DEVELOPING A CLIMATE-SMART AGRICULTURE STRATEGY AT THE COUNTRY LEVEL: LESSONS FROM RECENT EXPERIENCE

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ACRONYMS

AD	Adaptation
ADMARC	Agricultural Development and Marketing Corporation
ASWAp	Agriculture Sector Wide Approach
C	Carbon
CAADP	Comprehensive African Agriculture Development Plans
CBDR	"Common but differentiated responsibilities"
CFS	Committee on Food Security
CO_2	Carbon Dioxide
CSA	Climate-Smart Agriculture
EIG	Environmental Integrity Group
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
G20	The Group of Twenty Finance Ministers and Central Bank Governors
GHG	Greenhouse Gas
GWP	Global Warming Potential
HLPE	High-Level Panel of Experts on Food Security and Nutrition
IPCC	Intergovernmental Panel on Climate Change
LDC	Least Developed Country
LSMS	Living Standards Measurement Study
MAC	Marginal Abatement Cost
MT	Mitigation
NAMA	Nationally Appropriate Mitigation Action
NAPA	National Adaptation Plan of Action
NGO	Non-Governmental Organization
PSA	Programa de Subsidios de Alimentos (Mozambique)
SBSTA	Subsidiary Body for Scientific and Technological Advice
SCT	Social Cash Transfer (Malawi)
SLM	Sustainable Land Management
SN	Safety Net
UNFCCC	United Nations Framework Convention on Climate Change

SCOPE OF PAPER

Since the Global Conference on Climate Change, Food Security and Agriculture held at the Hague in 2010, the concept of climate-smart agriculture (CSA) has gained increasing attention at international and national levels, with several countries initiating related activities. The objective of this paper is to highlight recent experiences with country-level implementation of CSA to identify some key lessons to incorporate in ongoing efforts to expand the use of the approach in developing countries. Section 1 describes the evolution of the concept of CSA since the Hague conference. Section 2 introduces the building blocks for developing a CSA strategy and combines them into a coherent framework. In sections 3 to 6 the paper goes into more depth on the building blocks, the data needed and potential approaches for prioritizing action. Finally section 7 provides some guiding principles on CSA investments.

KEY MESSAGES:

- The magnitude of the need for adaptation and the potential for mitigation in agricultural development has major implications for successful agricultural development planning to support food security and poverty reduction.
- When designing a CSA strategy one must consider that, at the farmer level, adaptation strategies and greenhouse gas (GHG) mitigation options encompass a wide range of possible activities that will need to be evaluated and prioritized.
- Defining a CSA strategy requires the coordination of activities that cut across a number of stakeholders, such as adaptation by farmers (private sector), the provision of credit for investment (financial sector), the definition of coherent policies and regulatory frameworks for food security and the provision of environmental services (government), and the dissemination of information on climate variability and its economic and social implications (research and extension).
- Given the complex nature of the interactions between adaptation, food security and mitigation activities, using appropriate indicators and methods of analysis is essential to establish a baseline that captures all relevant information, as well as for meaningful monitoring and evaluation.
- For farmers to adapt to climate change, rural communities need access to better information, inputs such as fertilizer, machinery and a diverse set of seeds and breeds, and to well-functioning output markets.
- Linking farmers to new sources of information on climate change will be important, but ‘translating’ the risks and potential margin of error that exist in a way that farmers can understand and use in making decisions is equally important.
- With climate change likely to result in an increased magnitude and frequency of shocks, innovative approaches to social safety nets might be needed to bolster local resilience, support livelihood diversification strategies and reinforce people’s coping strategies.
- Adopting CSA options also implies a need for increased investments at the farm level. Extended transition times may be needed to realize the benefits to CSA in the form of productivity or increased resilience. During the transition, the returns to agriculture are low or negative, and thus some form of financing to support this transition is necessary.
- Policy instruments will change incentives and farmers’ capacity to undertake changes in their production systems. Depending on how they are designed, rural credit programmes, input and output pricing policies, tenure regimes, extension services and safety net programmes all have the potential to impact livelihoods and affect individual farmers’ incentives to adapt to climate change.

1. INTRODUCTION: EVOLUTION OF THE CONCEPT AND DEFINITION OF CSA

The meaning and definition of the term 'climate-smart agriculture' has evolved over the past two years, in particular in relation to the concept of sustainable agriculture. An important question is how CSA differs from sustainable agriculture. FAO considers CSA as a combined policy, technology and financing approach to enable countries to achieve sustainable agricultural development under climate change. The CSA approach involves the direct incorporation of climate change adaptation and mitigation into agricultural development planning and investment strategies (FAO 2010).

The magnitude of the need for adaptation and the potential for mitigation in agricultural development has major implications for successful agricultural development planning to support food security and poverty reduction. This, together with the potential of obtaining significant levels of climate-related financing in addition to traditional sources of agricultural investment finance, justify a strong and specific focus on integrating climate change adaptation and mitigation into agriculture development planning. CSA encompasses sustainable agriculture, expanding it to include the need for adaptation and the potential for mitigation with associated technical, policy and financing implications.

BOX 1: THE EVOLVING CONCEPT OF CSA

CSA seeks to support countries in securing the necessary policy, technical and financial conditions to enable them to sustainably increase agricultural productivity and incomes, build resilience and the capacity of agricultural and food systems to adapt to climate change, and seek opportunities to reduce and remove GHGs in order to meet their national food security and development goals. CSA is site specific and takes into consideration the synergies and tradeoffs between multiple objectives that are set in diverse social, economic, and environmental contexts where the approach is applied. CSA builds upon sustainable agriculture approaches, using principles of ecosystem and sustainable land/water management and landscape analysis, as well as assessments of resource and energy use in agricultural and food systems. Innovative financing mechanisms that link and blend climate and agricultural finance from public and private sector are a key means for implementation of CSA, as are the integration and coordination of relevant policy instruments. The adoption of CSA practices at scale will require appropriate institutional and governance mechanisms to facilitate the dissemination of information and ensure broad participation.

Between mitigation and adaptation, the latter will clearly be the priority for less-developed countries or low income agricultural-based populations in any country where agricultural development for food security and poverty reduction are the main policy objective. In this context, mitigation is a secondary benefit, but one which is nonetheless important to consider since mitigation-related activities are often synergistic with sustainable development generally, and adaptation specifically. Such actions often involve increasing the efficiency of resource use, as well as the restoration and conservation of agro-ecosystems to improve resilience. The potential for financing such mitigation actions in developing countries goes well beyond carbon offsets, with several alternative financing alternatives linked to the Green Fund currently under discussion.

CSA is not a single specific agricultural technology or practice that can be universally applied, such as conservation or organic agriculture, although either may be key components of a CSA strategy in specific locations and countries. The CSA approach involves site-specific assessments of the adaptation, mitigation and food security benefits of a range of agricultural production technologies and practices, and identifies those which are most suitable for a given agro-ecological and socio-economic situation.

In this context, when designing a CSA strategy one must consider that, at the micro (farmer) level, adaptation strategies encompass a wide range of activities that will need to be evaluated and prioritized. Examples include modifying planting times and switching to varieties resistant to heat and drought (Phiri and Saka, 2008); developing and adopting new cultivars (Eckhardt et al., 2009); changing the farm portfolio of crops and livestock (Howden et al., 2007); improving soil and water management, including conservation agriculture (Kurukulasuriya and Rosenthal, 2003); integrating the use of climate forecasts into cropping decisions (Howden et al., 2007); improving fertilizer use and increasing irrigation (Howden et al., 2007); increasing labour or livestock input per hectare to increase productivity (Mortimore and Adams, 2001); increasing the storage of food/feed or the reliance on imports (Schmidhuber and Tubiello, 2007); increasing regional farm diversity (Reidsma and Ewert, 2008); and shifting to non-farm livelihoods (Morton, 2007).

Food security will be linked to adaptation, but it is broader than household adaptation since it depends on the policies in place and the institutional environment. In developing countries in particular, adaptation is a means towards attaining a food security objective. Once prioritized according to the local context, the adaptation strategies listed will play an integral part in limiting households' vulnerability to climatic disruptions. However, these strategies will only be successfully adopted if there is an enabling policy and institutional environment that helps address barriers to adoption and smooth income losses associated with extreme climatic events so as to guarantee food security for the more vulnerable households.

On the GHG mitigation front, substantial technical potential exists in the agriculture sector with a broad set of practices (Caldeira et al., 2004; Smith et al., 2008), and 70 percent of this potential could be realized in developing countries (FAO 2009). This potential varies significantly by country, and a distinction needs to be made between technical potential and what is economically and socially viable in the context of a developing country's agricultural development strategy. Even so, a number of mitigation practices may be attractive to farmers if climate finance were made available. For example, greater efficiency in agricultural production and the processing chain, leading to fewer emissions per unit of product could be viewed favorably. Another option for which there is increasing funding is to reduce emissions from deforestation and forest degradation, which is often linked to agricultural drivers. Reducing emissions of methane and nitrous oxide can be obtained through improved animal production, improved management of livestock waste, more efficient management of irrigation water on rice paddies and improved nutrient management. Carbon can be sequestered through conservation farming practices, improved forest management, afforestation and reforestation, agroforestry, improved grasslands management and restoration of degraded land.

In many developing countries, the impact of climate change is already apparent. The challenge is to figure out how to create a policy and institutional environment that is conducive to agricultural development and improving food security by combining adaptation measures with potential mitigation actions. This paper tries to synthesize ongoing work at the Food and Agriculture Organization of the United Nations (FAO) on developing CSA strategies at the country level. Section 2 introduces the building blocks for developing a CSA strategy and combines them into a coherent framework. In sections 3 to 7 the paper goes into more depth on the building blocks, the data needed, and potential approaches for prioritizing action.

2. WEAVING RESEARCH, POLICY, AND INVESTMENT INTO A CSA STRATEGY

Defining a CSA strategy requires the coordination of activities that cut across a number of stakeholders, such as (i) adaptation by farmers (private sector); (iii) the provision of credit for investment in climate-smart activities (financial sector, and possibly government); (iii) the definition of coherent policies for food security, adaptation to climate change, and the provision of environmental services (government); and (iv) the generation and dissemination of information on climate variability and its economic and social implications (research and extension).

The framework presented in Figure 1 illustrates the links necessary for such coordination to occur. We break down the problem into five components that are interconnected: (i) assessing the situation, (ii) understanding barriers to adoption of CSA practices, (iii) managing climate risk, (iv) defining coherent policies and (v) guiding investment.

CSA activities can range over a very broad spectrum, depending on the relative importance of its 3 pillars – food security, adaptation, and GHG mitigation – in a given country. Any country developing an agricultural strategy in the context of a changing climate will have to first **assess what CSA practices are relevant** given existing and projected climate variability, the current production patterns and practices, and whether there is mitigation potential that might provide additional financing.

