Chapter 2
Achieving Food Security in a Changing Climate: The Potential of Climate-Smart Agriculture

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Abstract It's increasingly and widely recognized that the global warming rate is accelerating, exacerbated by humans' past and present unsustainable practices which result in human and environmental-induced effects and risks. Any move toward sustainable development models will involve significant paradigm shifts, particularly from the current economic models, in which it is presumed that a society can only develop by expanding its use of resources and increasing per capita consumption patterns, despite the related long term negative effects. In this context, and since climate change is generating risks and opportunities for agriculture, which is the main component of development strategies in many Southern countries, climate-smart agriculture (CSA) has recently emerged as a significant option in multilateral climate change debate. This option is believed to generate enormous benefits both in terms of adaptation, mitigation, and food security enhancement. This chapter aims at exploring how climate change is likely to impact agriculture, food production and security, and what actions can be taken to increase agriculture productivity, build resilience, and reduce GHG emissions through enhancing CSA, both in policies and practices. Given the inter-linkages between climate change, agriculture and food security policies, a governance approach has been recommended. Some of the

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most important guiding principles include equal emphasis on the management of natural resources, appropriate institutional and financial mechanisms, and improving preparedness of stakeholders to engage in well-informed actions.

Keywords Climate change • Food security • Climate-smart agriculture • Greenhouse gases • Governance

2.1 Introduction

This first decade of the third millennium has gained rapid international recognition, leading to global consensus that the global warming rate is accelerating, exacerbated by humans' past and present unsustainable practices. These practices, including those responsible for large volumes of greenhouse gas (GHG) emissions, deforestation, excess consumption of finite resources, reducing global biodiversity and contamination of water supplies, result in human-induced effects and risks that negatively impact on our quality of life. Politically, most countries agree that the debate about global warming is over, that climate change is a key symptom of how humans have impacted on planetary systems and that it is time for serious collaboration to help transform our institutional and individual practices, if next generations are to inherit a sustainable future. This concern and call for concerted action to tackle impacts of climate change, duly recognizing the environmental and related social problems, are reflected in the rising numbers of academic papers and popular literature articles since the 1960s. In general terms, transformation of global societies from mainly unsustainable practices to a more sustainable way of living will involve significant paradigm shifts, particularly from the current economic paradigm, in which it is presumed that a society can only develop by expanding its massive use of resources and increasing per capita consumption patterns, despite the long term negative effects of this behavior (Daly 1996).

In this context, many researchers, decision-makers, land use planners and civil society actors increasingly believe that the interaction between climate change and food security will be one of the biggest challenges for the coming decades. By the year 2025, 83 % of the expected global population of 8.5 billion will be living in developing countries, where most of the poor are living, and the resources are vulnerable to climate change. Yet the capacity of available resources and technologies to meet the demands of growing population remains uncertain. Presently, close to one billion people are already suffering from hunger worldwide and the future is daunting too: food needs are projected to increase by 70 % by 2050 when the global population reaches nine billion, while climate change is projected to reduce global average yields, among other severe consequences. Within this perspective, many believe that agriculture must become central to future climate-change and food security governance. This is on account of at least three important interrelated aspects:

- *Firstly*, agriculture is the sector most vulnerable to climate change and many threats, including the reduction of agricultural productivity, production stability and incomes in many areas of the world already characterized by high levels of food insecurity and limited means of coping with adverse climate impacts. Moreover, climate change will affect agriculture through higher temperatures, greater crop water demand, more variable rainfall and extreme climate events such as heat waves, floods and droughts. Many impact studies point to severe crop yield reductions in the next decades without strong adaptation measures, especially in areas where rural households are highly dependent on agriculture and farming systems are highly sensitive to inclement climate;

- *Secondly*, agriculture contributes a "significant" proportion of global carbon dioxide and nitrous oxide emissions (about 14 % of emissions according to current estimations) (Wright 2010); and
- *Thirdly*, agriculture can be a major part of the solution: helping people to feed themselves and adapt to changing conditions while mitigating impacts of climate change (carbon sequestration). This mitigation potential can be largely achieved in developing countries.

