USAID's recent survey of 81 projects in 24 sub-Saharan Africa countries engaging in agricultural GHG mitigation, only 8 percent were able to establish whether money had actually been exchanged (Shames and Scherr, 2010). It is also a result of a lack of systematic evaluation of the projects. This is true in agriculture globally, but it is particularly true in Africa (APEC, 2010). Finally, the variable price of carbon credits (currently low), farmer's lack of participation capacity, and the high transactions costs combine so that "mitigation from smallholder agriculture will not be cost effective for international offset compliance markets." (FAO, 2011: 31). FAO suggests that, at the ground level, confidence, capacity and experience may be grown through a stepwise approach. Given how much agriculture is integrated with other sectors, especially water management, it is recommended that that approaches to agriculture include a "wide lens", encompassing livestock management (Lipper, 2010), mixed-land management (including agro-forestry), water management and energy. The following presents key common challenges and early lessons.

Risk associated with changing land management practices to sequester carbon and subsequent impact on labour productivity

Key factors determining farmers' decision on whether or not to engage with mitigation projects will include the potential for increased incomes, projects' alignment with cultural values, or how it affects labour productivity and availability. As the poor typically operate in situations where markets are poorly functioning or non-existent, non-market costs need to be considered. Poor selection of crops, which may be difficult to avoid in an uncertain and changing climate, suppresses subsequent yield. Often, sequestration will lead to a decrease in the householder's returns to land. The compensation – say, through carbon markets – needs to be greater than the loss of returns of alternative land use (Lipper *et al.,* 2010). Reducing risks can be done in part through privileging land-management practices that have some proven capacity to support both mitigation and poverty reduction, such as leaving crop residues on the field and applying nutrients, and combining mulching, manure and inorganic fertilizer rather than purely inorganic fertilizers (Bryan *et al.*, 2011).

Transaction costs

Transaction costs include search costs, negotiation costs, approval costs, monitoring costs, enforcement costs and insurance costs as well as administration costs (Cacho, 2003; Lipper *et al.,* 2010; Shames and Scherr, 2010). There are many ways to reduce transaction costs. Bundling many smallholders into a coordinated project can significantly reduce costs. Building social capital helps make that possible (Lipper and Cavatassi, 2004; Lal *et al.*, 2011). Involving intermediary organizations, rather than relying upon national governments who do not know local needs and may not have the technical know-how can lower costs, as can relying upon community-orientated institutions that already exist. For example, in Tanzania, the TIST project reduced transaction costs when it organized local farmers into small groups of 10–12 people to support their process. Hiring local people to do the monitoring reduced further costs and the local people did the evaluation themselves (Jindal *et al.,* 2008).

To achieve impacts on reducing poverty and mitigating climate change, hundreds of thousands of villages and communities will need to be involved, requiring coordination, monitoring and on-going support. Local stakeholders must be involved at every stage for this process to succeed. In Zambia, the Conservation Agriculture Project uses pre-existing organizational structures to reduce transaction costs. Community markets manage it for Conservation, a highly de-centralised organization that works with 50,000 farmers and has an infrastructure and network of extension services along with payment mechanisms to bring markets to remote rural communities. Such a programmatic approach reduces MRV expenses (Shames and Scherr, 2010).

At the same time, active support from policymakers and other actors can reduce transaction costs through generating information such as baselines, teaching smallholders to measure carbon, bundling payments for other environmental services and promoting secure land tenure (Cacho *et al.,* 2003).

Securing property rights and land tenure

Secure property rights and land tenure will overcome one of the greatest concerns for carbon markets, namely farmers defaulting. Secure property rights give farmers greater ability to determine what will happen to their land. Without that, when they face pressures such as food insecurity, they are more likely to "default", meaning they no longer use the land as a carbon sink (Jindal, 2008; Cacho *et al.,* 2003; Lipper and Cavatassi, 2004; CAADP, 2010). Land under stable community management is likely to have significant advantages over individual private land ownership, as it has a longer planning horizon. This requires redesigning property rights for a more communal land governance model (Cacho *et al.,* 2003).

