

How can sustainable agricultural systems promote food security in a changing climate?

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Abstract: A theoretical framework of the link between climate change, rural development, sustainable agriculture, poverty, and food security is presented. Some options to respond to climate change are described. Current knowledge and potential effects on agricultural productivity is discussed. Necessary conditions for successful adaptation includes secured property rights to land, institutions that make market access possible and credit possibilities. The options of mitigation and enhanced adaptive capacity and the requirements for their implementation are discussed.

Keywords: Climate change, sustainable agriculture, adaptation, carbon trade, productivity growth, property rights, Fair Trade

Introduction

Sustainable agricultural and rural development is considered an essential step toward achieving the first Millennium Development Goal (MDG) of eradicating extreme hunger and poverty. In 2009, according to FAO's estimation, 1.02 billion people are undernourished – more than ever since 1970, the earliest year when comparable statistics are available. Directly or indirectly, agriculture provides the livelihood for 70 percent of the world's poor. Therefore, development, cooperation, trade and agricultural policy are needed to improve agriculture's contribution both to food supply and to poverty reduction and economic growth. The causes of hunger and poverty range from high population growth, high prices of energy and requisites which translate into high food prices to lack of water, crop failures and calamities, low productivity growth, and lack of infrastructure and institutions that provide easy access to markets, credits, education and extension. There is clear evidence that many countries that have had high rates of productivity growth have succeeded to reduce poverty. Increased productivity does not necessarily imply equity, however. To eradicate hunger, the food-insecure need better control over resources, access to opportunities, and improved governance (FAO, 2009).

In addition to the foregoing factors, the threat of climate change and global warming has become pertinent to agriculture and food security in recent years. Based on findings of the Intergovernmental Panel for Climate Change (IPCC), climate change is anticipated to have severe effects on food security, environmental sustainability and equity, possibly increasing the number of hungry people from 100 million to 380 million by 2080 (Easterling et al. 2007). The estimated rise in temperature, according to Meehl et al. (2007), is in the range of 2°C to 4.5°C, with a most likely value of about 3°C. More recent findings emphasise the possibility of abrupt changes and suggest that climate sensitivity ranges from 2.5 to 6.0°C (Monastersky 2009). Sub-Saharan Africa (SSA) is especially vulnerable to these climatic changes and to the resulting agricultural production response. According to projections, climate change impacts on SSA are considerable; even a 1°C to 2°C warming would lead to high yield losses in arid and semi-arid areas (30-50% by 2050). Projections related to climate

change are subject to huge uncertainties, especially for smaller geographical areas, so effects may vary by region.

The aim of our study was to identify options to respond to the climate change with means which enhance rural livelihoods and food security in low-income countries, especially in the Sub-Saharan Africa. Findings from several on-going case studies were integrated to identify such options.

Theoretical framework

A theoretical framework has been prepared as a mapping strategy for the presentation of the research study. The term *Sustainable Agricultural and Rural Development (SARD)* is here defined as a process, which entails the following elements. First, it ensures that the basic nutritional requirements of present and future generations are met, while providing a number of other agricultural products. Second, such process provides durable employment and sufficient income for all those engaged in agricultural production. Third, that process maintains and, where possible, enhances the productive capacity of the natural resource base as a whole, and the regenerative capacity of renewable resources, without disrupting the functioning of basic ecological cycles and natural balances, destroying the socio-cultural attributes of rural communities, or causing contamination of the environment. Finally, that process is presumed to reduce the vulnerability of the agricultural sector to adverse natural and socio-economic factors and other risks, and strengthens self-reliance (FAO 1995). We also noted that the SARD approach has been further elaborated and operationalized, by other scholars such as Rabbinge (1995); Bouma et al. (2007), Roetter et al. (2007), and in the International Assessment of Agricultural Science and Technology for Development (IAASTD, 2009; www.agassessment.org), including for instance, equity aspects. The multi-functional character of agriculture and land use (commonly referred to MFCAL framework) also builds on SARD (FAO, 1999).