The need to tackle climate change while producing more food to feed the world's growing population means that "climate-smart agriculture" (CSA) is one of the advocated ways forward. This approach primarily defends an agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation). This will simultaneously help meet the goals of food security and overall development. This also envisions transformation of agriculture to feed a growing population in the face of a changing climate without corroding the natural resource base significantly and mitigate the negative effects of climate change. However, more productive and resilient agriculture will need better management of natural resources, such as land, water, soil and genetic resources through practices such as conservation agriculture, integrated pest management, agroforestry and sustainable diets.

This chapter aims at exploring as how climate change is likely to impact agriculture, food production and securities, and what actions can be taken to increase agriculture productivity, build resilience to tackle the negative impacts of climate change, and reduce GHG emissions through enhancing CSA – both in policies and practices. Given the inter-linkages between climate change, food security and agriculture policies, a governance approach has been recommended in this chapter. Some of the most important guiding principles include equal emphasis on the management of natural resources, appropriate institutional and financial mechanisms and improving preparedness of stakeholders to engage in well-informed actions.

2.2 Agriculture at the Intersection of Climate Change, Food Security, and Poverty Alleviation

As mentioned above, climate change is one of the main challenges facing our globalized world today since the science clearly indicates that a global temperature rise of 2 °C above pre-industrial levels may change the face of the world irreversibly. Furthermore, this challenge is increasingly considered as a 'threat multiplier' since it increases a range of livelihood threats and vulnerabilities, rather than being an isolated specific risk (IFAD 2010).

The poor population in developing countries will be particularly impacted by this delicate environmental problem, of which developed – and currently emergent – countries are the major drivers. In addition, food security, poverty and climate change are closely linked challenges and should not be considered separately. In countries where the economic and human development strategies are heavily based on agriculture, the development of agricultural sector, with a clear redistribution potential, remains an efficient poverty reduction policy. Yet agricultural expansion for food production and economic development which comes at the expense of soil, water, biodiversity or forests, environment, conflicts with other global and national goals, often compromises production and sound development in the longer term.

It is true that over the past six decades world agriculture has become considerably more efficient, especially in the 1960s through green revolution. Improvements in production systems and crop and livestock breeding programs have resulted in a doubling of food production while increasing the amount of agricultural land by 10 %. However, projections based on population growth and food consumption indicate that agricultural production will need to increase substantially to meet future demands. Most estimates also indicate that climate change is likely to reduce agricultural productivity, production stability and incomes in some areas already suffering from food insecurity, high rates of poverty, and feeble adaptive capacities to cope with adverse climate impacts. Preliminary estimates for the period up to 2080 suggest a decline of some 15–30 % of agricultural productivity in the most climate change-exposed developing country regions – Africa and South Asia (UNCTAD 2011). Hence, climate change is expected to exacerbate and multiply the existing challenges faced by agriculture and human security.

It is also true that human societies, over the centuries, have developed the capacity to adapt farming practices to environmental change and climate variability. These adaptations include, among others, practicing shifting cultivation, adopting high yielding, and new crop varieties tolerant to salts and drought and modifying grazing patterns. But today the speed and intensity of climate change are outpacing autonomous actions and threaten the ability of poor smallholders and rural societies to cope. For most of the one billion extremely poor and hungry people who live in the rural areas of major developing countries, agriculture remains the principal income source. These people are already vulnerable, and climate change will in most cases deepen their vulnerability. More specifically, and in countries most reliant on rainfed agriculture and natural resources, poor rural women, who are often the primary food producers, have fewer assets and less decision-making power, are even more exposed than men (IFAD 2010).

Therefore, ensuring food security under a changing climate should be considered as one of the major challenges of our era, especially that many countries' agriculture is highly vulnerable to negative impacts of climate change. Even using optimistic lower-end projections of temperature rise, climate change may reduce crop yields by 10–20 % by the 2050s, with more severe losses in some regions (Jones and Thornton 2009). World food prices for some of the main grain crops are likely to rise sharply in the first half of the twenty-first century, unlike the price declines witnessed in the twentieth century. Projections of price rises range from about 30 % for rice to over 100 % for maize, with about half or more than half of this rise due to climate change. Under a pessimistic high-end projection of temperature rise, the impacts on productivity and prices are even greater. Moreover, increasing frequencies of heat stress, drought and flooding events, not factored into the projections mentioned above, will result in further deleterious effects on productivity. It is likely that price and yield volatility will continue to rise as extreme weather continues. Climate change will also impact agriculture through effects on pests and disease. These interactions are complex and the full implications in terms of productivity are still uncertain (Gornall et al. 2010).