In Mozambique, for example, the Nhambita Community Carbon Project deposits $40.50 per hectare to a community fund. The land is registered in the name of the village chief with no individual household titles, and the entire community gains from these group payments (Jindal *et al.,* 2008). However, this could be abused by individuals who have power within the community. Even if a communal land governance model is not taken up, it is considered that increased clarity and secure property rights and land tenure will lessen the possibility that more powerful people will try to take control over the land, which could lead to poor people not receiving any benefits from carbon sales (Shames and Scherr, 2010). For example, a 50-year concession owned by Tree Farms AS of Norway for commercial plantations and carbon offsets from land in Uganda threatens the livelihood of the local communities. Local people are prevented from their traditional use of the forests for farming, fishing, cattle grazing and collecting timber (Jindal, 2008). When local people do not possess formal land titles, they may be evicted. Given the complicated communal and individual land ownership system and the inconsistency of land titling programs, this requires careful negotiation. It is possible to facilitate government coordination to allocate rights (Jindal *et al.,* 2008; Robbins, 2004). Natural resource management and conflict-mitigation efforts have long highlighted land rights as a major challenge to development. There is no evidence that the urgency of climate change is leading to increased political will to confront these long-standing barriers to citizen ownership. In other words, rights to carbon are closely associated with rights for land (Shames and Scherr, 2010).

Institutional development and improved governance

Effective institutions are a key element of successful mitigation and poverty reduction. For poor people to benefit from carbon markets, institutional reforms that will reduce the transaction costs associated with those markets are necessary to enable smallholder participation (Cacho *et al.*, 2003; Shames and Scherr, 2010). It is widely recommended to build on local institutions instead of creating new ones (Lipper *et al.*, 2010; Jindel, 2008; Shames and Scherr, 2010; Scherr and Sthapit, 2009). Often, local institutions need strengthening to meet the specifications of carbon payment programs. In much of Africa, the land tenure issues raised above are reinforced by governance and institutional structures. In the context of power dynamics that do not favor the poor, ensuring that programs do not disenfranchise the poor is a concern that can only be adequately understood and addressed at the local level (Lipper *et al.,* 2010).

From the experience of REDD, we know that a high level of political engagement needs to be maintained at all levels of governance. This should be planned through a period of preparation and a phased approach to capacity strengthening, in order to create consensus and confidence in both the technical and financial aspects. Policymakers' learning processes need to integrate lessons from the field level (Negra and Wollenberg, 2011). The same is true for other institutions, such as NGOs, which are increasingly coming to realize where their existing programmes do and do not enable mitigation (Urquhart, 2010). Mitigation efforts need to be incorporated with national development plans and poverty reduction strategy papers. Ideally, national engagement with mitigation efforts need to occur over the long term, not just a 5-year period, as carbon sequestration projects have a long gestation period (Jindal *et al.,* 2008).

As nations go through this process, ensuring they have the best knowledge to date is critical. Scherr and Sthapit (2009) recommend ensuring that the full range of terrestrial emission reduction, storage and sequestration options is included in national legislation and investment programmes. Doing so brings in both technical knowledge and the potential for a range of stakeholders, from citizens to businesses, to become involved. As countries consider what is needed, they will need to work across large areas, which means coordinating across various institutional and regulatory structures (Scherr and Sthapit, 2009). Thus far, this remains a suggestion more than a practice. While it is critical to build on local institutions and support the capacity of national institutions, there is also a role for new, collaborative institutions or structures both within and between African nations to facilitate learning for mitigation. An African agricultural carbon facility, as proposed by Streck *et al.* (2010), might be one learning institution to build capacity and enable scalable carbon finance and practice.