Typically this initial screening of potentially relevant CSA practices will be driven by the vulnerability of staple crops and whether there are low cost GHG mitigation options that could be useful in financing activities focusing on food security and adaptation. Once potentially relevant CSA activities have been identified, another part of this assessment process will be the definition of **baseline activities** without CSA interventions by stakeholders. This is relevant both for obtaining adaptation funds, based on potential vulnerability, and for mitigation funds for which the baseline can serve as a reference level for accounting emission reductions. Potential CSA options identified in the initial assessment screening will then be evaluated according to economic and social criteria in line with a country's food security and development objectives.

In developing the initial assessment, it will also be useful to consider **potential synergies and trade-offs** relative to the baseline activities for those CSA practices that are thought to be relevant. Synergies will be important when preparing investment proposals, whereas trade-offs will matter when making the decision as to whether or not to adopt specific CSA activities given existing constraints.

A crucial part of the process of developing a CSA strategy is to **understand barriers to adoption** of CSA practices. Some barriers may be due to trade-offs that CSA practices engender in terms of resource use (e.g. crop residue management competing with livestock fodder or labour intensiveness of some practices). However, farmers may want to adopt certain practices, but do not, due to institutional barriers, financial bottlenecks, or a lack of access to input or output markets. Understanding what drives adoption or disadoption of CSA practices is an empirical question that needs to be answered to make informed choices on guiding policies and investments.

Another element that needs to be understood when dealing with agriculture and climate change is the **management of climate risk**. In some areas, climate change will manifest itself in clear ways consistently year after year (e.g. warmer average temperature), and farmers will adapt accordingly. In other areas, however, climate disruption may be more difficult to react to, such as when there are changes to the variability of rainfall. The latter type of change is difficult to adapt to because it is challenging for farmers to perceive a change in probability distribution. Farmers will therefore have to make decisions without being able to rely on past experience. Hence information and its distribution on the ground will be a key element in any climate change strategy. Gaining a better understanding of the risk profile of potentially relevant CSA practices would also play an important role in defining a CSA strategy that addresses the types of uncertainty introduced by climate change. Another important aspect will be designing policy tools to reduce the climate risk faced by farmers without reducing farmers' incentives to adapt to climate change.

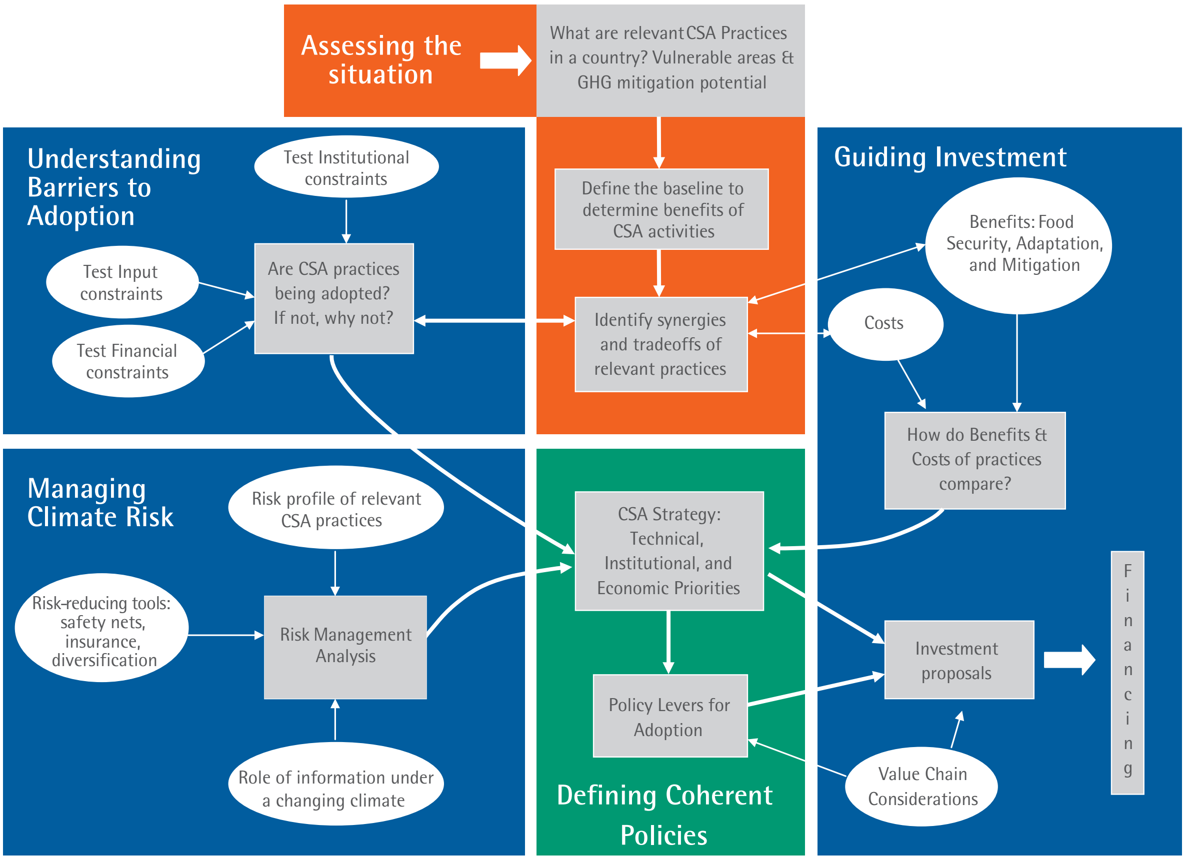

Figure 1. A Framework for developing a CSA strategy and investment proposals

Before developing an overall strategy, the **investment options** for the relevant CSA practices will have to be detailed. Quantifying the benefits of practices in terms of food security, and the timing of such benefits, will help prioritize them in the search for financing. The mitigation benefits of practices, if any, can play an important role for supplemental financing. From an investment perspective, it will be very important to identify all the costs of undertaking specific activities.

With an appreciation of the potentially relevant CSA practices, the barriers to their adoption, their implications for farmers' management of risk, and the benefits and costs of these different CSA practices, it is possible to combine this information to develop a CSA strategy that takes into consideration technical, institutional, and economic aspects. This will allow for a prioritization of CSA activities and create an **enabling and coherent policy environment** for agricultural development that takes climate change into account. Once the CSA activities are prioritized in the broader context of an agricultural development strategy and the necessary policy levers are put in place, investment proposals can be developed that build on the data collected on the benefits and costs. The final step is obtaining financing, which should be facilitated by integration of the CSA strategy with a country's broader development goals.

3. ASSESSING THE SITUATION AND THE IMPORTANCE OF IDENTIFYING A BASELINE SCENARIO

CSA answers the question of how we should change agricultural development planning and investment to take into account the effects of climate change. This means that CSA builds on existing agricultural development plans, but also involves the development of alternative options and scenarios that include various aspects of climate change. For example, to identify adaptation benefits from any specific agricultural development activity, we need to have an idea about how climate change is projected to affect that location and agricultural system, as well as about the effectiveness of strategies for reducing vulnerability and increasing adaptation to such changes. For mitigation we need to understand the increase in emissions that could be expected under a conventional agricultural growth strategy, as well as the reduced growth or absolute reduction in emissions that could be achieved under an alternative strategy.

Therefore, to implement CSA we need to define three main scenarios: (i) the current situation, (ii) a baseline or 'business as usual' agricultural growth path and (iii) the development of alternative or CSA growth paths that integrate adaptation activities based on projected climate change impacts and activities that potentially lower emissions growth against the baseline scenario. What is most important to recognize is that all these scenarios focus on the transformation of the agricultural economy so that it better promotes food security and poverty reduction since this is assumed to be the priority for agriculture in the context of developing countries.

With regards to adaptation, most least developed countries (LDCs) have agricultural development and food security strategies, but these do not generally include any detailed analysis of how projected climate change impacts may alter the assumptions and projections on which such plans are based.

The projected impacts of climate change vary by location and system, and there is considerable uncertainty about the effects. Agricultural development strategies that fail to take into account the impacts of increased uncertainty and volatility will not attain the expected growth in agricultural income. Conventional agricultural growth strategies tend to focus on increasing average agricultural productivity, but not reducing the variability of yields (e.g. the resilience of the system). Yet the changes that climate change introduces greatly increase the importance of considering this variability in agricultural development planning. The failure to incorporate this variability can be expected to lead to lower than projected rates of income growth and ultimately higher rates of food insecurity.

A CSA agricultural development path that includes the impacts of increased uncertainty and volatility and builds in measures to reduce their effects on agricultural incomes is likely to reduce the negative impacts of climate change on agricultural growth.

A similar exercise can be done for analyzing mitigation. Current levels of agricultural productivity and incomes are low, as are the associated emissions. Under the baseline agricultural development strategy we can expect to see a fairly steep growth in agricultural emissions. Conventional agricultural growth strategies generally include energy intensive development, high use of nitrogen fertilizer and, in some cases, the expansion of agricultural lands into forest or wetlands, all of which are significant sources of emissions growth. A climate-smart strategy would consider growth paths that have lower emissions growth than the baseline path. It is important to recognize that the CSA emissions growth path is likely to be higher than the current level, but at a lower rate of growth than the business as usual or baseline path. The mitigation that should be creditable to the country would be the reduction in emissions growth from the baseline emissions scenario.

The above discussion concerning baselines and alternative development paths highlights the need for comparison across scenarios. This in turn requires choosing a set of indicators that are appropriate to carry out such comparisons across the three pillars of CSA: adaptation, food security, and mitigation. In the next sub-section we provide a brief review of options and point to indicators that have the potential to be used at the country level based on available data.

The need for clear indicators in assessing adaptation, mitigation and food security

Given the complex nature of the interactions between adaptation, food security and mitigation, the implications of any given agricultural practice/policy and the approaches to assess each pillar of CSA merit detailed discussion. Branca et al. (2012) present a conceptual approach to assess the pillars of CSA activities in national agricultural development plans. Here we discuss quantitative approaches for assessing these pillars that can be incorporated into investment plans. Using an appropriate indicator is essential for the establishment of a baseline that captures all relevant information, as well as for meaningful monitoring and evaluation. We discuss various approaches used in the literature to assess the food security, adaptation and mitigation implications of agricultural practices/policies that have been implemented as part of national priorities in developing countries.

Representing food security benefits

Food security is a multifaceted phenomenon for which no single definition exists. The most recent Committee on Food Security (CFS) created a consensus that there is no unique indicator that can capture all the dimensions of food security and a suite of indicators should be developed and monitored (CFS 2011)[1]. However, such discussions about the definition of food security are mainly to monitor its changes over time and across countries on a macro scale. A detailed discussion of the definition of food security is beyond the scope of this paper. Instead, we focus on a few operational definitions that can be used to assess and monitor food security in the context of CSA.

