



## **PhD Topic CLIFOOD-17-01**

### **FSC's Long-term Scholarship 2017 – 2020 (South-South)**

Within the German-Ethiopian SDG Graduate School: Climate Change Effects on Food Security (CLIFOOD) coordinated by Food Security Center (FSC), University of Hohenheim, Germany and Hawassa University, Ethiopia

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## **Agricultural intensification for improving soil health, enhancing food security and climate change adaptation in Southern Ethiopia**

### **Discipline**

Agricultural Sciences

### **Main discipline**

Soil Science

### **Other relevant disciplines**

Soil health, agronomy, plant science

### **Description of the research topic and research methodology**

Agriculture is the backbone of Ethiopia's economy on which the livelihood of the majority of the population is relied on. At national level, land degradation and climate change are the prime limiting factors for both crop and livestock productivity. The national annual nutrient deficit for N, P and K is estimated to be -42, -6 and -26 kg ha<sup>-1</sup> yr<sup>-1</sup> respectively (Stoorvogel and Smaling 1990; Elias 1998). To combat these constraints, the country set strategies to use any available improved technologies during the growth and transformation plan II (GTP2). Ethiopia is currently undergoing rapid economic growth and transformation, with improvements in education, health and infrastructure development. However, the proportion of the population under extreme poverty is still high, though reduced from 38% to 29% during the last decade (WFP, 2014). Ethiopia remains one of the world's most food insecure countries, where approximately one in three people live below the poverty line (WFP, 2014). In the GTP2, the Ethiopian government plans increases in agriculture of between 8% and 11% to contribute to the country's overall plan to become a middle income country by 2025. Smallholder and pastoralist agriculture will continue to be the major source of agricultural development, which in turn will ensure rapid economic growth.

The Sidama Zone of Southern Nation, Nationalities and Peoples Region (SNNPR) has been experiencing tangible climate change over the last decade, with average temperatures of the SNNPR region rising by 0.4 °C (NREPA, 2012) above the national 0.37 °C (MoWRNMA, 2007). This shows the seriousness of the problem in the region. The most severely affected areas in the Zone are semi-arid and dry areas, such as the Boricha, Loka Abaya and Hawassa Zuria districts. In terms of climate change related research, current knowledge and understanding of the vulnerability and adaptation by communities is improving than before due to some project interventions (Seyoum,

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2012). Continuous mono-cropping with limited external input has depleted soil fertility and negatively affected soil health in southern Ethiopia. By contrast, certain parts of southern Ethiopia, for example in the Loka Abaya, Boricha and Shashamane districts, farmers traditionally (with their own indigenous knowledge) produce diverse types of crops in spatial and temporal arrangements; this inadvertently improves soil health, crop diversity, food security and climate change adaptation. These practices provide good examples of locally accepted agricultural intensification that will enhance production and productivity in the face of climate change. The sustainability of such traditional practices needs to be investigated and developed from using scientific understanding of sustainability, constrained by availability of resources. Farmers are great innovators, but the question we address here is how their local innovations can be scaled up to the wider community, districts, regions and the nation.

**Phase I:** Research that address land degradation and soil health issues will be explored on farmers fields in selected districts of Sidama Zone.

**Phase II:** Conducting climate change mitigation and/or adaption research to enhance sustainability and food security of the farming community.

The experiments will be conducted both at on-station and on farmers fields using participatory action research and extension methodologies.

#### **The 5 main research questions:**

1. Is it possible to intensify the agriculture of smallholder farmers to respond to soil degradation and climate change?
2. Can agricultural intensification improve soil nutrient balance, soil health and reduce climate change impacts?
3. Can total productivity of smallholder farmers be improved through conservation farming practices?
4. Can agricultural intensification help farmers to diversify income and diet?
5. Can cropping systems change /modification improve farm productivity and climate change adaptation?

#### **Logistics**

The field research will be conducted in Ethiopia. For the PhD research diverse materials and facilities will be required. These include maize and legume (haricot bean) varieties, implements for conservation practices, soil moisture measure, soil core sample, augur, etc. Different fertilizer types that are available on the market like (Urea, NPS, etc) will be used for the experiments. Soil samples and plant will be collected for base line and treatment effect assessment.