Context matters: Local people and local places

Mitigation strategies need to be tailored to the biological and cultural dynamics of each agro-ecological zone. Technology, including biotechnology, can make a difference (Oyoo, 2011) but it needs to be context-specific and negotiated with local communities to be effective over the long term (CAADP, 2010). Local communities (Jindal *et al.,* 2008) and farmers (CAADP, 2010) need to be a central focus. There is tremendous uncertainty about many of the "solutions", and while models continue to develop to address these uncertainties (Delobel, 2011), long-term success will only be possible with local people's engagement. While the *ex-ante* cost-effectiveness of centralized, top-down processes of institutional intervention is less than the use of participatory methods, more community-based processes have much lower *ex-post* transaction costs (Cacho *et al.*, 2003). Engaging farmers in decision-making processes also reduces the risk of their defaulting (Shames and Scherr, 2010). Community-based natural resource management processes in Burkina Faso proved to be a useful institutional base for carbon sequestration (Lipper *et al.,* 2010).

Capacity strengthening

Greater access to extension services is seen to be one of the most influential services to enable successful uptake of changing land management procedures (Magaombo *et al.,* 2011; Cacho *et al.,* 2003). This needs to have a long-term component. African research centres such as the International Crops Research Institute in the Semi-arid Tropics (ICRISAT) and the World Agroforestry Centre have been developing appropriate planting techniques (CAADP, 2010). Capacity building is recommended as an integral component of each carbon project. The World Bank-funded Western Kenya Integrated Ecosystem Management Project includes a comprehensive capacity-building phase to establish a national carbon assessment and certification capacity within Kenya's national research system, which has proved supportive. However, for long-term success, this needs to be financed at the national level, not merely by international agencies (Jindal *et al.,* 2008). In general, there is a need for both implementation and management capacity. Many project managers and other actors will be dealing with carbon-related issues for the first time, and they need to be supported through appropriate expertise in project design. In recognition of this, the World Bank BioCarbon Fund holds training sessions for project developers (Shames and Scherr, 2010).

Addressing structural and financial barriers

Generally, the poor have not adopted land-use systems that generate higher returns due to social, economic or agronomic constraints, which has led to so-called "poverty traps". Lack of investment capacity, poorly defined property rights, high discount rates and risk aversions are all well-known constraints to the poor's capacity to make land-use decisions. Payments are needed to enable adoption of productive land use systems, such as high capital costs (Lipper and Cavatassi, 2004). Access to financing – especially pre-project financing – is of particular importance (Shames and Scherr, 2010). Currently, start-up costs are generally covered by outside donors, but this has problems for producing scalable, country-owned programmes integrated into national policies for poverty reduction. Relaxing credit constraints could also be helpful in reducing overall risk and addressing financial barriers in agriculture and rangeland management (Lipper *et al.,* 2010).

Synergies and trade-offs with adaptation efforts

IFPRI research in Kenya highlights the complexity of the links among adaptation, mitigation and poverty reduction, as measured by productivity and profitability of mitigation efforts (Bryan *et al.,* 2011). IFPRI's work found that farmers recognized changing crop variety as a key adaptation strategy. However, crop simulation results showed that the hybrid maize variety did not generally improve soil carbon sequestration, even with nutrient management practices. Thus, crop rotation with legumes, a common adaptation strategy, has mixed mitigation potential and mixed productivity potential. The study highlighted that appropriate fertilizer and manure use as well as incorporation of crop residues had positive benefits for adaptation, mitigation and productivity, as did appropriate livestock feeding and destocking. While some additional agricultural inputs, including both seeds and nutrients, lead to additional crop yields, others, such as nitrogen fertilizer, have negative effects on yield but contribute to improving the soil (Lal, 2011). Thus, potential synergies and trade-offs between adaptation and mitigation must be carefully considered.