The literature on vulnerability provides practical examples of how food insecurity can be measured and how its various determinants can be assessed in relation to agricultural production of smallholders in developing countries. Vulnerability can be defined as the probability of falling below a food security threshold, which can be proxied with the probability of falling below a specific income, food consumption or food expenditure threshold (Lovendahl and Knowles, 2005).

Karfakis *et al.* (2011) demonstrate an empirical approach to assessing food security under climate change using a Living Standards Measurement Study (LSMS) and climate data in Nicaragua. The authors first establish the links between climate (temperature) change and agricultural productivity and then the links between agricultural productivity and household food consumption expenditure to analyze the probability of a household falling below the food poverty line. This

1 http://www.fao.org/docrep/meeting/023/mc204E.pdf

methodology can be adopted to analyze the effects of CSA priorities of each country on agricultural productivity and through that on food security[2].

Karfakis *et al.* (2011) distinguish between the impact on food consumption of income from productive activities as opposed to relying on assets (including safety nets). In a different context, Kimura *et al.* (2010) define a diversification index built on the coefficient of variation of market revenue when changing the portfolio of commodities produced, while keeping the variability of yields constant. A change in the index has to be interpreted as a reduction in variability of profits due to the farmer's new choice in the composition of commodities in the farm production portfolio. In the context of a developing country with safety nets in place, one could compare this index to one calculated to include sources of revenue from safety nets to see the relative importance of adaptation strategies and safety nets in reducing income variability. The approach listed above for indicators fits well in the broader definition of a CSA strategy that aims to clarify the link between food security and adaptation.

Representing contribution of adaptation activities to food security

For the purpose of this paper, we can define adaptation as adjustments to agricultural systems in response to observed or expected climate stimuli (modifying the definition of Smit et al., 2001). Adaptation can significantly decrease the vulnerability of households and communities to climate change, moderate potential damages and improve their capacity to cope with negative consequences (IPCC, 2001). The analyses of adaptation and food security, therefore, are closely related as adaptation is an important component in decreasing vulnerability to food insecurity[3]. Adaptation benefits should be understood as a component of the broader food security benefits since income generation and food security are the main objectives for farmers.

Attempts at quantifying adaptive capacity in the literature have run into aggregation problems due to the complex issues of scale and the multi-dimensional aspects of adaptation (Below *et al.*, 2012). Most applied economics literature defines adaptation as a binary variable indicating whether or not the household adopted at least one adaptation option from a list to study who adopts, where and why (Bryan *et al.*, 2009; Di Falco *et al.*, 2011; McDowell and Hess, 2012).

Let us now turn our attention to linking a measure of adaptation to that of food security introduced in the previous sub-section. For a narrow focus on households who depend mostly on agriculture for their livelihoods, the definition of adaptation benefits can be considered, for practical purposes, as the extent to which income is increased or stabilized for an acceptable livelihood level by

2 One critical issue in empirical analysis is establishing a link between certain CSA activities and changes in food security outcomes. To be able to disentangle the effects of various variables from that of a particular CSA practice, careful analysis is needed to control for self selection in the adoption of the practice and the effects of adoption conditional on adoption. Data collected from the same respondents over time (panel data) is very useful because it allows for the isolation of the effect of a CSA practice on production and food security (by controlling for household fixed effects). Given the scarcity of panel data, instrumental variables approaches (as in Karfakis et al., 2011) can be used to control for the confounding effects of unobserved variables.

3 Although we acknowledge that adaptation activities can be divided into adaptation to slow-onset climate change and adaptation to extreme events, here we focus on the latter since it is more directly related to food insecurity. In addition, adaptation to slow-onset climate change can be structured along more classical development plans.

a combination of the following: (i) productivity increases and reduced variability by adopting certain practices; (ii) diversifying livelihood strategies on the farm; and (iii) diversifying income through off-farm activities. Household level adaptation is typically referred to as autonomous adaptation in the climate change literature (Heltberg et al., 2009). This is not to say that other forms of adaptation, such as social safety nets, are not important. In fact, local actors will increasingly need external support to address large, covariate risks of the kind associated with climate change. However, autonomous adaptation at the household level is structurally different from other forms of adaptation at the more aggregate level (e.g. safety nets) and should be kept distinct in a framework for a CSA strategy[4]. From here on the term 'adaptation' will refer to household autonomous adaptation, while safety nets or risk management policies will deliver food security benefits separately.

Figure 2 presents food security benefits adjustments after a climatic shock as the sum of benefits from safety nets and from adaptation. This can be interpreted conceptually as an extension of the approach of Karfakis *et al.* (2011) so as to include adaptation to climate change. Karfakis *et al.* (2011) consider the impact of climatic disruption on the likelihood of households falling below the poverty line due to decreased productivity, accounting for access to safety nets and assets. Here we extend the approach by including the different forms of autonomous adaptation listed in the previous paragraph.

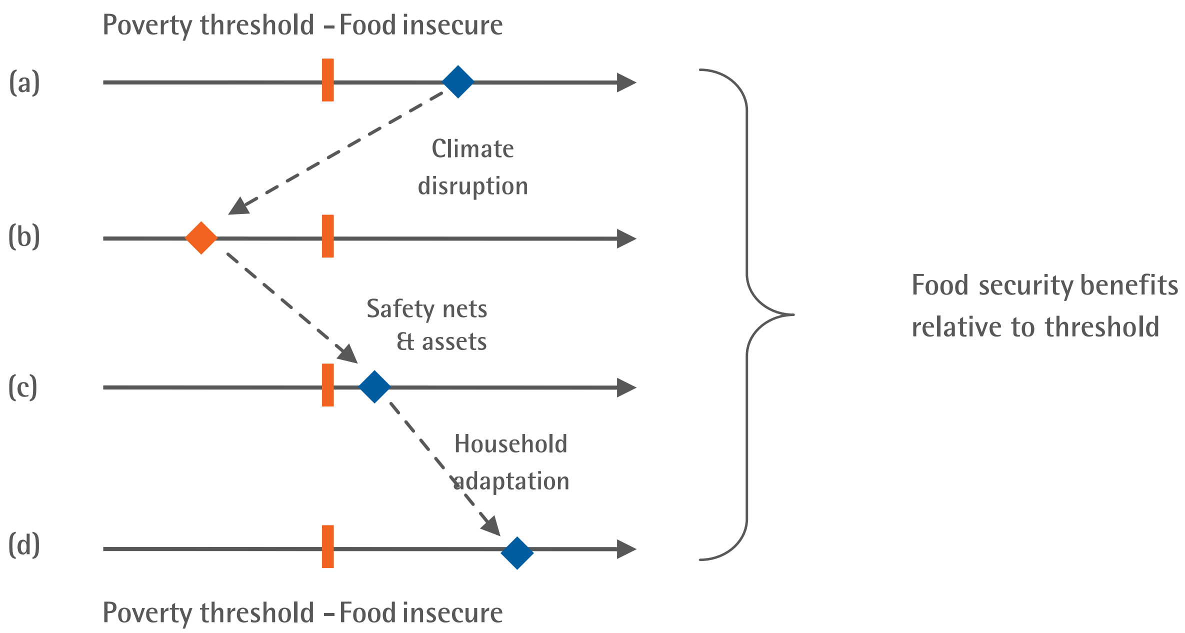

Figure 2. Food security relative to the poverty threshold:

(a) households' normal food security level, (b) impact of climate disruption, (c) safety nets and assets to rise above the poverty line but not to normality, (d) household adaptation is needed to return to an equilibrium.

4 Other approaches are possible, such as the Activity-based Adaptation Index (AAI) developed by Below et al. (2012) combining a list of adaptation practices identified through household surveys and participatory workshops. However, this approach is very data intensive and of limited use to examine risk-related aspects of an adaptation strategy. In this respect, the literature on resilience (defined as the ability to maintain livelihoods in the face of shocks) may provide a more broadly implementable indicator of adaptation, which is created using generally available data from country statistical offices (Alinovi et al., 2010).

The main challenge in empirical assessments of food security benefits is to avoid attributing to CSA adoption food security benefits that may have other causes (see Box 2). There are many factors that affect farmers' adoption of technologies and that, if not carefully controlled for, may confound the effects of CSA. For example, farmers who adopt certain practices may also be the ones that are more likely to be have higher efficiency in production (due to unobserved factors such as ability or openness to innovation). If not accounted for, this selection effect can lead to an overestimation of adaptation benefits. Careful analyses are required to account for selection and barriers to adoption as a first step as detailed in the next section.

Representing benefits from mitigation activities

Indicators for GHG mitigation are conceptually straightforward. However, since agriculture is a net emitter of different GHGs, with very different atmospheric lifetimes and different radiative properties, it is important to have a metric whereby emissions of different gases can be compared and weighted according to their contribution to climate change. Such a metric facilitates a desired multi-gas abatement strategy in a decentralized manner (Fuglestvedt, 2003). The most widely used metric is the Global Warming Potential (GWP), which compares the impact over a specific time horizon of a 'pulse' emission of one unit of a specific gas. It is thanks to metrics that emissions are expressed as tons of carbon dioxide (CO_2) equivalent, using CO_2 as a normalizing factor[5].

Assuming the GWP metric is given, indicators for climate change mitigation will revolve around precise measurement of the gases emitted or of the carbon sequestered. The ease of measurement for the different gases and the uncertainty in such measurements will typically determine the attractiveness of mitigation activities, since greater uncertainty will entail a discounting of the creditable reductions so that they are within a pre-defined confidence interval.

Several sources of uncertainty are associated with agricultural carbon sequestration activities that will need to be addressed by monitoring systems for GHG accounting: (i) uncertainty over whether or not an activity is implemented and an accurate accounting of the land area involved; (ii) uncertainty arising from emission factors attributed to mitigation actions, particularly in heterogeneous agricultural landscapes; (iii) uncertainty due to lack of scientific documentation of the impacts of management practices on non-CO2 emissions associated with carbon sequestering processes.

5 It should be noted that alternative metrics have been proposed and are being debated within the IPCC and the UNFCCC (see Tanaka et al., 2010; Shine, 2009). Whereas many industrial sectors would not be affected by a change in metric since they mostly emit CO2, the viability of mitigation activities in agriculture could be affected by a change in metric since nitrous oxide and methane are an important part of emissions from agriculture, and the equivalence with CO2 could be altered by changing the metric used.