The theoretical framework of the link between climate change, rural development, sustainable agriculture, poverty, and food security that the research team adopted is presented in Figure 1 below

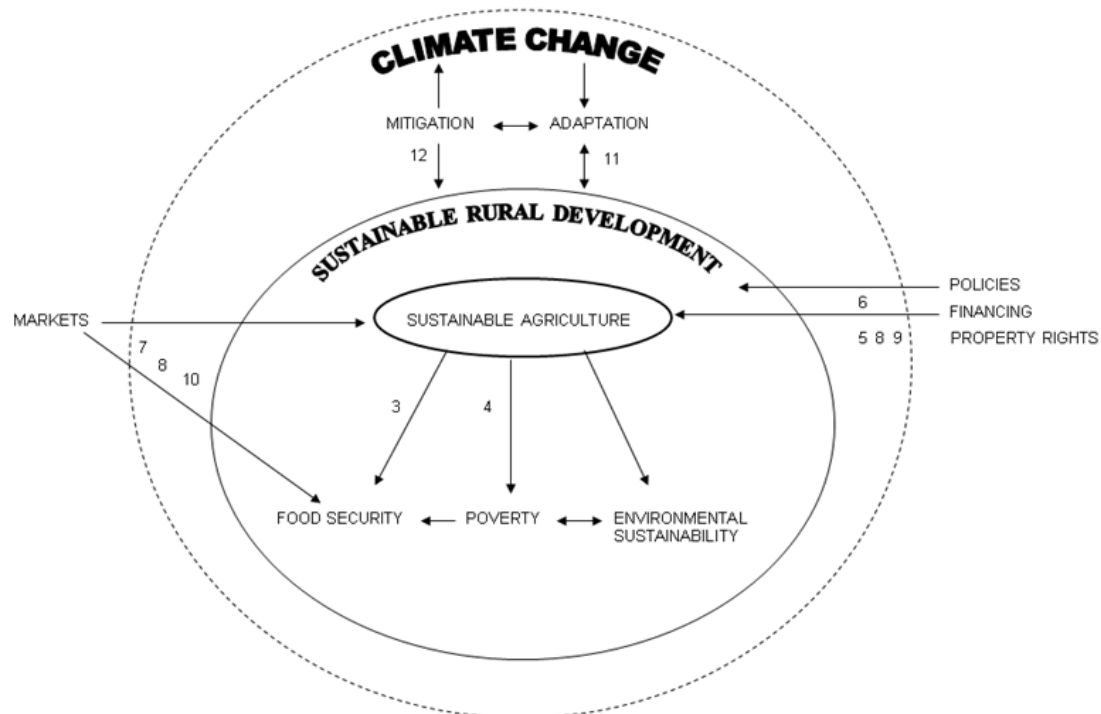


Figure 1. Theoretical framework of the relation between rural development, sustainable agriculture, climate change, poverty, and food security (Sumelius et al., 2009).

Climate change is affecting food security, poverty, environmental sustainability and agricultural productivity. Mitigation and adaptation offers ways of handling the consequences of climate change. Policies, financing possibilities, property rights and markets are in turn important instruments that partly directly affect climate change and also the possibilities to adapt or mitigate climate change, improve food security and to decrease poverty.