#### **Target region (in Ethiopia) or country (in East Africa Region)**

Selected districts of Sidama Zone

#### **Work content**

- On farm experiment: 40%
- On-station experiment: 20%
- Lab work: 30%
- Desk work: 10%

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**Required qualifications of the applicant**

MSc in Soil Science

**Methodological competence of the applicant**

The candidate should have experiences in soil science, agronomy research and practical skills of laboratory analyses of nutrients and soil physical properties.

**Supervisor and Institute**

Dr. Girma Abera and Dr. Sheleme Beyene

School of Plant and Horticulture Sciences, Hawassa University

**Faculty**

College of Agriculture



## **PhD Topic CLIFOOD-17-02**

### **FSC's Long-term Scholarship 2017 – 2020 (South-South)**

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## **Seed regeneration of invasive species: germination ecophysiology and woody vegetation encroachment processes in Borana, southern Ethiopia**

### **Discipline**

Agriculture

### **Main discipline**

Rangeland ecology

### **Other relevant disciplines**

Seed ecology, Ecophysiology

### **Description of the research topic and research methodology**

The spread of invasive woody plants is a common worldwide challenge. Similar to other African savannas, vast areas of Borana rangelands of southern Ethiopia are encroached by native invasive woody plants. The expansion in bush encroachment poses a great threat to the Borana rangelands with consequences on the environment and livelihoods of the pastoral communities. Bush encroachment leads to dense thicket bushes which negatively affect forage productivity, carrying capacity and ultimately the livelihoods and food security of local communities. On the other hand, trees assist in carbon sequestration and eventually reduce global warming. Several native species of Acacia are reported to be invasive species in Borana rangelands (Coppock, 1994). There is little information about regeneration capacity, germination ecophysiology, and process of woody vegetation in response to pastoral land use system, soil, rainfall, grazing and fire regime. Yet, this information is vital for the management and control strategies of invasive woody species. This PhD study will focus on examine the mechanisms and factors determine the invisibility of major invasive woody plants. In this regard, sets of experiments will be conducted in Borana rangeland of south Ethiopia. A combination of methods that consists of a greenhouse experiment, nursery, manipulative field experiments (germination, seedling survival and recruitment) and Geographical Information System (GIS) will be used. In line with this, various data on ecophysiological traits and morphological responses of species will be gathered. The species' ecophysiological responses to environmental conditions, together with additional aspects of their seeds germination and regeneration ecology that will be identified in this study could provide the basis for planning environmentally sound control strategies in suppressing invasive species. This will help to restore rangelands' health and enhance forage productivity to support sustainable livestock production in

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the region. The output further helps in predicting the potential occurrence of these and other species with similar characteristics. The study will also enable to understand the regeneration ecology and recognize ecophysiological characteristics that would make invasive species to spread in dryland.

#### **The 4 main research questions:**

1. How do population and regeneration status of invasive woody plants are distributed and what factors might be responsible for this pattern.
2. What are the regeneration and seed bank behavior of invasive woody species?
3. How do invasive native woody species differ in their response to livestock grazing, rainfall and fire with regard to recruitment success?
4. Do soil nutrients (termite mounds) enhance invasion process of invasive woody species?

#### **Logistics**

The field research will be conducted in Ethiopia.

#### **Target region (in Ethiopia) or country (in East Africa Region)**

Ethiopia, Borana rangelands of southern Ethiopia

#### **Work content**

- Field work: 50%
- Lab work: 40%
- Desk work: 10%

#### **Required qualifications of the applicant**

MSc in Rangeland Management or Rangeland ecology with GIS background, other related discipline

#### **Methodological competence of the applicant**

- Extensive prior experience with GIS software and spatial analysis
- Applicant should be highly motivated to work in pastoral and rangelands areas of Africa
- Good writing skills demonstrated through research reports and publications in peer reviewed journals
- Extensive experience in field survey design, and conducting vegetation studies
- Previous work experience in pastoral and rangeland areas will be added advantages.

