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Exploring Potential of Carbon Trading to Enhance Food Security in Sub-Saharan Africa

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Introduction

Developed countries have mainly caused climate change, but developing countries bear a disproportionate share of the impacts. Impacts are expected to be most severe in low-latitude and less developed areas. Sub-Saharan Africa (SSA) is considered to be one of the most vulnerable regions for climate change, because of the high exposure and the low adaptive capacity of agriculture which is the most important livelihood (IPCC, 2007). Changes in the production capacity of agriculture and decreasing incomes have negative impacts on local food security (Jones and Thornton, 2003, Brown and Funk, 2008, Schmidhuber and Tubiello, 2007).
Due to global change, agricultural area has increased also in SSA causing negative implications for the environment and natural resources while it has not been able to solve problems related to food security (Smith et al., 2007). Conversion of natural land to agriculture releases significant amounts of CO_2 emissions into atmosphere. In Sub-Saharan Africa, agriculture, land-use and forestry sector's share is currently 73 % of the total greenhouse gas emissions (WRI 2009). Future predicted greenhouse gas emissions from agriculture are estimated to increase 95 % between 1990 and 2020, mostly in the Middle East, North Africa and Sub-Saharan Africa (Smith et. al., 2007).
Carbon trading is a market mechanism to mitigate climate change. In carbon trading one party pays for another party in return for greenhouse gas emission reduction or for the right to emit (Capoor & Ambrosi, 2008). The Kyoto mechanisms allow the countries with Kyoto commitments to meet their target of reducing greenhouse gas emissions in a cost-effective way and motivate developing countries to join global emission reduction (UNFCCC, 2009). Thus carbon trading offers an opportunity to increase climate equity. Treaties include potential to finance mitigation and adaptation to climate change and enhance sustainable development.
The mitigation potential through Africa's agriculture has been estimated at 17 % (970 $MtCO_2eq^{-1}$) and through forestry at 14 % (1925 $MtCO_2eq^{-1}$) of the global total of these sectors by 2030. Of this total mitigation potential, 89 % is from carbon sequestration in agricultural soils. Africa's mitigation potential is estimated to be largest in the eastern part of the continent, with mitigation potential of 109 $MtCO_2eq\ y^{-1}$, most promising mitigation options being cropland management (69 $MtCO_2eq\ y^{-1}$), grazing land management, (65 $MtCO_2e\ y^{-1}$) and restoration of organic soils (61 $MtCO_2eq\ y^{-1}$) (Smith et al. 2008).

The objectives of our study were: 1) To create an analytical framework to examine the impact of varied mitigation options on food security and 2) To apply the framework for assessing the potential of agricultural mitigation options in the Ethiopian Central Rift Valley (CRV) for mitigation and enhancement of food security.

Materials and methods

We have created an analytical framework for exploring the impacts of varied options to mitigate climate change on food security, based on literature and results from a pilot survey carried out in the CRV, Ethiopia. Stakeholders (mixed agriculture farmers, crop farmers, researchers, advisers and public servants) were interviewed for the interrelations of mitigation options, adaptive capacity and food security, to identify the obstacles for implementation of the relevant management options and bottlenecks for access to carbon markets.
Secondly, we have calculated the mitigation potential of agriculture-related land use in SSA, Ethiopia and the CRV, based on reported results.

Results and conclusions

The options to mitigate climate change concern practices which reduce emissions, increase sinks or avoid emissions. In agriculture sector many options despite of mitigation improve simultaneously soil productivity through improved management or land use change improving food security (Figure 1). Agroecosystems imply significant potential for terrestrial carbon sequestration. Carbon sequestration can be improved through adding biomass to the soil, reducing soil disturbance and conserving soil and water (Lal, 2004). Such practices include soil fertility management, reduced tillage, diverse crop rotation, erosion control and irrigation management. Options which improve soil fertility enhance directly adaptation to climate change maintaining or improving agricultural productivity, thus meeting the food demand. In the long term sustainable soil management increase as well system's stability to maintain food security in unexpected circumstances climate change causes. Adopting mitigation options and selling emission reduction in carbon markets creates new income for local people increasing population access to resources through which adequate nutrition is achieved.
Implementation requires, however, overcoming agroecological and socio-economic constraints. Agroecological and socio-economical factors contribute to which mitigation options are implemented in the region, who have access to participate international carbon trading as well as how and to whom are the emerging benefits distributed. In addition, knowledge is needed of the possibilities carbon trading can offer and the verification process as well as how different mitigation options can be implemented locally.