While agriculture is the most vulnerable sector, it is also a major cause of climate change, directly accounting for about 14 % of GHG emissions, and indirectly much more as agriculture is an important driver of deforestation and land-use change responsible for another 18 % of global emissions (IPCC 2007). Even if emissions in all other sectors were eliminated by 2050, growth in agricultural emissions in a business-as-usual (BAU) scenario, world with a near doubling in food production would perpetuate climate change. Therefore, while trying to cope with the effects of a changing climate, agriculture is simultaneously facing two other challenges: increasing food production in developing countries to meet population increases and dietary changes whilst remaining central to mitigation efforts (IFAD 2010).

2.3 Climate-Smart Agriculture: A 'Triple Win' Approach

A range of mitigation solutions is needed to tackle impacts and reduce the buildup of GHGs with implications on the 2 °C limit. The need for "no regret measures", and more precisely a truly sustainable and climate-friendly agricultural development, is currently less controversial than before. A glance at global mitigation potential shows that changes in agriculture and land use, including deforestation in tropical areas, presently account for one-third of global GHG emissions. Increasingly, therefore, agriculture is being recognized as part of the problem in global climate governance. While developed countries' emissions result mostly from industry, energy consumption and transport, the Food and Agricultural Organization figures reveal that 74 % of all agricultural emissions originate in developing countries, and 70 % of the agricultural mitigation potential can be realized in these same countries (Gattinger et al. 2011). For example, about half of the 47 African countries that have recently submitted Nationally Appropriate Mitigation Action (NAMAs) have included agriculture-related actions (Streck and Burns 2011). In general terms, agriculture has much to contribute to a low emissions development strategy. It can mostly contribute to mitigation (Smith et al. 2008) in three ways: avoiding further deforestation and conversion of

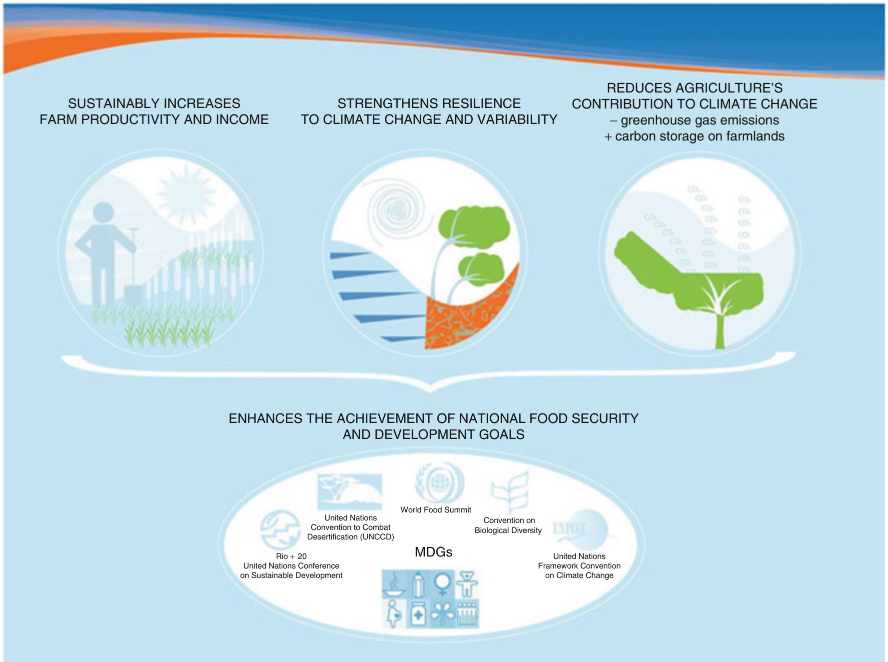

Fig. 2.1 Potential of climate-smart agriculture (CSA) (Source: FAO 2010)

grasslands and wetlands; increasing the carbon sequestration by vegetation and soil; and reducing current, and avoiding future, increases in emissions from nitrous oxide (from fertilizer use and soil organic matter breakdown) and from methane (from livestock production and rice cultivation) through appropriate cross-cutting and mutually enforcing policies, plans, programs and local initiatives.