#### **Supervisor and Institute**

Assoc. Prof. Dr. Tesfaye Abebe (Vice President for Research and Technology Transfer)  
School of Plant and Horticulture Science, Hawassa University, Ethiopia

#### **Faculty / College**

College of Agricultural Sciences

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## **PhD Topic CLIFOOD-17-03**

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Within the German-Ethiopian SDG Graduate School: Climate Change Effects on Food Security (CLIFOOD) coordinated by Food Security Center (FSC), University of Hohenheim, Germany and Hawassa University, Ethiopia

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## **Assessing the feeding values of potential local feed resources with low enteric methane emission in vivo for improved livestock productivity and sustainable food security in Ethiopia**

### **Discipline**

Agricultural Sciences

### **Main discipline**

Animal Production

### **Other relevant disciplines**

Animal nutrition, Forage production

### **Description of the research topic and research methodology**

Livestock production has a key role for food security in many African nations in general and in Ethiopia in particular. Moreover, livestock is an integral part of nearly all rural livelihood farming systems in the developing world. However, ruminant animals are the main source of methane (CH<sub>4</sub>) emissions, in which tropical animals are considered as the major contributors.

This is because half of the global ruminant population is located in the tropical region. Moreover, tropical cattle are mainly supported by low quality high fibrous feed resources which produce high enteric CH<sub>4</sub> due to poor digestibility and nutrient content. Thus, enteric CH<sub>4</sub> emission could be reduced through feeding improved forages. Nevertheless, such practices may not be feasible under smallholder farm settings. Hence, searching for local feed resources with low CH<sub>4</sub> production owing better nutrient quality will be justifiable.

Recently, Melesse et al. (unpublished data) have conducted a comprehensive study focusing on screening of 48 local plant materials (including foliages of multi-purpose trees, grasses, leaf of root crops, fruit wastes and agro-industrial byproducts) with possible low CH<sub>4</sub> production in vitro while owing better nutrient quality. Moreover, the nutrient compositions and anti-nutritional factors as well as the feeding values (using the Hohenheim in vitro gas production technique) of these plant materials have been intensively investigated. Accordingly, leaves and pods of multipurpose trees (*Acacia nilotica*, *Prosopis juliflora*, *Cajanus cajan* and *Milletia ferruginea*), forages (*Panicum coloratum* and *Desmodium intortum*) and leaves of herbaceous as well as root crops (cassava, samma and enset) were identified as potential candidates in mitigating CH<sub>4</sub> emission while owning better feeding quality. However, these in vitro based research findings shall be further verified through in vivo study by using live ruminant animals such as cattle, sheep and/or goats.

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The principal aim of the proposed PhD project is thus to investigate the potential of already identified plant materials and their combinations with different levels of locally available conventional animal feeds (concentrates and by-products) in reducing CH<sub>4</sub> emissions while enhancing digestibility and animal productivity in vivo. This PhD research project will be conducted in two major phases:

**Phase I:** Among identified feed materials, those with most promising CH<sub>4</sub> reducing potentials will be collected and processed.

**Phase II:** Conducting the actual animal based experiments (at least three separate experiments) by using sheep.

Thus, the PhD candidate has to carry out on-station experiment by feeding each of the identified feed materials to sheep in combinations with locally available concentrates and/or by products.

**The 3 main research questions:**

1. Is there any significant difference in the quality of the investigated feed materials in vivo?
2. Which feed materials would bring a better impact on the growth performances and carcass components of sheep by reducing enteric CH<sub>4</sub>?
3. Can we develop viable feeding strategies which are aimed at reducing enteric CH<sub>4</sub> emission from the livestock sector while enhancing their productivity?

**Logistics**

The field research will be conducted in Ethiopia. Following consumables and items will be required for research:

- Leaves from Acacia nilotica, Prosopis juliflora, Cajanus cajan, Millettia ferruginea, Cassava (Manihot esculenta) and Samma (Urtica simensis). Forages from Panicum coloratum and Desmodium intortum are also required.
- Experimental animals (young aged sheep)

**Target region (in Ethiopia) or country (in East Africa Region)**

Hawassa University, Ethiopia

**Work content**

- Field work: 25%
- On-station experiment: 50%
- Lab work: 10%
- Desk work: 15%

**Required qualifications of the applicant**

MSc in Animal Production or Animal Nutrition

**Methodological competence of the applicant**

The candidate should have experiences in field as well as animal based experiments.