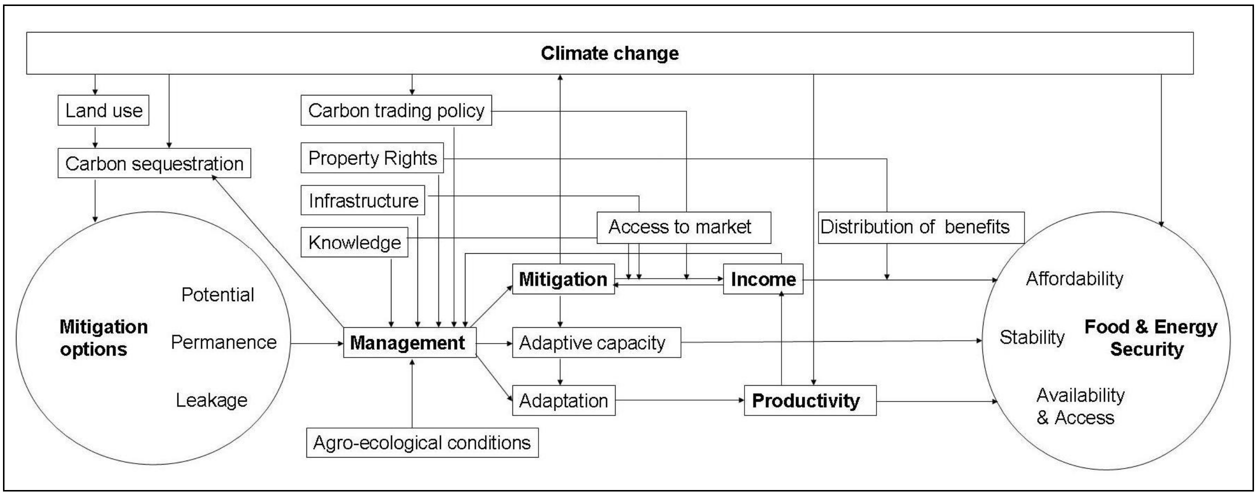

Figure 1. Analytical framework

There exists a high potential for increasing soil organic carbon stock through restoration of degraded land in SSA and Ethiopia as well as through grassland management in SSA (Figure 2.). The combined technical carbon sequestration potential corresponds to 40 -100 % in SSA and 120-260 % in Ethiopia of total GHG emissions of the agricultural sector if assumed that options are realized in all available land area. If assuming that practices are adopted on 20 % of available cropland, 10 % of grassland, 5 % of degraded lands and 20 % of agroforestry land (Sampson and Scholes, 2000) the agricultural total mitigation potential would correspond to 3-9 % and 10-20 % of annual agricultural emissions in SSA and Ethiopia, respectively. In CRV more detailed information of land use (Jansen et al., 2007) enabled examination of cropland and agroforestry land separately. There cropland and agroforestry management was found to have highest mitigation potential. In FAO database, agroforestry is included in “arable land”, thus agroforestry could not be separated from cropland in examination of SSA and Ethiopia. When the future changes in land use due to the expected global change are considered, the importance of restoration of degraded land will be emphasised relative to the other options.