BOX 2: DATA REQUIREMENTS TO ASSESS BENEFITS OF CSA ACTIVITIES

The availability of data will be a determining factor in the choice of indicators of food security in practice. In the context of creating an evidence base for CSA, the objective is to establish linkages between the CSA practices as identified above and household food security outcomes. Ideally, the concept of vulnerability and resilience to food security should be measured using data collected from the same households over time (panel data), tracking agricultural production, income sources and consumption. Panel data rich enough to cover all these components, however, are usually not available in most developing countries (although the World Bank has been investing considerable effort in improving this situation). Large-scale cross-sectional data (e.g. LSMS data collected by the World Bank in collaboration with country statistical offices) can be used to assess the food security situation in the baseline using one of the definitions above.

Data requirements examining adaptation are similar to those for food security (i.e. large scale household surveys with detailed information on agricultural production). The data should be ideally panel data and contain enough variation in adopters and non-adopters of the practices to be assessed to allow meaningful attribution of adaptation benefits. This type of data, however, is not enough to assess adaptation benefits as there is a need to link key climatic variables (e.g. rainfall and temperature) with production and income data. National weather stations may provide useful historical weather data, but they may not cover long periods of time and/or not have enough spatial resolution to be useful in household level analyses. Fortunately, obtaining historical low-resolution climatic data is becoming easier thanks to international efforts to track and forecast climate change[1]. Given that changes in climatic variables are only observed over long periods of time and that it is almost impossible to find panel data tracking households for long enough to capture these changes, a compromise needs to be found to link climate data with household data. Empirical econometric analyses can link historical averages and variation (coefficient of variation) in climatic variables with the effects of CSA practices to understand how the adaptation impacts of certain practices interact with climatic variables. For example, if we find that agroforestry practices improve the adaptation indicators more in communities with a higher historical rainfall/temperature variation, we can conclude that CSA provides adaptation benefits in these communities.

The effects of CSA on the variability of production (its vulnerability to climate change) can be very different from the effects on productivity. Some CSA practices may help smooth production by attenuating the effects of weather extremes, but may have no (or negative) effect on average productivity in a given year. Other practices may even have negative effect on variability in the short-run as farmers and agricultural systems adjust to the new practices that in the long run decrease vulnerability (Giller et al., 2009; McCarthy et al., 2011). Therefore, using the appropriate time horizon is very critical in assessing the adaptation effects related to vulnerability. Econometrically, vulnerability effects are harder to establish, especially given the lack of long time series data to capture the distribution of production. In the absence of such data, existing econometric techniques based on short panels and historical climate data can be used to differentiate the effects of some variables (CSA practices) on the mean and the variance of yields or incomes (Just and Pope, 1979; Christiaensen and Subbarao, 2005; Kusunose, 2010). For cases where even a short panel is not available, the probability of income falling below a pre-defined threshold can also be used to assess food security benefits using cross-sectional data. How CSA practices (and their interactions with climate data) affect this probability can provide useful indices to rank various practices for policy targeting.

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1 Historical bioclimatic data are available from WorldClim (http://www.worldclim.org/download); rainfall data are available from National Oceanic and Atmospheric Administration's Climate Prediction Center (NOAA-CPC) (http://www.cpc.ncep.noaa.gov/products/fews/RFE2.0_desc.shtml); and Vegetative Cover data are available from the Spot Vegetation Mission (http://www.spot-vegetation.com/index.html).

Even allowing for the challenges in measurement and the discounting that uncertainty may imply, mitigation can provide a third pillar to diversify income sources along with adaptation and safety nets. We can characterize this contribution by extending Figure 2 to incorporate the mitigation component on the vertical axis. By so doing we obtain Figure 3, which expresses food security relative to a poverty threshold based on agricultural production and safety nets, and income to households from mitigation activities. The safety net (SN) functions similarly to Figure 2, where it is meant to position the household above the poverty line when a shock occurs, without having any mitigation activities. Now the adaptation (AD) by households may have mitigation co-benefits that can provide an extra source of income (synergies). Finally, the mitigation activities (MT) while providing additional income, may involve a trade-off in terms of income from agricultural activities. An example would be the case of funding for reducing emissions from deforestation, which would entail a decrease in agricultural land and therefore a potential decline in production relative to the baseline.

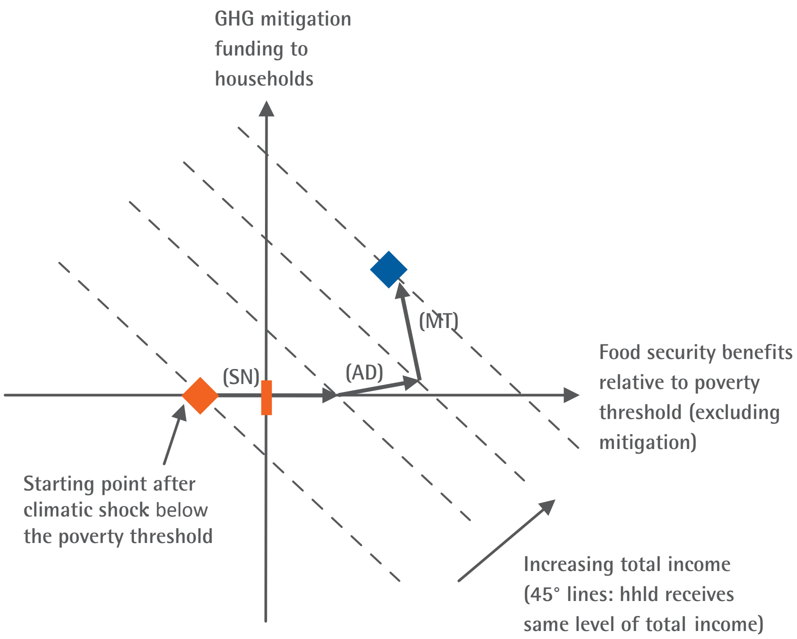

Figure 3. Introducing mitigation funds into the food security equation:

The safety net (SN) positions the household above the poverty line when a shock occurs; the adaptation (AD) by households may have mitigation co-benefits that can provide an extra source of income (synergies); mitigation activities (MT) provide additional income but may imply a trade-off.

4. BARRIERS TO ADOPTION AND THE ROLE OF INSTITUTIONS

In the previous section, an outline of how to assess the situation in terms of food security, adaptation, and mitigation was discussed. The rationale was to introduce indicators for these three pillars and put them in relation one with the other into a coherent framework. This involved defining adaptation at the household level, articulating a component on safety nets to link autonomous adaptation to broader issues of food security, and pointing out the potential contribution of mitigation activities to diversifying income. However, an important part of developing a CSA strategy will be understanding barriers to adoption.

Studies of farm-level adaptation that make use of household datasets confirm that farmers respond not only to climate stimuli but to a number of other factors as well (Smit *et al.*, 1996; Brklacich *et al.*, 1997; Bryant *et al.*, 2000; Bradshaw *et al.*, 2004; Belliveau *et al.*, 2006; Maddison, 2007; Nhemachena and Hassan, 2007). Farm-level changes that might be expected given a certain climate signal may not actually occur due to other intervening factors, such as human capital (e.g. level of education, age, ethnicity, gender), economic conditions (e.g. relative prices, input and output market development, credit availability) and the policy environment (Bradshaw et al. 2004). The nature of farmers' responses to climate change and variability also depends on the socio-economic position of the household. Poor farmers are likely to take measures to ensure their survival, while wealthier farmers make decisions to maximize profits (Ziervogel et al., 2006). Climate change is thus expected to affect different segments of the rural population differently. At the same time heterogeneous responses to changing climate can be expected, based on differences in the socio-economic characteristics of different groups of people and localities (i.e. household resource endowments, poverty levels, livelihood coping strategies and infrastructure status).

As reviewed by McCarthy et al. (2011), the adoption of CSA options is also constrained by a lack of tenure security, which may affect farmers' incentives to adopt because of the time delay in enjoying the benefits from CSA and farmers' limited access to finance and insurance. CSA practices may increase labour requirements for weeding when implemented without herbicides, as is the case for most smallholders. Therefore, labour constraints may be binding for households without access to herbicides and enough labour. Although there is no conclusive evidence in the literature, agro-ecological constraints such as soils (e.g. drainage capacity) and climate (e.g. semi-arid regions with termites) are also likely to affect adoption. In addition to traditional constraints, for some CSA practices, competition for crop residues from livestock, which traditionally graze freely on harvested fields in most parts of Africa, is likely to decrease incentives for adoption in regions where livestock rearing is an important livelihood diversification strategy.

Overall, farmer adaptation to climate change requires rural communities to have access to better information, inputs such as fertilizer, machinery and a diverse set of seeds and breeds. Increasing the returns and benefits that agricultural producers derive from their production systems is an essential component of CSA and therefore also requires well-functioning and accessible output markets. To address these issues, innovative approaches to both formal and informal institutions may be needed to bolster local resilience, support livelihood diversification strategies and reinforce coping strategies. In this section, we focus on the importance of institutions that are known to affect farmers' adoption behaviour and that are also likely to increase in importance as the climate changes.

Information

One of the key constraints to widespread adoption identified in the literature concerns information and knowledge flows. Information on the types of options, particularly those well-suited to local conditions, is often scarce. For example, this lack of information can increase the risk of planting expensive seeds that may not survive or otherwise do poorly (Ajayi et al., 2007; Franzel et al., 2004; Franzel & Scherr, 2002). Information available to farmers on the types of CSA options that are well-adapted to the locality is likely to be an important determinant for adoption. Information may come from a number of sources, including government extension programmes and non-governmental organization (NGO)/donor programmes.

Based on the abundant evidence that seasonal climate variability plays an important role in risks faced by producers, it is natural to conclude that the foundation for building adaptive capacity of rural communities is knowledge management. Improving the access to reliable information is key to facilitating adaptation in the form of the choices farmers make regarding crops, varieties and farming systems. One key role of institutions is the production and dissemination of knowledge and information, ranging from impacts of climate change on production and marketing conditions, to the development of regulations and standards. Climate change, by increasing uncertainty, as well as the value of rapid and accurate response (or the costs of not doing so) increases the value of information and the importance of institutions that generate and disseminate it (Campbell et al., 2010). These include institutions engaged in agricultural research, extension, agricultural production and marketing statistics and the provision of climate-related information.

Adopting CSA requires farmers to make both short- and long-term planning decisions and technology choices. Agricultural extension systems are the main conduit for disseminating information required to make such changes. Yet, problems with delivering information at a relevant spatial and time scale, difficulty in communicating the information and lack of user participation in development of information systems are all problems that have been encountered (Hansen et al., 2007). Box 3 below provides insight from Malawi and Zambia related to the role of formal and informal institutions in improving input supply to smallholders.