Could agriculture therefore be part of the solution, particularly in developing countries? Globally, three-quarters of all malnourished people depend on agriculture and would be directly affected by international mitigation agreements aimed at agriculture. Various “climate- friendly” agricultural solutions have already been proposed. They include CSA, which has been advocated during the last climate negotiations in Durban (2011) as instrumental in achieving many aims.

CSA can be defined as an approach which seeks to increase productivity in an environmentally and socially sustainable way, strengthen farmers’ resilience to climate change, and reduce agriculture’s contribution to climate change by reducing GHG emissions and increasing carbon storage on farmland (Fig. 2.1). Climate-smart agriculture includes proven practical techniques – such as mulching, intercropping, conservation agriculture, crop rotation, integrated crop-livestock management, agroforestry, improved grazing, and improved water management – but also innovative practices such as better weather forecasting, early warning systems and risk insurance. It is about getting existing technologies off the shelf and into the hands of farmers and developing new technologies such as drought or flood tolerant crops to meet the demands of the changing climate. It is also about creating and enabling policy environment for adaptation (World Bank 2011).

The CSA approach neatly combines the twin goals of today's climate negotiators, helping to prevent climate change while at the same time adapting farms to inevitable change. It incorporates practices that increase productivity, efficiency, resilience, adaptive capacity, and mitigation potential of production systems (i.e. carbon sequestration). However, CSA requires more careful adjustment of agricultural practices to natural conditions, a knowledge-intensive approach, huge financial investment, and policy and institutional innovation, etc.

2.3.1 Climate-Smart Agricultural Production Systems: Relevant Practices

The production, processing and marketing of agricultural goods are central to food security and economic growth. Products derived from plants and animals include foods, fibers, fuels and raw materials and inputs for other industries. Production has been achieved through a number of production systems which range from smallholders mixed cropping and livestock systems to intensive farming practices such as large monocultures and intensive livestock rearing. The overall efficiency, resilience, adaptive capacity and mitigation potential of the production systems can be enhanced through improving its various components, some of the key ones are highlighted here to illustrate the feasibility and constraints of developing CSA. Two important manifestations of such interventions could be reduced deforestation and lesser encroachment of land systems for agriculture purposes. Other key issues, such as access to markets, inputs, knowledge, finances and issues related to land tenure are also fundamental for ensuring food security. These issues are also highlighted here:

2.3.1.1 Soil and Nutrient Management

The availability of nitrogen and other nutrients is essential to increase yields. This can be done through composting manure and crop residues, more precise matching of nutrients with plant needs, controlled release and deep placement technologies or using legumes for natural nitrogen fixation. Using methods and practices that increase organic nutrients inputs, retention and use are therefore fundamental and reduce the need for synthetic fertilizers which, due to cost and access, are often unavailable to smallholders and, through their production and transport, contribute to GHG emissions.

2.3.1.2 Water Harvesting and Use

Improved water harvesting and retention and water-use efficiency are fundamental for increasing production and addressing increasing irregularity of rainfall patterns. Today, irrigation is practiced on 20 % of the agricultural land in developing countries but can generate 130 % more yields than rain-fed systems. The expansion of efficient management technologies and methods, especially those relevant to smallholders, is fundamental.

2.3.1.3 Pest and Disease Control

There is evidence that climate change is altering the distribution, incidence and intensity of animal and plant pests and diseases as well as invasive alien species. The recent emergence in several regions of multi-virulent, aggressive strains of wheat yellow rust adapted to high temperatures is a good indication of the risks associated with pathogen adaptation to climate change. These new aggressive strains have spread at unprecedented speed in five continents resulting in epidemics in new cropping areas, previously not favorable for yellow rust and where well-adapted, resistant varieties are not available.

2.3.1.4 Resilient Ecosystems

Improving ecosystem management and biodiversity can provide a number of ecosystem services, which can lead to more resilient, productive and sustainable systems that may also contribute to reducing or removing GHG. Services include, control of pests and disease, regulation of microclimate, decomposition of wastes, regulating nutrients cycles and crop pollination. Enabling and enhancing the provision of such services can be achieved through the adoption of different natural resource management and production practices.