**Supervisor and Institute**

Prof Aberra Melesse

School of Animal and Range Sciences, Hawassa University, Ethiopia

**Faculty / College**

College of Agriculture

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## **PhD Topic CLIFOOD-17-04**

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## **Challenges, opportunities and adaptation strategies of sorghum production under climate change in southern Ethiopia**

### **Discipline**

Agronomy

### **Main discipline**

Crop physiology, agroclimatic analysis, modeling, biostatistics

### **Other relevant disciplines**

Agroecology, stress physiology

### **Description of the research topic and research methodology**

Food production for a rapidly growing population from a continually shrinking farm size is a prime developmental challenge, in Ethiopia. More importantly, this has to be accomplished under changing climate, which poses new risks and uncertainties for crop production. Rainfed crop production is at risk due to problems associated with climate change such as delay in onset of season, early cessation of rains and poor distribution of rainfall leading to increased intensity and occurrence of drought. Sorghum is an important drought tolerant indigenous crop only preceded by teff and maize in acreage and is one of the productive cereals with an average yield of 2.37 tone ha<sup>-1</sup> in the country. In southern Ethiopia, it is also the third widely cultivated staple cereal crop. All sorghum production is based on rainfed agriculture and is derived from small subsistence farmers at both regional and country level. As a drought tolerant crop sorghum is expected to play an increasingly important role in addressing food security of humans under the expected climate change. On the other hand, sorghum is one of the crops that is vulnerable to the negative impacts of climate change partly due to the niche it occupied currently. Expected changes in rainfall patterns, total annual rainfall amounts and rising temperature are going to impose direct and indirect effects on productivity of sorghum. Needless to say, these effects would be compounded to the consequences of the sub-optimal agronomic management strategies practiced by the majority of subsistence small farmers. Thus, it is greatly important to address location specific climate change impacts on productivity of sorghum and identify the challenges, opportunities and potential management options that could help sustain and enhance productivity. To this end, there is a need to distinguish key existing constraints, analyze the current yield gap, assess the possible impacts of climate change on productivity and consider effectiveness of alternative

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agronomic strategies towards addressing the impacts of climate change. Field experiments involving selected agronomic management options will be conducted in representative sites in southern Ethiopia. The data will be used as a basis to evaluate the impact of climate change on sorghum production by using appropriate models. It will also be used to test comparative agronomic strategies and identify the suitable ones as means to adapt to the consequences and to exploit possibilities under climate change. Moreover, survey and appropriate tools will be used to identify the key existing constraints and the current yield gap

### **The 3 main research questions:**

1. What are the existing constraints and the current yield gap level for sorghum production in southern Ethiopia?
2. What are the impacts of climate change on sorghum production in southern Ethiopia?
3. How do adaption strategies differ across different agro-ecologies and varying agronomic management strategies for sorghum in response to climate change in southern Ethiopia?

### **Logistics**

The field research will be conducted in Ethiopia.

### **Target region (in Ethiopia) or country (in East Africa Region)**

The focus of the work will be sorghum growing areas of southern Ethiopia

### **Work content**

- Field work: 45%
- Lab work: 10%
- Desk work: 45%

### **Required qualifications of the applicant**

MSc in agronomy or related fields

### **Methodological competence of the applicant**

The applicant is required to have skills in field research planning, execution, data collection, analysis and technical report writing / scientific paper writing. Experience and use of crop models and other statistical packages will be essential.

### **Supervisor and Institute**

Dr. Walelign Worku

School of Plant and Horticultural Sciences, Hawassa University, Ethiopia

### **Faculty / College**

College of Agricultural Sciences

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## **PhD Topic CLIFOOD-17-05**

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## **Grain Legumes for Climate Change and Food Security**

### **Discipline**

Agricultural Sciences

### **Main discipline**

Crop Sciences, Biological Farming, Plant Physiology, Plant Nutrition, Climate Change

### **Description of the research topic and research methodology**

Two key challenges facing humanity today emanated from food insecurity and climate changes. Agriculture has a significant role in addressing both challenges and it is major economic sector of many developing countries including Ethiopia. Besides its economic importance the sector is also expected to respond to intense climate change. In this regard, grain legumes can be taken as a strategic crop having a potential to bring several benefits from nutritional and symbiotic points of view. They are often referred to as meat of the poor due to their high protein and dietary nutrients contribution to the daily diet of people in the developing countries. From symbiotic point of view N<sub>2</sub>-fixing legumes are known to play an important role in improving soil fertility due to their inherent ability to fix atmospheric N<sub>2</sub> through biological N<sub>2</sub> fixation, thereby contributing to the soil N economy. Although there are some research activities which are working towards exploiting legumes potential to achieve food security worldwide, limited work has been done in Ethiopia in this regards. Therefore, there is an urgent need to undertake a systematic and holistic investigation to fully exploit the wide ranging potential of the legumes in Ethiopia. Thus, the aim of this project is to explore the potential of grain legumes to address climate change and food security concerns in Ethiopia. A detail survey, field experiments and laboratory analyses will be implanted to attain the aim of the project.