There are other ways in which climate change adaptation strategies degrade native ecosystems and their associated carbon sinks. Charcoal production, logging and hunting are potential strategies for coping with the loss of food production due to climate change, and banning such practices raises questions about alternative livelihood options. While conservation agriculture has adaptation benefits, a survey of current projects in WWF and CARE found few benefits for mitigation (Milder *et al.,* 2011). Links between conservation agriculture and conservation of native ecosystems and their associated carbon stocks exists in principle but have not been achieved in practice (Milder *et al.*, 2011).


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4

Synthesis of Lessons and Recommendations

Based on the review and analysis in previous sections, this section identifies crosscutting issues underpinning the success of AAR- and CPR-type efforts and proposes a set of recommendations for future practice. Recommendations are listed in Boxes 6–8 below.

1. There is limited experience of AAR- and CPR-type work in practice

A clear message emerging from this review is the limited experience of AAR- and CPR-type activities beyond theoretical assumptions. Three interrelated issues may help explain this.

- **AAR AND CPR ARE EMERGING AREAS OF WORK, SO MOST PROGRAMS ARE EITHER IN EARLY STAGES OF IMPLEMENTATION OR HAVE NOT STARTED YET.**
  A few of the cases reviewed had results at the output level (Selby and Venton, 2009; GTZ, 2010a; GEF, 2010). However, most programs remain focused on the short term (World Bank, 2009; GEF, 2010) and therefore longer-term benefits and contributions of AAR and CPR to resilience and poverty reduction remains limited. Results from most evaluations conducted to date clearly illustrate the importance of understanding both AAR and CPR efforts within long-term timeframes. Evaluations in particular highlight the fact that programs of such nature not only require long-term support and facilitation but also need to account for the uncertainty in climate projections (Watkinson, *et al.* 2008; Swennenhuis, 2010; Ziervogel *et al.*, 2008; Owuor, 2010).

  AAR and CPR policymaking and program design take place in a context of decision-making under uncertainty. Notwithstanding progress made in climate projections and efforts to develop tools and guidelines to support robust decision-making (Wilby and Dessai, 2010), dealing with uncertainty remains a key challenge for resilient agricultural development. For example, the recent rainfall failure in the Horn of Africa came in areas where the IPCC scenarios show an overall long-term *increase* in rainfall (Boko *et al.*, 2007). Clearly, successful AAR and CPR efforts will not arise out of identifying a list of possible measures or market instruments to implement. Instead the challenge remains in dealing with an uncertain future. Thus, accounting for and dealing with uncertainty and long-term processes remains a key gap in existing programs.

- **THERE IS A LACK OF MONITORING AND EVALUATION SYSTEMS TO ACCOMMODATE CLIMATE VARIABILITY AND CHANGE.**
  Existing evaluations acknowledge this challenge is limiting our understanding of successful programs (Owuor, 2010; Swennenhuis, 2010; GEF, 2010). Therefore, claims of AAR and CPR work and their contribution to enhancing resilience in agricultural systems and poverty reduction remain to a large extent theoretical, as limited evidence exists. This emphasizes not only the need for a learning-by-doing approach, but also flexible design, program planning and action as a continuous and flexible process that can be subjected to periodic review. For those programs engaged with the global carbon markets, effective M&E needs to be streamlined with MRV. The implementation needs to be monitored, evaluated regularly and revised in terms of both the validity of the underlying scientific assumptions and the appropriateness of projects, policies and programs (UNFCCC, 2010). Implications for resilient agricultural development will be to focus on providing flexible options rather than specific solutions to uncertain climate outcomes. There is also a need to develop monitoring and evaluation systems that can contribute to building an evidence base of AAR and CPR-related work, and improving the understanding of how such efforts play out in practice. Evaluation frameworks and guidelines are increasingly emerging which may offer avenues for improving program design, implementation and collecting evidence (Sanahuja, 2011; World Bank, 2010b).