2.3.1.5 Genetic Resources

Genetic make-up determines a plants and animals tolerance to shocks such as temperature extremes, salts, drought, flooding and pests and diseases. It also regulates the length of growing season/production cycle and the response to inputs such as fertilizer, water and feed. The preservation of genetic resources (establishing gene banks, genetic engineering) of crops and breeds and their wild relatives is therefore fundamental in developing resilience to shocks, improving the efficient use of resources, shortening production cycles and generating higher yields per area of land. Generating varieties and breeds, which are tailored to ecosystems and the needs of farmers, is crucial.

2.3.1.6 Harvesting, Processing and Supply Chains

Efficient harvesting and early transformation of agricultural produce can reduce post-harvest losses and preserve food quantity, quality and nutritional value of the product. It also ensures better use of co-products and by-products, either as feed for livestock, to produce renewable energy in integrated systems or to improve soil fertility. As supply chains become longer and more complex, it becomes ever more important to increase the operational efficiency of processing, packaging, storage, transport, etc. to ensure increased shelf life, retain quality and reduce carbon footprints. Food processing allows surplus to be stored for low production years and allows a staggered sale. This ensures availability of food and income throughout the season and in years and low production. Food processing creates job and income opportunities, especially for women.

2.4 Transition Toward CSA: A Governance Approach

It is increasingly believed that the mitigation of climate change and the enhancement of food security will not be fully achieved without the transformation of agricultural systems toward more productivity, less variability in crop yields, and minimum carbon footprint. Such transformations can be supported by the adoption of climate-friendly practices as mentioned above, many of which not only improve food security but also deliver both reduced emissions and adaptation benefits – the "triple win". Careful selection of production systems, adoption of appropriate methods and practices and use of suitable varieties and breeds, soil management can allow considerable improvements to be made (Table 2.1). Currently, there are several resources, guidelines, tools (i.e. the Carbon Balance Tool developed by FAO to provide ex-ante estimations of the impact of agriculture and forestry development projects on GHG emissions and carbon sequestration, indicating its effects on the carbon balance) and other applications to assist policy makers, extension workers and farmers in selecting the most appropriate production systems, undertaking land use and resource assessments, evaluating vulnerability, and undertaking impact assessments (Bockel et al. 2012).

However, there are numerous and substantial challenges in transitioning to high production, intensified, resilient, sustainable and low-emission agriculture: i.e. there are still considerable gaps relating to the suitability and use of these production systems and practices across a wide variety of agro-ecological and socio-economic contexts and scales. There is even less knowledge on the suitability of different systems under varying future climate change scenarios and other biotic and abiotic stresses. In many cases, even existing knowledge, technologies and inputs have not reached all farmers (weak research-extension-farmer link), especially in developing countries. For this to be achieved there is a need for a governance system with the potential to provide inclusive policies, infrastructures

Table 2.1 Selected climate smart agriculture (CSA) best practices

Crops	Livestock	Agroforestry	Water management	Soil management	Fisheries and aquaculture
No tillage, direct seeding	Increased feeding efficiency, reducing methane emission through improving digestibility	Multipurpose trees on farms	Water harvesting, storage- e.g. water pans	Conservation agriculture	Saline resistant species
Rotations with legumes	Improved rangeland management	Nitrogen-fixing trees, bushes, fodder	Alternate wetting and drying (rice) rather ponding	Stone bunds	Increased feeding efficiency
Intercropping with legumes	Efficient treatment of manure	Improved fallows	Dams, pits, retaining ridges	Planting pits (zai)	Integration of aquaculture in farms
New varieties: shorter cycle, drought and salt tolerant etc.	Improved livestock health	Hedges, windbreaks, shelterbelts, live fences	Improved irrigation practices	Mulching, nutrient management	Low energy fuel efficient fishing
Improved storage and processing technologies	Animal husbandry improvements	Fruit orchards	Increased water productivity (crop per drop)	Reclaimed salt-affected lands	–

and considerable investments to build the financial and technical capacity of farmers (especially smallholders) while enabling them to adopt climate-smart practices which could generate sustainable rural livelihood, economic growth and ensure sustainable food security.

2.4.1 Institutional and Policy Options

Ensuring food security and development under climate change will involve increasing yields, income and production, which can generally be expected to lead to increased aggregate emissions. While agricultural production systems will be expected first and foremost to increase productivity and resilience to support food security, there is also the potential for enhancing low emission development trajectories without compromising development and food security.