Strategies to respond to climate change

The major strategies to reduce the potentially harmful effects of global changes, especially climate change are; 1) adapting of food and farming systems to climate change; 2) enhancing the adaptive capacity to changes in climate variability and extremes that are difficult to predict, and to global change more generally (including socio-economic changes), and 3) mitigation of climate change. Because of inertia in the system, climate change seems unavoidable; warming will take place even if greenhouse gas emissions will be substantially reduced, and therefore adaptation is imperative. The vulnerability of poor rural households can be reduced by enhancing adaptation through new water and soil management practices. Adaptive capacity - the capabilities, resources and institutions to implement effective adaptation measures to varied changes - is closely related to enhancing systems resilience. Decision-making has to be based on a set of uncertainties concerning climate, population and technological change. Through mitigation of GHG emissions over the coming decades, long term effects can be reduced. Mitigation implies technological change and substitution that reduce resource inputs and emissions per unit of output, and to enhance carbon sinks for improving the carbon budget. A regulatory framework to reduce GHG emissions is imperative. The earlier and stronger the reduction in emissions, the quicker the concentrations will approach stabilization, and the lower the economic and social costs will be. Carbon trading through market-based transactions offers, to industrial countries, a realistic option for changes required to reduce emissions and to low-income countries one possibility to finance adaptation and build adaptive capacity. In agriculture, mitigation can be achieved through carbon sequestration (afforestation, avoidance of deforestation) or emission reduction (biological N-fixation to replace fossil-energy based fertilizers, improved livestock management) while simultaneously enhancing productivity and food availability. Through carbon trade, industrial countries pay low-income countries for GHG emission reductions or for the right to release a given amount of GHG emissions. The Clean Development Mechanism (CDM) of the Kyoto-protocol offers such a possibility, but agricultural options are not supported by it at the moment. Instead, voluntary carbon market frameworks are available for such options at present already. However, Africa, excluding North African countries and South Africa, currently represents only 1% of global carbon markets. According to IPCC (2007a, p. 36), agriculture contributed by 13.5% of total anthropogenic GHG-emissions in 2004.

It is estimated that the world population will continue to rise, but less rapidly. That growth will average 1.1 percent per year until 2030; compared to 1.7 percent per year over the past 30 years. Still that will mean a population increase from the current 6.7 billion to more than 8.5 billion by 2050 (UN World population prospects: the 2006 revision) and to 9.35 billion people in the mid 2050s (Population Reference Bureau, 2008). Agricultural productivity growth is necessary in increasing agricultural production in order to match the growth in world population. A major share of increased agricultural production has to be accomplished through productivity growth rather than area expansion in order to meet the increasing demand. At the same time, productivity needs to be increased in more sustainable ways than in the past in order to protect the natural resource base of agriculture and provision of ecosystem services.

Sustainable productivity growth

The research on climate change effect on productivity and rural development is scarce. The high uncertainty of climate change effects and the implications on agriculture is based on extrapolations and scenarios. Our knowledge on local environmental issues and agriculture is insufficient and local

agricultural research data do mostly not exist. However, according to the some Special Reports on Emissions Scenarios (SRES), climate change scenarios by IPCC (2007a) suggest that climate change will aggravate both agricultural productivity and food security in many developing countries. Therefore, in order to prevent crop failures arising from natural disasters, which render rural poor people vulnerable, it is recommended that adaptive measures through increasing disaster preparedness must be improved. Early warning systems to detect natural disasters should be developed.

Sustained negative rates of per capita agricultural growth may be contributing to food insecurity. Hunger is caused by many factors including crop failures because of weather and natural calamities, war and violence, insufficient means to production and high costs of inputs and requisites. Empirical results on malnutrition show a strong relationship between mothers' education and malnutrition. Improving female education for all calls for geographical targeting of the poorest rural areas. In addition to this, there is need to attend to the specific needs of girls and women. Insufficiency of trained human resources has led to inadequate formulation of food, agricultural and environmental policies. Effective communication, including the use of new information technology and mobile telephones, can facilitate communication in rural communities and decrease dependency on outside information. Access to these technologies can reduce the risk of farmers relying on information provided by middlemen.