BOX 3: ACCESS TO EXTENSION SERVICE IN MALAWI AND ZAMBIA

Data from the Living Standard Measurement Survey (LSMS) 2010 community survey in Malawi show that a high proportion of communities have an assistant agricultural extension development officer living in the community, with 39 percent of communities in northern part of the country, 36 percent on the central areas, and 26 percent in the south having an officer in the community. For those communities without an agent, the distance to the nearest agricultural extension office was about 9 kilometers for farmers in all three regions. Despite the relatively large numbers of communities with agriculture extension officers, in 2010, information from the household survey indicates that just 21 percent of households received any extension advice in the northern region, followed by 18 percent and 12 percent in the central and southern regions respectively. The household survey also gathered information on extension advice received by the household; in particular, questions were asked about information received on 13 specific activities, though only 'pit planting' and 'forestry' specifically related to sustainable land management (SLM) activities. For pit planting, 16 percent, 17 percent, and 10 percent received such advice in the northern, central and southern regions respectively. For forestry, 16 percent, 19 percent and just 9 percent received advice in the northern, central and southern regions, respectively. The data also show that extension advice is dominated by government agricultural extension services and electronic media, largely radio. Other sources, including NGO's and farmer field schools played a very limited role.

Data from the Rural Incomes and Livelihoods Surveys from Zambia show that only around 9 percent of communities surveyed throughout the country had an extension officer living in the village in 2008. These communities were concentrated in the Lusaka and the Eastern provinces, while in some provinces less than 5 percent of the communities (Copperbelt, Central and Western) had a resident extension officer. The distance to the nearest agricultural camp office ranged from between 6.5 and 23 kilometers, with significant differences across provinces. Communities in the Eastern and Luapula provinces had the shortest distance, whereas Copperbelt had the longest distance. Household surveys asked about extension advice provision mainly related to SLM activities (e.g. minimum tillage, nitrogen-fixing rotation and residue management). Data indicate that 60 to 70 percent of all farmers had received extension information on these issues in both years. There was a decrease in the percentage of farmers that received minimum tillage advice between 2004 and 2008 in all provinces except in the Eastern province. Similar to the case in Malawi, extension services in Zambia are dominated by the ministry of agriculture, followed by fellow farmers. Other sources of information play a limited role.

The bottom line in both countries is that the extension service coverage is relatively low and varies significantly across regions. Improving extension service both in terms of coverage and efficiency is essential in helping farmers to overcome barriers to information and adapt to climate change.

Source: Own analysis based on Rural Incomes and Livelihoods Surveys from Zambia and Living Standard Measurement Survey (LSMS) 2010 from Malawi

Finance and insurance

Adopting CSA options implies a need for increased, as well as extended, investments at the farm level. McCarthy *et al.* (2011) document the extended transition times needed to realize the benefits to CSA in the form of productivity or increased resilience. During the transition, the returns to agriculture are often low or negative, and thus some form of financing to support this transition is necessary. Their capacity to make the required adjustments depends on the existence of policies and investments to support farmers' access to credit, insurance, as well as on proper economic incentives. There are several types of institutions that are relevant, but here we focus on two that are perhaps more relevant in the context of CSA: access to microfinance and productive social safety nets, with the latter being discussed under risk management.

As reviewed by McCarthy et al. (2011), the adoption of CSA is subject to most of the traditional constraints found in the literature. As with any new technology, CSA options may be perceived as a risky investment, as farmers will need to learn new practices and typically do not have access to insurance. Credit constraints will affect adoption, especially when initial investment costs are high, given the evidence that the benefits of the practices are usually realized after around 4 years. Just how binding a cash constraint might be is obscured by the fact that many projects promoting CSA practices in fact provide the inputs such as seeds and seedlings for free, particularly in East and Southern Africa (Franzel et al., 2004); thus, it will be particularly important to determine conditions under which farmers access seeds/seedlings. Nonetheless, a number of empirical studies have found that wealthier households with greater landholdings are more likely to adopt CSA practices such as agroforestry. This indicates that cash constraints and opportunity costs of land in the near term are likely to affect adoption decisions (Phiri et al., 2004; Kuntashula et al., 2002). Box 4 below highlights some descriptive information related to access to credit by Malawian and Zambian farmers and points to the role of institutions in overcoming the liquidity problem.

Agricultural input and output markets

Agriculture is based on the use of natural resources supplemented with material and non-material inputs to produce food and other products and services. The decisions farmers make about the type of technologies and practices they adopt is determined by the benefits and costs associated with it, which in turn is affected by the ability of producers to access input supply and output market chains. Improved market access that raises the returns to land and labour is therefore a critical force for the adoption of new climate-smart practices in agriculture. However many smallholder farmers in vulnerable areas continue to face complex challenges in adoption of CSA options. There is still inadequate understanding of the market, policy and institutional failures that shape and structure farmer incentives and investment decisions.

Market failures in rural areas often arise out of asymmetric information, high transaction costs and imperfectly specified property rights. They are more pronounced in areas with underdeveloped road and communication networks and other market infrastructure. Under these circumstances, households tend to withdraw from markets and focus predominantly on subsistence production when food security through markets is not assured (de Janvry *et al.*, 1991; Shiferaw *et al.*, 2007).

BOX 4: ACCESS TO FINANCE IN MALAWI AND ZAMBIA

According to 2010 LSMS Malawi household survey, just 16 percent of all households accessed some form of credit, from both formal and informal sources; 57 percent of loans came from neighbours, relatives or friends; approximately 27 percent came from microfinance and NGO sources; 8 percent from commercial banks; and the remaining 8 percent came from various 'other' sources. Although access is quite low across all regions, access to credit differs somewhat between the central region and northern and southern regions. For instance, just 10 percent of households in the north, and 13 percent of households in the southern accessed any source of credit. In the central region, 17 percent of households had access to credit. Interestingly, the percent of households accessing informal as opposed to formal credit (including microfinance institutions) bears little relationship to overall poverty patterns. Informal credit sources provide just 39 percent of credit accessed in the poorest northern region. The percentage increases to 57 percent of loans in the wealthiest central region, and increases yet again to 63 percent in the moderately poor, but most densely populated, southern region. In terms of local credit/savings clubs, findings from the community-level surveys in 2010 indicate that about 5 percent, 13 percent and 10 percent, respectively in the northern, central and southern regions.

In Zambia, only 10 percent of households had received any agricultural loan in 2008, down from 13 percent in 2004. Around 65 percent of all loans were provided by cotton, tobacco or other crop companies with out-grower schemes. Government loans accounted for only 10 percent of the loans. In 2008, crop companies provided almost 90 percent of all loans in the data. Government loans decreased to 3 percent. Loans from private banks and microcredit institutions were negligible in both years (less than 5 percent). Overall, the results from both Malawi and Zambia show that farmers' access to credit is very limited. This suggests that liquidity constraints may be a potentially important barrier to adoption of CSA practices.

Source: Own analysis based on Rural Incomes and Livelihoods Surveys from Zambia and Living Standard Measurement Survey (LSMS) 2010 from Malawi

Addressing these overlapping constraints requires innovative institutional arrangements and partnerships that improve local availability and utilization of CSA options and effective market linkages that offer more stable and better prices to producers. Farmer organizations have the potential to mitigate the effects of imperfect markets by enabling contractual links to input and output markets and promoting economic coordination in liberalized markets, hence leveraging market functions for smallholder farmers (Shiferaw et al., 2007). This can be expected to stimulate adoption of CSA options, which in turn drives the process of commercialization in rural areas.

Realizing the adoption potential of CSA practices will, however, depend on the ability to convey market information, coordinate production and marketing functions, define and enforce property rights and contracts and, more critically, mobilize producers to participate in markets and enhance the competitiveness of agro-enterprises. This suggests that institutions provide multiple functions to markets. They transmit information, mediate transactions, facilitate the transfer and enforcement of property rights and contracts, and manage the degree of competition; thus providing alternative mechanisms through which market failures in rural areas can be remedied (Shiferaw et al., 2007). Box 5 below provides an insight from Malawi related to the role of formal and informal institutions in improving input supply to smallholders.

BOX 5: ROLE OF INSTITUTIONS IN INPUT SUPPLY IN MALAWI

Malawi 2004 and 2010 LSMS data provide some insight on the role and coverage of institutions in supplying input to the farmers. In terms of sellers of SLM-specific inputs in the communities, no information is available from the surveys. However, in both survey periods, we do have information on whether there were any sellers of hybrid maize seed and fertilizers in the community. In 2010, 16 percent, 43 percent and 31 percent of the communities in the northern, central and southern regions had at least one seller of fertilizer and hybrid maize. These figures are significantly higher when compared to 2004, where 9 percent, 12 percent and 26 percent could purchase fertilizer and hybrid seeds within the community. In terms of the state-controlled Agricultural Development and Marketing Corporation (ADMARC), 16 percent, 26 percent and 14 percent of communities have an ADMARC agent located in the community in 2010. In terms of daily and larger weekly markets, there is again a distinct difference between the central region versus the northern and southern regions: 64 percent versus 33 percent / 30 percent for daily markets; and 45 percent versus 27 percent /32 percent for larger weekly markets. These descriptive results show the crucial role the institutions play in overcoming the barriers to accessing inputs for smallholders which in turn contribute in enhancing adoption of CSA systems.

Source: Own analysis based on Living Standard Measurement Survey (LSMS) 2010 from Malawi

5. ADDRESSING VULNERABILITY AND MANAGING CLIMATE RISK

For the purpose of defining a CSA strategy, it will be crucial to have a clear idea of households' vulnerability to shocks in climatic variables (based on their asset portfolio), the social safety nets available, and risk management options. Vulnerability will depend not just on exposure and sensitivity to risks, but also on the losses relative to a threshold for household well-being and on local institutions and the policy environment through their impact on adaptive capacity.

A risk management analysis should examine how climate change, by affecting the mean, variability, and covariance of weather events, affects the appropriateness of different risk management tools, such as safety nets, crop insurance, diversification by farmers, adoption of CSA practices and the interaction between these elements. An important aspect to be considered is also how *ex-ante* tools, such as insurance, could improve the outcome as compared with a government's *ex-post* disaster assistance.

A major policy issue to be considered is the extent to which the use of different policy instruments may hinder or enhance household adaptation to climate change. On one hand, the availability of safety nets or insurance can potentially enhance resilience in the face of shocks and can be seen as a form of adaptation. On the other hand, by providing transfers that shift risk to more aggregate levels, some of these policies could cause farmers to be less inclined to change their production techniques and portfolio of activities. Care should be taken that risk management policies are designed so as to not impede autonomous adaptation by households.