### **Main research questions:**

- To what extent do grain legumes contribute towards food & nutrition security of the small scale farming communities producing grain legumes in the Southern Ethiopia?
- How grain legumes are performing in the changing climatic conditions, and contribute to the regulation of climate change?
- What is the potential contribution of grain legumes towards ensuring food and nutrition security in the changing climate?

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**Logistics**

Field work and part of the laboratory analysis will be carried out in the southern Ethiopia or Hawassa University; part of the lab work will possibly be carried out in the University of Hohenheim with prior approval by the project coordinator.

**Target region (in Ethiopia) or country (in East Africa Region)**

Southern Ethiopia (within the southern region, the work will focus on dominantly grain legume growing areas).

**Work content**

- Field work: 55%
- Lab work: 35%
- Desk work: 10%

**Required qualifications of the applicant**

MSc in Crop Sciences and/or Organic Agriculture

**Methodological competence of the applicant**

- Experience in Field research (planning, data collection, analysis, scientific writing through presentation). The experience of the applicant in journal manuscript preparation demonstrated through prior experience in publishing articles in peer reviewed journals
- Motivation in and proximity to the proposed topic/ prior involvement in related projects

**Supervisor and Institute**

Dr. Tarekegn Yoseph

School of Plant and Horticultural Sciences, Hawassa University, Ethiopia

**Faculty / College**

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## **PhD Topic CLIFOOD-17-06**

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## **Effect of dietary interventions in climate sensitive agriculture target villages in Southern Ethiopia on micronutrient status of mothers and children**

### **Discipline**

Human Nutrition

### **Main discipline**

Agriculture Nutrition Impact study

### **Description of the research topic and research methodology**

Malnutrition is one of the major development challenges in Ethiopia. For this reason, the Ethiopian Government and partners are targeting ways to minimize malnutrition in the country. Among the different forms of malnutrition, undernutrition and micronutrient deficiencies (particularly in iron and vitamin A) are highly prevalent in Ethiopia and rural mothers and children are the most affected section of the population. To address these problems, agriculture-based interventions are given high priority since the majority of the Ethiopian population depends on agriculture production, both for food and income. In its newly granted CLIFOOD project, Hawassa University is collaborating with Hohenheim University of Germany to strengthen its teaching and research capacities related to climate change and sustainable development goals. Within the CLIFOOD project, 12 PhD projects will be funded. One of these PhD projects is in the field of nutritional sciences and will link the climate change-targeted agricultural interventions with nutritional status, in particular the micronutrient status of mothers and children. The nutrition research will be conducted in collaboration with agricultural researchers from Hawassa University so that agriculture interventions will be evaluated regarding their impact on nutrition. Dietary interventions will be investigated using biochemical and anthropometric indicators to assess health and micronutrient status of mothers and children.

### **Research questions:**

What is the impact of dietary intervention on micronutrient status and health of mothers and children in CLIFOOD project areas, South Ethiopia?

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**Logistics**

The field research will be conducted in Ethiopia

**Target region (in Ethiopia) or country (in East Africa Region)**

Rural areas in Ethiopia

**Work content**

- Field work: 60%
- Lab work: 30%
- Desk work: 10%

**Required qualifications of the applicant**

MSc in Human Nutrition, Agriculture and Nutrition, Public Health Nutrition

**Methodological competence of the applicant**

- Experience in field work in Ethiopia
- Research project management experience
- Skill in working in diverse culture and remote areas
- Experience in Qualitative and quantitative Research methods

**Supervisor and Institute**

Prof. Dr. Jan Frank, Institute of Biological Chemistry and Nutritional Science, University of Hohenheim, Germany

Dr. Samson G/Medhin, School of Human Nutrition, Hawassa University, Ethiopia

**Faculty / College**

College of Agriculture

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