Land tenure and property rights

Secure land tenure and property rights are a necessary condition for successful adaptation measures. Farmers with insecure property rights are reluctant to make investments for periods longer than a cropping season. Therefore, some of the conclusions drawn in some of the countries of the study suggest that land should be privatized. Privatization of land creates optimal patterns of land of different sizes through market transactions and that in turn increases productivity. Cooperatives, autonomous associations of persons united voluntarily to meet their common needs through a jointly owned and controlled enterprise, offer a good organisational solution as to how small and middle size farmers could fully participate in marketing and agricultural food processing. Reform policies giving landless access to land are needed to ensure that farmers feel emotionally attached to the land they cultivate and are ready to make investments in it. Landholding institutions should be strengthened through good governance. It should be possible to use land as collateral for loans. For agriculture to become sustainable and income distribution among the small-scale farmers economically viable, incomes should be distributed evenly.

Food and product prices fluctuate because of demand and supply factors. On the demand side, energy prices, population growth and consumer habits are the most important factors. On the supply side, the following factors affect prices: input factors and prices, lack of water, soil quality, weather, climate, technological development, policies and institutions, product prices and trade. Eventually, changes in these factors may lead to sharp increases or drops in food and producer prices.

Rural financial services

The agricultural sector requires investments and incentives that can guarantee sustainable development. The impact of climate change cannot be ignored while assessing those impacts. The general indication of it is that there are negative impacts that have the potential to adversely affect the sustainability of the agricultural sector. Collective effort is necessary in order to mitigate both short and long terms effects on the livelihoods of people in Finland's partner countries. Agricultural policies need to be structured so as to provide support to small-scale farmers through projects that can improve, diversify and market agricultural products

Farmers need credit possibilities in order to buy input, to make investments and to finance adaptation measures. However, financial constraints are more common in agriculture and related

activities than in other sectors, because of the small size of farms, the nature of activities and transaction costs (costs of seeking information, negotiating the outcome or travelling) (World Bank, 2008). Access to rural financial services has a potential to improve these constraints and improve productivity, food security, reduce poverty and enhance adaptive capacity. Micro-credit institutions and cooperatives offer possibilities to come out of the deeply rooted poverty trap and are significant for improvements of productivity. In order to improve rural financial services, credit providers should improve their information and risk management strategies and develop weather-based risk management products. Rural micro-financial institutions focusing upon smallholders should be established. Grassroots marketing cooperatives may be in a position to compete with private traders. Governments in developing countries may facilitate financial services by establishing information systems and overhauling required legislation.

Fair Trade certification

Fair Trade certification offers one way to guarantee minimum prices for farmers. Based on a field study on coffee production and trade in Nicaragua, it was concluded that the Fair Trade system of minimum prices guaranteed a higher price in times of very low producer prices: However, during other times the price of certified products were not necessarily higher than market prices for conventional products. Workers on Fair Trade farms did not enjoy better working conditions (Valkila and Nygren, 2009). Organically certified Fair Trade farms provided various environmental services and resilience in terms of climate change but the price premiums did not enable farmers to earn as much as they would earn using more intensive conventional methods of coffee production. Further compensations for the environmental services provided would be needed in order to realize adaptation measures (Valkila, 2009).

Options for solutions

There are options to combine mitigation and enhanced adaptive capacity with productivity and food security, but their implementation requires: 1) Development of the international carbon trading framework to respond to the needs and potential of SSA. This implies, e.g. revising and simplifying the CDM rules and standards to get agriculture and avoidance of deforestation included in the CDM mechanism; 2) Creation of international, national and regional participatory interlinkages in the value network for effective integration, from the global governance of carbon trading to the sectoral and micro-level design of products, markets and contracts; 3) Affiliation to the multiple carbon markets and create a supportive institutional structure to enhance voluntary carbon markets. This implies e.g., to create a third party organ with competence and credibility to standardize and certify voluntary carbon offsets; 4) Development of appropriate climate change policies to unleash the potential for pro-poor mitigation in SSA. Such policies should focus on increasing the profitability of environmentally sustainable practices that generate income for small producers and create food security and investment flows for rural communities; 5) Empirical research on impacts of mitigation options on carbon balance, adaptation and resilience in terms of food security, and related competence and capacity building

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