To meet these multiple challenges, it has been suggested that a major transformation of the agriculture sector will be necessary and this will require institutional and policy support. Better aligned policy approaches across agricultural, environmental and financial boundaries and innovative institutional arrangements to promote their implementation will be needed. This section covers summarily the required critical adjustments to support the shift toward CSA:

2.4.1.1 Enabling an Integrated Policy Environment

Key requirements for an enabling policy environment to promote climate-friendly agricultural transformations are greater coherence, coordination and integration between climate change, agricultural development and food security processes. Inter-sectoral approaches and consistent policies across these areas are necessary at all levels. Such policies have both impacts on smallholder production systems and on GHG emissions. Lack of coherence can prevent synergy capture and render the pursuit of the stated policy objectives ineffective and costly.

- *At the national level*, climate change policies are generally expressed through the National Action Plan for Adaptation (NAPAs) and the Nationally Appropriate Mitigation Actions (NAMAs) as well as through national and regional strategies. Agriculture and food security plans are generally expressed in national development and poverty reduction strategies. Better alignment of the technology approaches envisioned in these different policy frameworks, and in particular better integration of sustainable land and water management factors into mainstream agricultural development planning will facilitate a more holistic approach to considering agricultural development, adaptation and mitigation. In addition, better integration of food security nets and adaptation policies offers the potential to reap significant benefits. Better use of climate science information in assessing risks and vulnerability and then developing the safety nets and insurance products as an effective response is already being piloted in some areas with fairly positive results. Policies related to price stability are also key to both adaptation and food security.

- *At the international level*, better integration of food security, agricultural development and climate change policies and financing is also needed. Two parallel global dialogues on reducing food insecurity and responding to climate change have until now had little substantive integration of issues under consideration. Likewise, the agriculture community has only recently become active in the discussions and negotiations of international climate change policies that could have profound impacts on the sector. The creation of mechanisms that allow dialogues between food security, agricultural development and climate change policy-makers seems fundamental and imposing.

2.4.1.2 Reducing Information Gap by Boosting Its Production and Dissemination

One key role of institutions is the production and dissemination of information, ranging from production and marketing conditions to the development of regulations and standards. The scientific and policy uncertainty pertaining to the management of climate change impacts as well as the costs of inaction, increase the value of information and the importance of institutions that generate and disseminate it. Thus, it will be critical that national and international agricultural research programs focus increasingly on developing countries to incorporate climate change into their policy-making processes.

In addition, improving the use of climate science data for agricultural planning can reduce the uncertainties generated by climate change, improve early warning systems for drought, flood, and pest and disease incidence and thus increase the capacity of farmers and agricultural planners to allocate resources effectively and reduce risks. Enhancing communication between producers and users of climate science is also clearly a requirement. Institutions to facilitate this exchange can be existing communications and information networks, including extension. Providing translation of climate information to planners and communities can also bridge the divide between science and field application. Capacity building of policy makers as well as technical staff is another avenue. Finally, platforms for collaborative action and information sharing which unites modelers, practitioners and donors, can enhance the development and use of climate science information for agricultural decision-making (FAO 2010).

The imperative of climate change also requires increased capacity of farmers to make both short and long term planning decisions and technology choices. Agricultural extension systems are the main conduit for disseminating the information required to make such changes. Yet in many developing countries, these systems have long been in decline due to weak linkage between research-extension and farmers. Resources have been severely curtailed and services increasingly outsourced to the private sector or dropped. Problems with delivering 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. It is equally important to consolidate information and insights from traditional knowledge of communities. These can be useful entry points for collective action strategies and enable a bottom–up approach.

2.4.1.3 Improving Access, Coordination and Collective Action

Input supply (i.e. access to fertilizers and seeds) is an activity that requires coordination beyond the farm. Given the market failures that lead to socially suboptimal use of seed and fertilizer, governments frequently step in to distribute them directly. Government-led distribution programs have often increased input use, but the fiscal and administrative costs are usually high and the performance erratic. Yet, cutbacks have often simply resulted in leaving smallholders without reliable access to seed and fertilizer. Producer organizations may offer a promising avenue to improving input supplies to smallholders. It is however important to ensure institutional arrangements of monitoring and verification of the quality of seeds and easy access to adapted varieties to guarantee environmentally sound management of productivity.