As is clear from the previous section on adoption of practices, a first step towards defining a risk management strategy under climate change is to identify the issues and institutions that are relevant to risk management analysis in the context of a specific country or region. Available farm-level data, such as the World Bank's LSMS, can be used to assess the risk environment faced by individual farmers and infer the variability of risk factors across time. This empirical information may be used to calibrate a micro-economic model to simulate farmers' responses to different risk environments and policy changes (Mc Carthy et al., 2012; Anton et al., 2012). A simulation model would allow for estimates to be made of policy impacts on the distribution of farm income and farming risk management behavior under different climate scenarios, information availability and policy environments.

Insurance options being considered by some developing countries include individual yield, area-yield and weather index insurance. When developing a risk management strategy, one should consider that each of these options have different characteristics in terms of data requirements, administrative costs, the distribution of risk and the impact on farmers incentives to adapt to climate change. Although we acknowledge the existence of these different types of crop production insurance and their importance in managing risk, it is beyond the scope of this paper to go into greater depth on this topic. Here we focus on the impact of information availability and reliability and on safety nets, which are two factors that are central to managing risk in developing countries.

The role of information in managing climate risks

Given the limited information countries typically have on the future impacts of climate change, it becomes difficult to develop a well-defined risk management policy framework that enhances farmers' adaptation to a changing climate. Adaptation strategies and policies that take all available information into consideration at one point in time may not be optimal *ex-post*, if the climatic variability is misrepresented in the *ex-ante* expectation.

Examining the role of forecast climate information in decision-making, Ziervogel et al. (2005) find that the use of accurate climate forecast information can improve household well-being. Poor forecast information can be harmful to poor farmers. Overestimating the accuracy of a forecast system can lead to excessive responses that are inconsistent with decision makers' risk tolerance and can damage the credibility of the forecast provider (Hansen et al., 2007). **These results suggest that linking farmers to new sources of information on climate change will be important, but is equally important is 'translating' the risks and potential margins of error in ways that farmers can understand and use in making decisions.** The ability to respond to climate forecasts and the benefits obtained from their use are however determined by a number of factors, including the policy and institutional environment, and the socio-economic position of the household (Ziervogel et al., 2005; Vogel and O'Brien, 2006). Given the potential for rural climate information to support adaptation and manage climate risk, there is a need to make climate information more accurate, accessible and useful for farmers (Roncoli et al., 2002; Ziervogel et al., 2005; Hansen et al., 2007).

The importance of information is highlighted in Anton et al. (2012), which explores the budgetary and welfare implications associated with a misalignment of the farmers' expectations with the actual probability distribution of weather events. The authors examine the robustness of different policy mixes in the face of uncertainty about the perturbation that will be brought about by climate change and how different types of insurance or other risk management strategies are affected by a misperception of climate variables under a changing climate.

Safety net programmes

There is growing recognition of the potential role of social safety nets in helping the poorest manage the risks associated with climate change. Safety nets are non-contributory transfer programmes targeted to the poor and people who are vulnerable to poverty and shocks. These programmes include conditional and unconditional cash transfers, cash for work, vouchers, food distribution, and distributions of seeds and tools. Indeed, safety nets are likely to become increasingly important in the context of climate change to address the expected increase in the incidence of widely covariate risks that traditional insurance mechanisms will be unable to cope with. Cash transfers provide recipients with resources to enable them to maintain a minimum level of consumption. These include child allowances, disability benefits, targeted income support and conditional cash transfers (World Bank, 2010). Workfare and public works programmes supply temporary employment to recipients who are able to contribute their labor in return for benefits. In-kind safety nets help recipients to access food, health services, education, housing, energy and other basic goods and services. Some of African safety net programmes implemented during the last decade include the Kenya Hunger safety net programme, Malawi Social Cash Transfer (SCT), Mozambique Programa de Subsidios de Alimentos (PSA), Ethiopia Social Protection Minimum Package.

It is important to note that most of these safety net programmes were not designed explicitly to address food insecurity due to climate change. However, we would expect these programmes to have impacts on the economic livelihoods of beneficiaries as well, and help protect those most vulnerable to climate risks, with low levels of adaptive capacity. These programmes often operate in places where markets for financial services (credit/savings/insurance), labour, goods and inputs are missing or do not function well, and where households are among the most vulnerable to climate change.

Cash transfer programmes for instance can build adaptation capacity at the household level through the following channels: i) improvements in human capital, including nutritional and health status and educational attainment; ii) investments that improve income generation capacity, including crop and livestock production and non-farm business activities; iii) investments that improve natural resource conservation, such as SLM practices and the use of production inputs, including new cultivars; and iv) changes in risk management, including adopting riskier and more profitable livelihood and production strategies that enhance farmers' adaptive capacity, avoiding detrimental risk-coping strategies (distress sales, child school dropout), and decreasing risky income-generation activities (commercial sex, begging and theft). Similarly to household impacts, community and local economy impacts of cash transfer programmes allow multiple channels. First, they can transform social relations to reduce underlying social and political vulnerability by relieving pressure on existing social networks of reciprocity. Second, they can stimulate local product and labour markets, and third they can create multiplier effects (Asfaw et al., 2012).

With climate change likely to result in an increased magnitude and frequency of shocks, innovative approaches to social safety nets might be needed to bolster local resilience, support livelihood diversification strategies and reinforce people's coping strategies. Explicitly incorporating climate change adaptation into safety net programmes would provide a unique opportunity to help people adapt to climate change. Furthermore, social safety net programmes and their design need to consider climate change to effectively address the multiple risk and vulnerabilities faced by the poor and excluded. However, developing safety net approaches for climate change adaptation requires a rigorous evidence base and an improved understanding of the social impacts and the policy and implementation processes. There are considerable gaps in knowledge regarding both the evidence base and the complexity of policy processes, especially with regard to its link to adaptation to climate change. There is a need to further develop an evidence base on how to effectively combine social safety nets measures to mitigate vulnerability to climate change in different contexts.

6. BUILDING COHERENT POLICIES AND INSTITUTIONS FOR EFFECTIVE IMPLEMENTATION OF CSA

Building a CSA strategy at the national level

Given the objectives of CSA to explicitly integrate the challenges and opportunities of climate change into agricultural development planning, it is essential to build national CSA strategies upon existing agricultural development strategies and policies. At the same time, most countries have developed, or are in the process of developing national climate change policies, and these too must be built upon in developing a national policy framework to support CSA. In general, both agricultural development and climate change national policies already contain elements that support the development and implementation of CSA. However, efforts to identify these and ensure a coordinated vision that articulates priorities, as well as specific policy levers, is likely to be necessary to identify a set of priority activities, institutions and policies to support them and the overall investment strategy. **Development of a national CSA strategy then, is an opportunity to promote coordination between key stakeholders working in agricultural development and climate change, bringing them together to articulate a unified vision of agriculture development under climate change.**

For example, in African countries, the Comprehensive Africa Agriculture Development Programme (CAADP) is a key continental policy instrument used by countries to articulate national agricultural development objectives and strategies. The goal of CAADP is to help reach and sustain higher economic growth through agriculture-led development that reduces hunger and poverty and enables food and nutrition security. Under the CAADP process, compacts to identify priority investment areas are developed through a process of consultation with key stakeholders. The compacts, and eventually the investment plans they generate, are built around four mutually reinforcing pillars: (1) extending the area under sustainable land management and reliable water control systems; (2) improving rural infrastructure and trade-related capacities for market access; (3) increasing food supply, reducing hunger, and improving responses to food emergency crises; and (4) improving agriculture research, technology dissemination and adoption (Omilola et al., 2010). In 2010, 24 countries have signed CAADP compacts, and 18 have drafted CAADP investment plans.

The CAADP compacts outline the national strategy for agricultural development, indicating specific sectors and activities for prioritization. For example, Malawi signed a CAADP Compact in 2010 and has also completed its related investment plan, which is based on the Agriculture Sector Wide Approach (ASWAp) formulated in September 2010. Some of the priority areas identified are achieving maize self-sufficiency, production diversification, scaling up of SLM practices and implementation of risk management tools, such as weather index insurance. These activities are likely to have important adaptation and mitigation impacts and provide a basis for building a larger national CSA strategy. Malawi has also developed a National Adaptation Plan of Action (NAPA) that includes improving crop production through appropriate technologies, increasing resilience of production systems through the adoption of sustainable land management techniques, and afforestation and reforestation to improve fuelwood supplies and improved watershed protection (Government of Malawi, 2006). In addition, Malawi has made a submission to the UNFCCC on the development of a Nationally Appropriate Mitigation Action (NAMA) that highlights the potential of changes in agricultural practices to bring about a greater use of sustainable land management and resource efficiency as ways to contribute to mitigation (UNFCCC, 2012).

Another example comes from Vietnam, where the government has created a National Target Programme to Respond to Climate Change, and the Ministry of Agriculture and Rural Development has recently issued a decision to promulgate an action plan for the climate change response of the agriculture and rural development sector for 2011-2015. The government has also issued a directive on Mainstreaming of Climate Change into Development, Implementation of Strategies, Long- and Short-term Plans, Projects on Agriculture and Rural Development in the Period 2011-2020. The Government set explicit targets to reduce GHG by 20 percent by 2020 in agricultural and rural development sectors, including crop production, livestock, forestry, fisheries, irrigation and non-farm activities. These targets cover a wide range of practices to improve production and decrease emissions at the same time, such as improving the efficiency of fertilizer use, improving rice farming techniques, using integrated solutions to save energy and fuel in land preparation, improving the livestock management, increasing the use of composting, and the reforestation and restoration of forests for sustainable utilization.

Clearly all of these national policies, if fully implemented, have the potential to result in major changes in Malawian and Vietnamese agriculture. As can be seen, there is considerable potential for achieving synergies between the three policy objectives of food security, adaptation and mitigation, with some of the same measures advocated by all three. However, there is also potential for conflicts, and certainly a need for coordination and prioritization of activities aimed at achieving food security, adaptation and mitigation through agriculture. This is where a CSA-specific strategy is needed. Such a strategy can be developed through consideration of priority areas and actions identified in each of the relevant policy statements, and through a consultative process that involves key stakeholders in agricultural development, food security planning and climate change.

Coordinating mechanisms already exist in Malawi that may be used as a basis for developing a CSA-specific strategy, such as sub-committees on food security and sustainable land management under the national ASWAp structure, or the national climate change coordination programme. In Vietnam, the government has already made significant efforts toward integrating sustainable development and climate change into national social and economic plans and investment planning. The National Target Programme to Respond to Climate Change is an already existing structure where CSA-specific strategies can be developed.

Identifying policy levers and institutions to implement the CSA strategy

Encouraging farmers, and more generally agricultural producers in the fishery, forestry and livestock sectors of the economy, to make changes in the way they produce, lies at the heart of implementing CSA. The question facing policy-makers is once they have developed a prioritized set of actions for CSA, how can agricultural producers be supported in making the desired changes.