- **RESILIENCE AND CARBON SEQUESTRATION EFFORTS FOR POVERTY REDUCTION OFTEN FAIL TO INTEGRATE ADAPTATION AND MITIGATION EFFORTS BEYOND THE RHETORICAL ACKNOWLEDGEMENT OF ITS IMPORTANCE (OWUOR, 2010).**
  AAR and CPR efforts tend to be addressed separately from each other. However, as highlighted in previous sections, AAR measures in one sector can negatively affect livelihoods in other sectors. CPR measures can threaten the land rights and livelihoods of rural people and undermine efforts to improve food security and sustainable development (Bryan et al., 2011). Thus, synergies, and more importantly trade-offs, that may arise from such programs continue to be unaddressed in practice.

BOX 6

Recommendations

1. Support long-term processes (not just projects), including building and partnering institutions and platforms for multi-stakeholder engagement
2. Integrate AAR and CPR efforts with an understanding of potential co-benefits, synergies and trade-offs
3. Ensure that enough flexibility is embedded in program planning, and periodically reviewed to avoid maladaptation
4. Develop M&E systems and tools to tests assumptions, and build an evidence base on the contribution of AAR and CPR in building resilience, improving food security and reducing poverty.

There is a need to improve understanding of the synergies and trade-offs among adaptation, mitigation and poverty reduction. The concept of climate smart agriculture promoted by FAO is one such approach that aims to contribute to the integration of such efforts (FAO, 2010). New approaches and frameworks have started to develop (Smith and

Olesen, 2010) such as climate compatible development (Mitchell and Maxwell, 2010) and the climate smart disaster risk management (Mitchell *et al.*, 2010). However, these frameworks remain more theoretical than practical and more practice is therefore required. Further studies are required to better quantify short-term and long-term effects, co-benefits and trade-offs. Nonetheless, a growing number of programmes and efforts to address such challenge are rapidly emerging with the objective of developing comprehensive approaches towards AAR, CPR and development in the region (UNDP, 2009; CC DARE,2011; Place *et al.*, 2010).

2. Many non-climatic factors determine the success or failure of AAR and CPR

The reviewed case studies clearly illustrate that non-climatic factors are key in determining the success of AAR and CPR. As highlighted throughout this document, understanding and addressing the underlying factors which shape farmers' vulnerability to climate change is of key importance.

SUCCESSFUL AAR AND CPR INITIATIVES MUST ADDRESS THE SOCIAL, ECONOMIC AND ENVIRONMENTAL DETERMINANTS OF VULNERABILITY. AAR efforts to enhance smallholders' resilience and adaptive capacity largely depend on the degree to which the poor will have access to resources, land and financial services, among others. The potential of carbon markets to achieve poverty reduction depends on the degree to which the poor will have access to and be able to be competitive suppliers of carbon sequestration. CPR efforts must address the needs of smallholder farmers in terms of resource access, capacity and institutional and legal structures that may hinder mitigation. This includes ease of access to carbon markets and other means of financing mitigation efforts. Risks for farmers are high, and without financial, capacity and institutional support, the incentive for them to engage in AAR and CPR is relatively small. Greater adaptive capacity has to be fostered, allowing communities to draw upon a range of options to support their livelihoods. The Millennium Development Goals are a necessary backdrop to integrating AAR and CPR efforts into development policy at all levels.

This report has illustrated the importance of geographic and cultural specificity, and how perceptions, culture and behavior play a critical role in the long-term ownership of AAR and CPR. This highlights the imperative to understand local realities, which form the cultural and behavioral factors that influence adaptation processes and mitigation actions. Further, effective long-term AAR and CPR policies must be developed according to local and national situations and be grounded in the local context (Ziervogel *et al.*, 2006).