Many of the biophysical improvements to increase resilience in smallholder agricultural production systems identified above require action and coordination amongst many stakeholders in the rural landscape. Restoration of degraded areas to improve soil quality, better management of community water resources, and informal seed systems to facilitate the exchange of plant genetic resources are all examples of collective resource management activities that are likely to become more important in the climate change context. In many cases, local institutions exist to govern collective pressure due to population growth, conflicts, changes in market patterns and state intervention (FAO 2010). It will be useful to establish synergies amongst them for collective action.

2.5 CSA: Financing Mechanisms

A good starting point will be to mainstream agriculture in climate change policy making at different levels. This trend will enable agriculture to benefit from mobilized financial resources dedicated to support mitigation and adaptation actions. In addition, investments in CSA must link finance opportunities from public and private sectors and integrate climate finance into sustainable development agendas (FAO 2012). In general terms, significant finance, both public and private, is crucially needed if CSA is to be scaled effectively. Climate finance presents an opportunity with regard to this perspective, through carbon markets, performance-based donor finance for mitigation and adaptation, and private sector finance for agricultural production.

Already some retailers and manufacturers are supporting CSA by purchasing agricultural produce approved to standards for mitigation and adaptation. But further progress depends on recognition of the vital role smallholders can play in greening supply chains and enhancing resilience to climate change.

Future climate negotiations present an opportunity for governments to commit funds for CSA and to signal support for developing countries to set out NAMAs for agriculture. Carbon markets are another potential source of finance but reforms are needed if this option is going to work for agriculture. A Recent research (PWC 2012) found that if carbon markets are to fulfill their potential for supporting the scaling up of CSA activities, three key changes are needed:

- A wider range of CSA activities needs to become eligible in both compliance and voluntary carbon markets;
- More methodologies are needed that support ‘triple-win’ CSA practices; and
- The technical burden of CSA carbon project development needs to be reduced.

It’s noteworthy that according to the World Bank (2011) new funds have been developed to increase food security, to respond to the food price crisis, to promote climate-resilient development, to reduce deforestation and forest degradation, or to support climate adaptation and mitigation more generally. In addition, the volume of finance associated with carbon markets is expanding rapidly. While a number of existing financing mechanisms have been instrumental in supporting climate change mitigation and adaptation, the FAO (2009) has indicated that the main mechanisms have generally not enabled agriculture to contribute fully to adaptation and mitigation efforts. The challenge for countries is to bring different funding mechanisms together so as to invest at the scale needed to achieve the goals of CSA. Practices that are profitable and self-sustaining in the long-run may need upfront finance to get off the ground. Capacity needs to be strengthened to enable concerned developing countries to access these existing and emerging climate finance mechanisms. There is also scope for the redirection of agricultural finance in developed and developing countries as well as development finance.

Patterns of public support which focus on research, investments in soil and water conservation, social protection and safety nets to enhance human capital and technology and value chain development are more effective, benefit more farmers and are more sustainable in the long run than price support (World Bank 2010). In China for example, investments in watershed management through public work programs based on food assistance have enabled impressive productivity increases. In Burkina Faso, investments in soil and water management from diverse stakeholders have powered what has been termed a “farming miracle” (FAO 2009). Participatory approaches directly involving farmers in decision-making generally work best. A key lesson is that the quality of public expenditure is as important as its quantity in facilitating private farmer investment in climate-smart agriculture.

2.6 Conclusions

The CSA offers some unique opportunities to tackle food security, adaptation and mitigation objectives. Many developing countries including Gulf States will specifically benefit from this option given the central role of agriculture in their economic and social development and the major negative impacts that climate change may cause them. Early action in CSA, while the global action continue with regard to mitigation, adaptation and food insecurity alleviation, is essential to build capacity, experience and guide future choices. The international community needs to demonstrate commitment to the multiple agendas of food security, adaptation and mitigation by stepping up investment support to CSA, in particular the scaling up of best practices and technologies as part of early actions. The chapter highlights some major aspects that have to be addressed in order to optimize the transition toward CSA while ensuring highly relevant outputs and outcomes. These have to be considered on a location and system specific basis and cannot be broad brushed across locations. Most importantly there is significant scope to enrich linkages across sectors including management of land, water and bio-resources and these have to be addressed on a priority basis and within a governance perspective.

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