Policy-makers have a set of tools or instruments, such as rural credit programmes, input and output pricing policies, including input subsidies, property rights, extension services as well as the implementation of safety net programmes, they can apply to change the incentives and capacity of farmers to undertake modifications in their production systems. The analysis of the barriers to adoption of CSA practices (see section 4 above) should give an indication of the how these levers are currently affecting adoption and identify key gaps where new levers are needed.

Take, for example, the issue of scaling up the adoption of sustainable land management practices, which form an important part of national agricultural development and adaptation strategies for many countries. Adoption rates of these practices has generally been lower than expected and the analysis of barriers to adoption give some important insights as to why this is the case. Delayed returns on investment, weak and missing input supply systems, farmers' lack of information about the system and how to apply it, and the low level of returns to crop diversification are some of the key barriers that have been identified (McCarthy et. al. 2011). Thus the levers that policy-makers will want to consider in countries where these barriers are present could include the following: launching credit facilities that support long-term investments; improving input supply systems through expanded government investment or promotion of private sector involvement; extending and deepening extension systems; and altering input subsidy or output market controls. Applying policy levers to effect change often involves altering existing instruments to achieve desired results. For example, a study in Kenya indicated that solely changing the timing of delivery of fertilizer inputs to farmers had a major impact on their likelihood of its being effectively used (Duflo et al., 2011). Input subsidy programmes designed to support more efficient use of fertilizers, rather than simply increasing their use, are clearly an important policy lever for CSA implementation, given the importance of such programmes in many countries in affecting use patterns and the critical role of efficient input use in CSA. Another example is the implementation of national safety net programmes that involve cash transfers to low income households. Recent research indicates the potential of designing such programmes to support farmers in making productive investments in their agricultural systems, another key aspect of CSA implementation.

Only a limited set of policy levers will be appropriate and feasible for any specific country. These may be identified through a process of assessing the barriers to adoption of CSA practices, as well as a consultative process with key stakeholders to identify realistic and feasible alternatives. For example, in the case of input subsidies, key stakeholders to be consulted could include fertilizer distributors, representatives from farmers' cooperatives, extension agents and national agriculture policy-makers. A consultation with these stakeholders could identify options for improving the design of input subsidy programmes to support CSA practices, which could then be analysed in more detail. The use of policy simulation models to assess the relative effectiveness of alternatives developed by key stakeholders can indicate which levers should be employed (See Box 6 for example). In addition, analysis of the costs that are likely to accrue to government and all other relevant stakeholders is necessary to ensure feasibility. In short, there are three main steps to identifying national policy levers to support CSA adoption:

1. assess current barriers to adoption of CSA practices;

2. develop a set of alternative, but feasible policy interventions to address identified barriers; and

3. assess the effectiveness of proposed levers through a process of stakeholder consultation, analysis (simulation models) and cost analysis.

BOX 6: SIMULATION OF POLICY LEVERS TO SUPPORT SLM ADOPTION IN ZAMBIA AND MALAWI

To identify effective policy levers to support the adoption of SLM in Zambia and Malawi under increasing frequency of extreme events that lead to crop loss, a simple simulation model was developed. The three policy levers considered were the provision of subsidized credit, payments for carbon sequestration and fostering community collective action. The practices considered, agroforestry in Malawi and conservation agriculture in Zambia, have moderate impacts on increasing average yields and moderately strong impacts on reducing the likelihood of production losses associated with increases in extreme climate events. They also generally increase carbon sequestration and thus contribute to mitigation. The model results indicate that, in general, as extreme events from climate change increase, farmers are more likely to adopt SLM practices even without policy intervention, since the practices are effective in reducing yield losses more than increasing yields. The results indicate that even though Malawian farmers are more exposed to the risk of crop losses and can be expected to have higher incentives to adopt SLM, the lower average yields obtained under SLM in Malawi reduces the incentives to invest in the system. This can be offset by payments for carbon sequestration in the Malawian case, where levels are relatively high. In contrast, such payments have a more limited effect on SLM adoption in Zambia. Subsidized credit has only a muted response in terms of increased adoption in both countries, except at very high levels. Not surprisingly, the model results indicate that when SLM adoption generates significant public goods (positive spillover effects on neighbouring farms) the ability to coordinate group actions becomes increasingly important in driving adoption. This indicates the importance of effective community- and farmer-based organizations as a policy lever.

Source: McCarthy et al., 2012

International policy developments affecting the development of CSA

National CSA strategies and policies are affected by developments at the international level, particularly in terms of developing agreements and mechanisms to support adaptation and mitigation. At the recently concluded UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA) meetings held in May 2012, consideration of a programme of work on agriculture was on the agenda. However, after two weeks of discussion, the SBSTA conclusions on agriculture only called for further consideration by SBSTA 37 in Doha at the end of 2012. The conclusions do not call for further submissions or an in-session workshop. They are procedural and contain no substance.

While this was a disappointing outcome, the interest in agriculture in the international climate change policy forum has substantially increased. More than 30 submissions on agriculture and additional submissions on agricultural NAMAs were made. These included 24 Party submissions, including those on behalf of multiple countries, e.g. European Union, LDCs, Africa Group and Environmental Integrity Group (EIG). Various informal pre-session facilitation and coordination meetings for negotiators were held. At the negotiations, there were a growing number of delegates from agriculture ministries and side events on agriculture.

The balance between mitigation and adaptation, global and national levels and the inclusion or exclusion of the UNFCCC principle of "common but differentiated responsibilities" (CBDR) were areas of contention. This was despite some apparent common ground on the importance of Article 2 of the Convention that the stabilization of GHGs should be at a level which *does not threaten food production*. The need to safeguard food security and capture synergies between agricultural adaptation and mitigation and recognize that adaptation of agriculture is a priority for many developing countries, given that agriculture, especially smallholder agriculture, is crucial for their food security, provides employment for the majority of their populations and is the engine of economic growth for their development.

The lack of progress on agriculture at the international level, within the context of the UNFCCC, contrasts with a growing interest in, and appetite on the part of many developing countries for, implementation of agricultural adaptation and mitigation activities at national level and particularly how this might best be done within specific national/sub-national contexts and nationally-owned policies and strategies, using different financing and investment options. The keen national interest to pursue CSA development offers important opportunities for learning-by-doing and shape more effective international instruments for sustainably addressing closely linked food security and climate change challenges.

There have also been some positive developments in other international policy regarding the integration of climate change and food security issues in the agricultural sector. The outcome document from the Rio+20 UN conference on environment and development recognized the urgent need for integrating climate change into sustainable development, and particularly agricultural development, calling on nations to meet their commitments under the Kyoto Protocol and for rapidly operationalizing the Green Climate Fund to support sustainable development. In the G20 meeting held in June 2012, the G20 leaders recognized that increasing agricultural production and productivity on a sustainable basis while considering the diversity of agricultural conditions is one of the most important challenges that the world faces today. They also recognized the need to adapt agriculture to climate change and the importance of improving the efficiency of water and soil use in a sustainable manner and called upon international organizations to provide a report on science-based options to improve the efficiency of water use in agriculture including in ways particularly suitable for small farms.

A final positive development has been the development of a paper on food security and climate change by the high-level panel of experts (HLPE) to the Committee on World Food Security (CFS). The recommendations of the paper will be discussed in a policy roundtable at the upcoming CFS session in October. The main role of the HLPE is to provide policy-oriented analysis and advice to underpin the policy work of the CFS. The recommendations developed by the report provide the basis for developing resilient agricultural systems that support food security. Overall, the above developments at the international level, although they are progressing at different speeds and may have different mandates, are all consistent with the CSA approach promoting the integration of climate change adaptation and mitigation into agricultural development planning and investment strategies.

7. GUIDING INVESTMENT

Following the analyses of the previous sections, which structured how to identify climate-smart practices based on their potential, the barriers to their adoption and their contribution to addressing the vulnerability of households to food insecurity, this section attempts to provide guidance on identifying investment options in terms of costs and benefits. In fact, one of the most important features of CSA is blending climate finance with agricultural investment finance.

Agriculture development requires substantial investments, public and private, to increase agriculture productivity and achieve food security, but planned investment expenditures are often higher than available finance resources, and additional funds are needed in order to fill the gap. Climate finance, comprising public and private funds to support adaptation as well as mitigation, is one potential means of filling this gap. Building the necessary evidence base, as well as crediting and financing channels to link climate finance with investments in agriculture, is a major focus of CSA approaches. Finance resources that catalyse low-carbon and climate-resilient development represent a source of funds that could potentially be used to reward the positive externalities of CSA.

All agricultural development costs can be divided into fixed, operating and opportunity cost categories. The first refers to capital investments, such as irrigation systems and roads, or terraces and trees on farms. These may also include the costs of establishing or strengthening institutions, such as the costs of establishing a credit facility or expanding extension services. The operating costs refer to the annual costs of operation, such as the costs of purchasing fertilizer, seed inputs or labour. Opportunity costs refer to the income or benefits that are foregone by adopting one agricultural development path over another (see Box 7).

BOX 7: MARGINAL ABATEMENT COST CURVES AS A POSSIBLE INPUT FOR DEVELOPING A COST-EFFECTIVE CSA STRATEGY: THE CASE OF MALAWI

The cost-effectiveness of different investment options could be a possible eligibility criteria for climate-smart programmes and activities to enable access to additional climate funds and financing mechanisms. For GHG mitigation purposes, marginal abatement cost (MAC) curves report costs of different abatement measures (per unit of equivalent CO2 abated) on the vertical axis and the GHG volumes abated (annual emission savings generated by adoption of the measure) on the horizontal axis, showing a schedule of abatement measures ordered by their specific costs per unit of equivalent CO2 abated estimated against what would be expected to happen in a 'business as usual' (BAU) baseline (Moran et al., 2010).

The MAC curve for climate-smart agriculture investments gives results in terms of cost-effectiveness of alternative mitigation options, and expresses the potential for options to be least cost. However, this is just indicative and very dependent on the assumptions used in building the MAC curve. Typically MAC curves are sensitive to the discount rate used, which can affect the comparison of activities with different time horizons. MACS also do not usually take into consideration transaction costs, the need to build institutional capacity, the cost of overcoming barriers to adoption, and how risk affects decision-making by farmers, all discussed in the previous sections. It is therefore important to emphasize that MAC curves should be one of several inputs used in prioritizing investments, and that they should be used only with a full understanding of the costs included in the curve.

An example applied to the Malawi national agriculture investment plan can be found in Branca et al. (2012a) and the MAC curve estimated is reported in Figure 4. The analysis shows that improved agronomic, integrated nutrient management and tillage/residue management practices have the potential to be least cost mitigation solutions and cost-effective climate-smart investment options.