BOX 7

Recommendations

1. Focus on understanding local realities and support fora for open discussion and negotiation about options available and potential trade-offs, expanding smallholders' involvement in planning and policy processes at an early stage
2. Understand the socio-economic causes that make people vulnerable and ensure that those are an integral part of programs
3. Support institution-building, partnering and reform to ensure that smallholders have access to markets
4. Work with and support development partners to ensure AAR and CPR are integrated within ongoing development efforts

It is important to remember that policies related to climate change are inherently political. Agricultural policy in the context of climate change is a growing agenda with multiple actors (research institutions, funders, NGOs, private sector, etc.) with different perspectives and interests. These interests shape the mechanism considered for AAR and CPR and, more importantly, they shape how "success" is defined (Osbahr *et al.,* 2010).

WHAT IS CONSIDERED SUCCESSFUL, EFFECTIVE OR LEGITIMATE DEPENDS ON WHAT PEOPLE PERCEIVE TO BE WORTH ACHIEVING AND PROTECTING. Understanding whose interests are included in and excluded from the process and whose success has been pursued is critical. What might be effective and contribute to improving food security in one place might be ineffective in another (Osbahr et al., 2010). Increasing calls for building resilient societies need to take into account the fact that building resilience entails the implicit (or explicit) creation of winners and losers (Nelson, 2011).

3. A focus on food production neglects the complex dynamics that characterize the agricultural sector.

When it comes to the designing of AAR and CPR, there seems to be an overemphasis on food production. Most programs focus on the impact of climate change on agricultural production or on the impact of agriculture on the environment, e.g. on land use, greenhouse gas emissions, pollution or biodiversity. Food distribution systems and other factors need also to be considered in efforts to address food security.

- **CONCERNS ABOUT CLIMATE VARIABILITY AND AGRICULTURAL PRODUCTION ARE LONG STANDING ISSUES IN AFRICAN AGRICULTURAL DEVELOPMENT, AND THE WEALTH OF LESSONS LEARNED SHOULD NOT BE UNDERESTIMATED.**
  Technological innovation such as irrigation systems, crop varieties or use of fertilizers has always been seen as the key for agricultural production and economic growth. Despite decades of investment in new agricultural technology, hunger, poverty and environmental degradation continue to plague large areas of Afri. Clearly, technical fixes alone will not solve the food security challenge in the context of climate change. Technological innovation does play an important role for agricultural development, but will not on its own secure the success of AAR and CPR efforts.

- **EFFECTIVE INTERVENTIONS NEED AN UNDERSTANDING OF THE INTERACTIONS AND FEEDBACKS OF BIOPHYSICAL PROCESSES THAT DETERMINE FOOD SYSTEM VIABILITY AND MANAGEMENT PRACTICES THAT ENHANCE THE RESILIENCE OF THESE SYSTEMS TO FUTURE SHOCKS AND STRESS.**
  Agriculture in Africa is characterized by high dependency on seasonal variations in resource access and climatic conditions. Highly diverse settings and stakeholders also characterize most rural areas. The potential of innovative technologies to support adaptation of farming practices and generate profit from sequestration will depend on the rate and quantity of sequestration. Such factors are largely determined by agro-ecological, social and cultural characteristics. Agriculture

needs to be conceived as an integral part of a complex whole system. However, scenarios specifically designed to investigate the wider issues that underpin food security and the environmental consequences of different AAR and CPR options are lacking.

Climate change is a global phenomenon with local impacts. However, to be effective, AAR and CPR strategies require supporting policy and institutional interventions at many different scales, ranging from crop and on-farm management to the community, national, regional, and global levels (Osbahr *et al.*, 2008). However, knowledge is still lacking on how this would work in practice. To date, most projects are in pilot stages only, and are not yet operational at scale.

AAR and CPR efforts are also embedded in a highly dynamic policy environment. The agricultural sector is profoundly affected by the trade environment and trade policies (Thompson and Scoones, 2009). The food crises in 2008-2009 and its impact on the economic stability and agricultural policies across developing countries clearly demonstrated the impact of the broader political-economic context into national and local agriculture development efforts.

