SP8: Climate change and ecological sustainability of horticultural value chains

Project partners:

Prof. Dr. W. Bokelmann, Division of Horticultural Economics, Humboldt Universität zu Berlin (HUB)
Dr. K. Plassmann
Dr. H. K. Bett, Department of Agricultural Economics and Agribusiness, Egerton University (EU)

I. Objectives

a. Overall aim and objectives of the sub-project

Sub-Saharan Africa is predicted to be one of the world's regions worst affected by climate change (Boko et al. 2007), with ecological, social and economic consequences, including for food security, food availability and farmers' incomes. Climate change threatens agricultural production in this region and yield reductions are expected for major crops; however, at the same time there is a need to increase overall food supplies for a growing population (FAO 2008). The widespread application of sustainable practices along entire food supply chains is essential to counter the increasing threats to food security and the environment and attempt to feed this growing population (Beddington et al. 2012). This sub-project will analyse the impacts of climate change on horticultural production and discuss wider environmental sustainability issues, considering different farming systems, including smallholders, outgrowers, export farms and urban/peri-urban glasshouse production. The sub-project will identify opportunities both for adapting to a changing climate and for reducing emissions of greenhouse gases (GHGs) on farms and along value chains. This will help producers and other stakeholders to contribute to climate change adaptation and mitigation efforts which both are urgently needed. The sub-project will also try to identify the most important synergies between adaptation and mitigation, taking into account concepts such as sustainable intensification and conservation agriculture.

b. Relevance of sub-project to the objectives of the project (main outputs)

This sub-project contributes to three different outputs. With Output 4 (*Situation analysis and evaluation of impacts*) it will analyse the ecological sustainability of food systems with a focus on climate change related issues and contribute to the analysis of relevant policy and governance frameworks where appropriate. Further, it will contribute to the sub-project '*Sustainable soil fertility and nutrient/mineral management in horticultural production chains*' within Outputs 1, 2 and 3 by analysing the implications of current and improved nutrient management on the emission of GHGs from cultivation. Finally, the sub-project will seek to establish links with other sub-projects where feasible and will seek to choose the same crops for any potential case studies.

c. Research and/or technical goals of the sub-project

In order to achieve the overall objectives stated above, this sub-project will:

- analyse the impacts of climate change on different farming systems and identify measures that may help make them more resilient to these impacts (climate change adaptation);
- estimate the amount of GHGs emitted per unit of product (Product Carbon Footprint, PCF) of different value chains and give recommendations for increasing production efficiencies and reducing the PCF (climate mitigation);
- identify synergies and trade-offs between climate change adaptation and mitigation measures;
- as nitrogen management is one of the main drivers of GHG emissions from field cultivation, work in close collaboration with the sub-project on nutrient management in order to evaluate the potential climate mitigation effects of improved nitrogen management;
- support the analysis of institutional arrangements and governance within Output 5; and
- consider other indicators of ecological sustainability of the chosen farming systems, looking at issues to be determined (e.g. water use, competition for land, biodiversity or pest management).

II. State of knowledge

Climate change has become one of the major environmental challenges of our time. Agriculture and horticulture are different from other industrial sectors in that they both contribute to climate change and are directly affected by a changing climate. Global warming will negatively impact agriculture, for example through the increased occurrence of extreme weather events, droughts, shortening of growing seasons, new distributions of pests and diseases and declining yields. At the same time, agricultural activities contribute to climate change by releasing significant amounts of GHGs into the atmosphere at all stages of agricultural value chains, including cultivation, the production of inputs (e.g. mineral fertilisers), transportation, processing and packaging, storage, retailing, consumption and waste disposal. It is estimated that agricultural activities account for about 15% of global anthropogenic GHG emissions (excluding emissions related to the use of fuels or the production of inputs), while land use change and forestry account for another 14% (www.cait.wri.org). In Sub-Saharan Africa, these figures rise to 20% and 40%, respectively, although total absolute GHG emissions are much lower than in industrialised countries.

This interaction between agriculture and climate change calls for two interconnected strategies: climate change adaptation and mitigation. As the expected impacts of climate change on food production represent a major risk for livelihoods (Seebauer et al. 2012), **adaptation** to a changing climate is needed in order to safeguard food production for a growing population. Some of the negative impacts of climate change are expected to be greatest for some tropical regions (Pachauri/Reisinger 2007), and in countries such as Kenya where negative effects are already being felt and the majority of the workforce depends on agricultural activities, this is a priority area for action. Rural farmers in these countries might be especially affected due to their reliance on natural factors, low use of inputs and lack of institutional support, endangering development aims such as poverty reduction and food security (Kandji et al. 2006). At the same time, the urgent need for climate **mitigation** means that absolute emissions from every industrial sector, including agriculture, need to be reduced. Agriculture has the potential to significantly contribute to climate change mitigation, in particular through increased carbon storage and sequestration in developing and tropical countries (Smith et al. 2007), increasing production efficiencies and reducing loss and waste along supply chains. Although Sub-Saharan countries understandably prioritise adapatation and increasing climate resilience, the significant contribution of agriculture to climate change means that meeting growing food demands using current technologies and practices undermine future food production, making mitigation an essential part of the solution to increasing food security. The concept of sustainable intensification, i.e. the production of more food from the same area of land while reducing the environmental impacts, is of particular importance in this respect (Beddington et al. 2012).

Although many of the issues facing agriculture in relation to climate change and food security have been identified, a lot of questions remain, and further research is urgently required. For example, more location-specific research is needed because synergies and trade-offs between adaptation and mitigation differ between locations (Vermeulen et al. 2012). The full impact of some mitigation practices are not yet well understood, and full life cycle assessments and GHG accounting per unit of output are lacking for most practices and agroecological and socio-economic contexts (Smith/Wollenberg 2012). However, GHG accounting per unit of product is essential for assessing efficiencies and potential leakage effects and addressing the challenge of increasing food production whilst simultaneously reducing GHG emissions. Further, there is a need to clearly demonstrate the effects of mitigation practices on adaptation and livelihoods to encourage uptake by small farmers and policy makers (Smith/Wollenberg 2012). Finding the optimum relationship between yields, the use of inputs and GHG emissions per unit of product is another important knowledge gap (Hillier et al. 2012), especially in relation to the use of nitrogen fertilisers and the problem of yield gaps in developing countries. A particular focus of this sub-project will be on smallholder farming systems as no information is available on the GHG emissions from these systems yet because analyses have so far focused on large export oriented farming systems (e.g. Edwards-Jones et al. 2009).

III. Utilization of results

This sub-project addresses some of the important knowledge gaps in relation to climate change. The results will be communicated to farmers, farmers' associations, extension services and other service providers, the private sector as well as policy makers in the region to encourage the uptake of relevant adaptation and mitigation measures both in practice and in the development of relevant policies. Finally, the work might identify new areas for further research.

IV. Internal division of labour and cooperation with other sub-projects

The achievement of sub-project objectives is based on a strong cooperation and effective division of labour between HUB and EU. EU will be primarily responsible for the local supervision of the African PhD students. Moreover, the sub-project will cooperate with others, in particular "*Sustainable soil fertility and nutrient/mineral management".* Also it will be involved with the interdisciplinary joint household survey, ensuring the collection of relevant data for "Climate change and ecological sustainability".