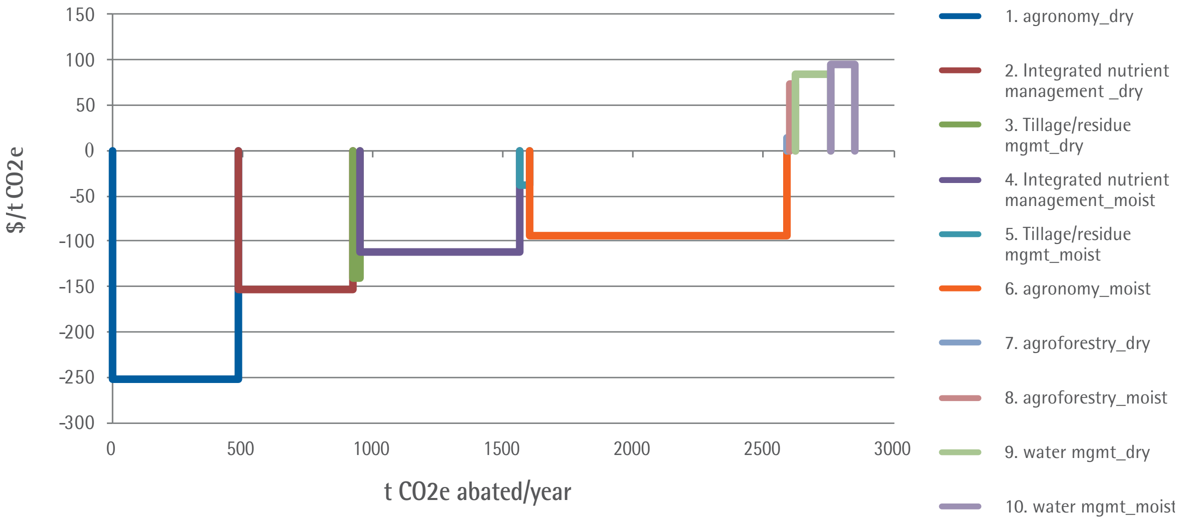

Figure 4: Marginal Abatement Costs curve for selected CSA practices in Malawi

Marginal abatement costs appear to be negative for improved agronomic, integrated nutrient management and tillage/residue management practices in both dry and humid areas (although with differences among the technologies and the agroclimatic zones). Adoption of the improved practices has the potential to generate gross margins higher than under conventional agriculture. This shows a possible synergy between food security and adaptation (higher incomes) and climate change mitigation (abatement potential). These technology options can therefore potentially generate both private and public benefits, addressing poverty and food insecurity as well as environmental issues (climate change mitigation). However, a word of caution is needed in interpreting these results because the phenomenon of negative abatement costs is not compatible with efficient markets, implying that there may be non-financial barriers to adoption that should be investigated before prioritizing investments.

On the other hand, agroforestry and water management are found to have positive abatement costs (costs higher than benefits) in Malawi. This is probably due to the fact that this type of investments requires larger investment costs (irrigation infrastructures, water harvesting land structures, seedlings production and planting). Also, they are characterized by a longer implementation period, where the costs are borne in the first years (building infrastructure and planting trees), while the benefits are gained in the medium and long term, therefore generating a negative flux of net benefits in the short-term. The discount rate used in the construction of the MAC curve is particularly important for these practices.

When using a MAC curve robustness of results should always be tested before prioritizing investments; nonetheless, even with the limitations mentioned, a MAC curve can be a useful input in prioritizing climate-smart investment options, when combined with an analysis of non-financial barriers to adoption and an understanding of how uncertainty affects farmers' decisions.

Source: Branca et al. 2012b

CSA approaches to agricultural development are likely to involve higher fixed cost investments at initial stages, since they involve higher investments in local institutions and technologies to realize higher rates of resource use efficiency. On the other hand, as resource use is more efficient under CSA, operating costs can be expected to be lower. Building resilience in agricultural ecosystems through the restoration and conservation of ecosystem services, such as soil fertility, often involve significant opportunity costs that can persist for periods up to 10 years. Likewise, avoiding deforestation can involve significant opportunity costs during an initial phase when alternative income sources are being built.

Taken together, these cost factors imply that a CSA investment strategy may well involve higher costs than a conventional growth strategy in the initial phases, but over time as the initial opportunity costs of the CSA strategy decline, and the savings from the resource efficiency aspects become more important, the CSA strategy could involve lower costs.

Through a recently developed FAO methodology (see Branca et al., 2012b) it is possible to screen investment plans in order identify their potential contribution to adaptation and mitigation and the potential to scale up existing national investment initiatives with high climate-smart potential. The analytical framework that drives the screening has been built in line with common knowledge available in the literature from the scientific community about food security, adaptation and mitigation. The screening is built on the basis of the results of the following set of climate-related tests performed on agriculture investment plans:

a. The degree to which investments are climate-smart, by ranking investment activities on the basis of their contribution to adaptation (slow onset and extreme events) and mitigation (absolute GHG reduction, carbon sequestration and GHG reduction through increased production efficiency). The resulting scores are synthesized through an index representing the climate benefits potentially gained as a result of the implementation of planned activities.

b. CSA investments priority areas, by estimating how much of the plan resources/costs are allocated to investment areas considered as strategic priorities for CSA production, since these areas can contribute to improve food production and adaptation capacity while delivering mitigation benefits. These areas cover production, the value chain, research and capacity building, institutional support, infrastructure, welfare and disaster management. This categorization will help identify how much investments are intended to finance the production phase of the value chain, the post-production phase (i.e. marketing, storage and processing) and the supporting institutions, infrastructure and knowledge.

c. Country policy environment for CSA investments, which considers key aspects in driving investment choices in agriculture, such as private sector readiness, country policy environment, successful experiences of ongoing agriculture projects and programmes, and institutional capacity.

Application of the screening methodology gives results in terms of the degree to which the planned investments are climate-smart. An example applied to the Malawi national agriculture investment plan (Agriculture Sector Wide Approach - ASWAp, 2009-13) is reported in Box 8.

BOX 8: CSA SCREENING OF PLANNED INVESTMENTS UNDER THE MALAWI AGRICULTURE SECTOR- WIDE APPROACH (ASWAP)

Most investments planned under the ASWAp are related to agricultural production increase (improved land and water management, improved seed production, enhanced fishery sector and research support), while only 11 percent of the investments are planned in improving physical infrastructure required for productive agriculture (mainly irrigation). A significant amount of resources (10 percent) is devoted to research, capacity building and institutional support, which are considered key elements in supporting the activities that focus on production increase.

Application of the screening methodology to the Malawi national agriculture investment plan for 2009-13 (ASWAp, 2009-13) showed that while only a few components of the plan enhance abilities to cope with adaptation to extreme events (e.g. actions to reduce storage losses, promotion of village grain bank schemes, establishment of a maize market insurance system, strengthening the weather forecasting capability for agriculture) most activities support enhancement of resilience to climate variability and gradual climate change (slow onset) and show potential mitigation benefits (Table 1).

Activities	Summary climate benefits		
	Adaptation		Mitigation
	Slow onset	Extreme events	
1. Food Security and Risk Management	6	1	2
2. Commercial Agriculture and Market Development	7	0	1
3. Sustainable Land and Water Management	3	2	1
4. Technology Generation and Dissemination	6	0	2
5. Institutional Strenghtening and Capacity Building	3	1	0
6. Cross-cutting issues	1	0	0
Total	**26**	**4**	**6**

Table 1. Climate-smart screening matrix of Malawi ASWAp (number of sub-programmes and activities)

'Food security and risk management', 'Technology generation and dissemination' and 'Commercial agriculture and market development' are the focus areas of the Malawi ASWAp that deliver the largest number of identified climate benefits, mostly on adaptation to slow onset climate change (improved productivity, increased income diversification and market opportunities, development of research and extension activities). The focus area 'Sustainable land and water management' is the most relevant in terms of contribution to the adaptation to extreme events (restoration of soil fertility, improved water management, expanded irrigation) and is also identified as key to increasing agricultural productivity in Malawi. The mitigation contribution of the ASWAp is limited. Mitigation benefits derive mainly from 'Technology generation and dissemination' (improved varieties, crop and livestock production technologies and post-harvest management).

Source: Branca et al. 2012b

8. CONCLUSIONS

The projected impacts of climate change vary by location and system, and there is considerable uncertainty about the effects. In fact, one of the most important impacts of climate change in agricultural systems is that it decreases the information we have available for planning, since it generates so much uncertainty. Over the next 20 years, most projections indicate that the most important impacts of climate change will be, and in some cases already are, increasing frequency and intensity of climate shocks, such as drought, flooding and extreme temperatures. In this context, CSA encompasses sustainable agriculture, expanding it to include the need for adaptation and the potential for mitigation with their associated technical, policy and financing implications.

This background paper has tried to provide the building blocks of an evidence base for countries interested in developing a CSA strategy. Each country will have a number of different options to choose from to increase the returns that agricultural producers get from their production systems and reduce variability in income for a more secure livelihood. A country-specific evidence base is needed to prioritize options and combine them in an overall package that is tailored to the needs and resources of rural populations vulnerable to climate change.

The building blocks needed to build an evidence base for a coherent CSA strategy are the following:

i. an assessment of the situation, by having a clear picture of existing policies and institutions, adopting clear indicators, and developing the ability to identify a baseline scenario for development relative to which a CSA strategy would be implemented;
ii. an understanding of the barriers to adoption of CSA practices, such institutional barriers, financial bottlenecks, or lack of access to input or output markets;
iii. an understanding of how to address vulnerability and manage climate risk, by analysing the risk profile of potentially relevant CSA practices, looking at how safety nets interact with autonomous adaptation by households and providing timely and relevant information;
iv. the definition of coherent policies, by addressing market failures and policy failures hindering cost-effective adaptation to climate change so as to facilitate the achievement of food security objectives; and
v. the provision of guidance for investment, by examining costs and benefits of different options (relative to the baseline) and identifying financing opportunities for both adaptation and potential mitigation activities.

When combining these elements into an effective CSA strategy, account must be given to the fact that many countries already have agricultural development plans and national climate change policies, which often contain elements that support the development and implementation of CSA. Efforts to identify these elements and ensure a coordinated vision that articulates priorities, as well as specific policy levers, are likely to be necessary to identify a set of priority activities, institutions and policies to support these activities and the overall investment strategy. In this light, the development of a national CSA strategy can be an opportunity to promote coordination between key stakeholders working in agricultural development and climate change and bring them together to articulate a unified vision of agriculture development under climate change. Examples are presented from Malawi, Zambia, and Vietnam on the issues discussed, and how to use the evidence base to inform investment options and policy actions.

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