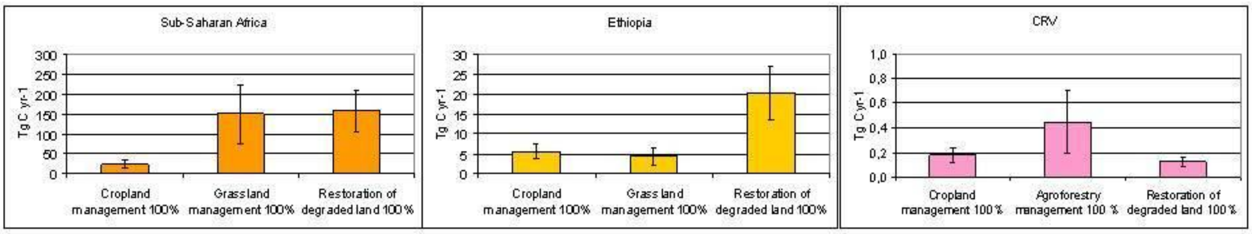

Figure 2.Technical carbon sequestration potential, if mitigation options were implemented on all the available field area (Source: FAOSTAT, TERRASTAT, Batjes, 2004).

According to the interviews, food insecurity in CRV is mostly the outcome of decreasing productivity of rainfed agriculture and poverty. In consequence, most promising agricultural mitigation options were considered as practices, which improve soil productivity, prevent soil degradation and create income (Figure 3). Deforestation, overgrazing and lack of agricultural input are the main causes for land degradation in CRV. Due to deforestation, it takes more time to find and collect essential fuelwood which has increased burning of animal dung. Feeding of large number of livestock rests on grazing and the use of crop residue. Implementation of the most important mitigation options would thus require replacing currently used energy sources with new sustainable ones. Utilization of alternative energy sources would provide deposit of organic amendments to soil, which would prevent land degradation and improve soil productivity.

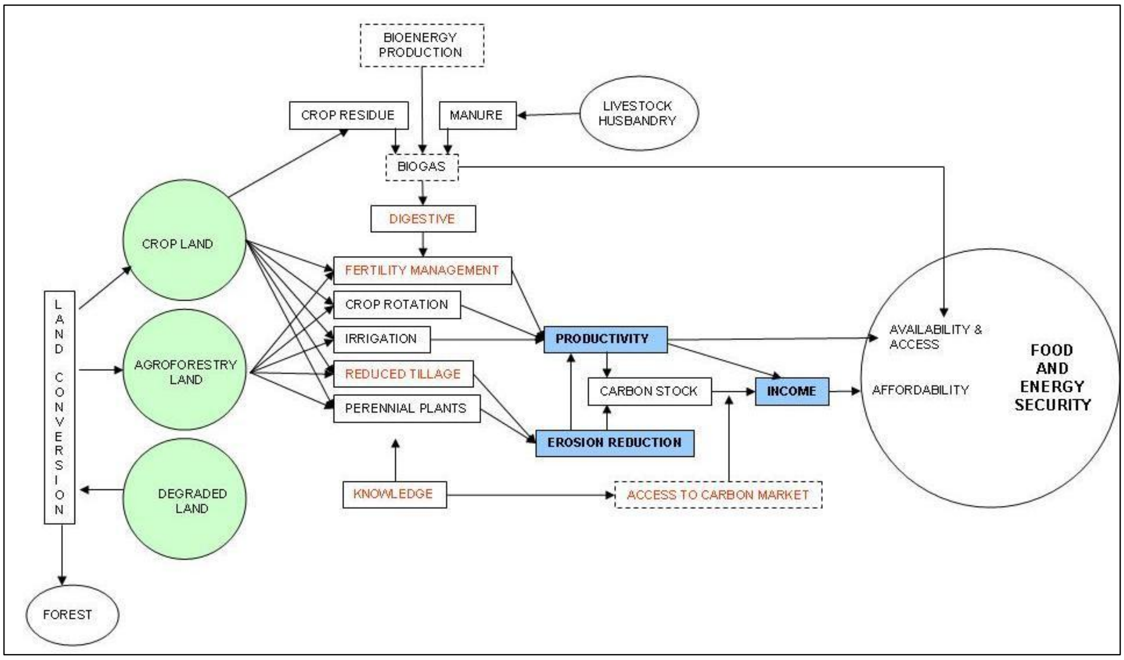

Figure 3. Influence of land use on potential mitigation options in CRV

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