- **THE LONG TERM SUCCESS OF AAR AND CPR EFFORTS IN AFRICA WILL BE HIGHLY DEPENDENT ON THE GLOBAL AND NATIONAL POLITICAL ECONOMY CONTEXT IN WHICH THESE TAKE PLACE.**
  Institutional analysis of the policy processes across scales and over time must be part and parcel of AAR and CPR efforts. Efforts are rapidly growing to improve an understanding of food system dynamics (ECI, 2008) and agricultural development in a broader context (Hoffman, 2011; CCAF, 2011). Research findings and lessons learned can potentially offer promising avenues for the near future.

BOX 8

Recommendations

1. Move from a focus on food production to an understanding of the socio-ecological dynamics and uncertainties involved
2. Take into account the impact of a variety of innovations in places with particular ecological and socioeconomic conditions
3. Engage with multiple stakeholders policy dialogue and support multi- and trans-disciplinary research
4. Analyze the wider political economy, including actors, interests and policy processes to understand its potential impact on AAR and CPR efforts

The challenges related to climate change, food insecurity and poverty reduction in the African region are ever more closely linked. Although there still little practical evidence, the answers are emerging. This synthesis report has provided a compilation of promising efforts, lessons learned and an account of remaining challenges. As the importance of AAR and CPR grows, a central message of this report is that it is essential to take a holistic vision of food security, agricultural mitigation, climate change adaptation and agricultural pro-poor development. Currently, there is an increasing level of international support and recognition of the need to take this opportunity into practice. But there is a need to step-up efforts. In an era of rapid change and growing risks, the challenge remains dealing with a complex and uncertain dynamic landscape where any decisions made today provide the context for future choices. AAR and CPR are not a one-off solution, but a long-term process of change.

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Annexes

ANNEX 1: SUMMARY OF FINDINGS AND RECOMMENDATIONS

CROSS-CUTTING LESSONS	RECOMMENDATIONS
Lack of understanding of AAR and CPR work in practice	Support long-term processes not just projects, including building and partnering institutions and platforms for multi-stakeholder engagement Integrate AAR and CPR efforts with an understanding of potential co-benefits, synergies and trade-offs Ensure that enough flexibility is embedded in program planning and periodically reviewed to avoid maladaptation Develop M&E systems and tools to build an evidence base on the contribution of AAR and CPR on building resilience, improving food security and reducing poverty
Many non-climatic factors determine the success or failure of AAR and CPR	Focus on understanding and embracing local realities - support forums for discussion an open negotiation about available and potential trade-offs - expanding smallholder's involvement in planning and policy processes at an early stage Understand the socio-economic causes that make people vulnerable and ensure those are an integral part of your programs Support institution-building, partnering and reform to ensure that smallholders have access to markets Work with and support development partners to ensure AAR and CPR are integrated within ongoing development efforts
A focus on food production neglects the dynamics that characterize the agricultural sector	Move from a focus on food production to an understanding of the socio-ecological and political dynamics and uncertainties involved Take into account the impact of a variety of innovations in places with particular ecological and socioeconomic conditions Analyze the wider political economy – including actors, interests and policy processes to understand its potential impact on AAR and CPR efforts Engage with multi-stakeholders policy dialogue and support multi and trans-disciplinary research

ANNEX 2: TECHNOLOGIES FOR ADAPTING FARMING PRACTICES

	TECHNOLOGY	SCALE
Water Use and Management	Sprinkler irrigation and dripping irrigation	Large and small
	Fog harvesting	Small
	Rainwater harvesting	Large and small
Soil Management	Slow forming terraces	Large and small
	Conservation tillage	Large and small
	Integrated nutrient management	Large and small
Farming systems	Mixed farming	Large and small
	Agro-forestry	Large and small
Capacity building and stakeholder organization	Farmer Field schools	
	Community-based agricultural extension	Small
	Forest user groups	Large and small
	Water users associations	Small

SOURCE: Clements *et al.*, 2011.