



# **Training workshop on Greenhouse Gas Measurement Techniques**



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**Work package title:** Summer school "Nutrient cycling in agricultural productions systems in Africa"

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**Deliverable title:** (in original proposal) Training school at ILRI campus on GHG measurement techniques

Lead beneficiary: International Livestock Research Institute

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# Outline

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# **Executive Summary**

One of the biggest global challenges in the 21<sup>st</sup> century is climate change occurring due to anthropogenic activities and subsequent rising greenhouse gas concentrations in the atmosphere. While there is substantial information on greenhouse gas (GHG) concentration and emissions from large parts of the globe, Africa remains an area with a considerable lack in available data which in turn leads to large uncertainties in climate predictions not only on the continent itself but also globally.

SEACRIFOG 'Supporting EU-African Cooperation on Research Infrastructures for Food Security and Greenhouse Gas Observations' aims at develop a concept for a pan-African Research Infrastructure (RI) for systematic long-term in situ observations of the main climate forcing components (ie greenhouse gas emissions) while linking these to food security. SEACRIFOG is funded by the European Union (EU) under the Horizon 2020 Programme. An essential criterion for the success of a future RI is the availability of the necessary human capacity with technical, theoretical and analytical skills. For this reason, the SEACRIFOG project, across all work packages (not only WP 2), includes tasks that focus on capacity building. Within WP2, Activity 2.3 aims at training young researcher in GHG measurement techniques in relation to agricultural production systems or in simple words: "How are greenhouse gas emission linked to nutrient cycling in agricultural production systems in Africa?".

Therefore, in July 2019 and with one-year delay caused by the security situation in Kenya in 2018, the International Livestock Research Institute (ILRI), organized a summer school on "Nutrient cycling in agricultural production systems in Africa". The overall goal of the training was to know and to understand different measurement techniques (particularly greenhouse gas emission quantification) that enable researchers to investigate nutrient cycling in agricultural production system in Africa. The course format consisted of theoretical courses combined with practical tasks including own measurements in the field and subsequent data analysis/data interpretation. The training took place at ILRI's Mazingira Centre (mazingira.ilri.org) and Kapiti Research Station in Central Kenya. Following the advertisement in the first quarter of 2019, ten PhD students from Kenya, Ethiopia, Uganda, Zimbabwe and Egypt applied. The trainees got insights in soil and animal greenhouse gas (GHG) emissions measurements during the first three days. Following this, the course covered ecosystem-scale GHG flux measurements using the eddy covariance technique and how such information can be further scaled with remote sensing approaches. The last two days focused on isotopic measurement techniques in order to identify specific biogeochemical processes driving GHG emissions and a session on experimental design. The latter involved a joint discussion of the research questions and approaches taken by each individual student. All courses and tasks were highly appreciated by the attendants, whom further asked if we are able to offer similar trainings to them and their colleagues regularly in the future.



# **1** Background

With Climate Change being a major challenge for humanity in the 21<sup>st</sup> century, detailed understanding of the consequences of climate change on agricultural production is necessary. Accurate predictions of agricultural production in Africa are scarce and hampered by a lack of available data. At the same time, greenhouse gas emissions from the African continent are highly uncertain which subsequently leads to inaccuracies in predictions of the consequences of climate change (ie temperature changes, changes in rainfall patterns etc.). The SEACRIFOG project aims at contributing to closing these knowledge gaps (lack of data) by designing a pan-African environmental research infrastructure (RI) capable of delivering crucially needed in-situ data on GHG concentration and emissions as well as agricultural productivity. Besides this, the necessary capacity (technical, theoretical, analytical) to run such a research infrastructure needs to be developed. In simple words: There is a need the to train the next generation of researchers and technicians on the African continent.

Again, the SEACRIFOG project takes a first step towards achieving such goal, by including a variety of training courses over the duration of the project. Work package 2 particularly focuses on links between nutrient cycling and greenhouse gas emissions in agricultural production systems in Africa and therefore organized a summer school entitled "nutrient cycling in agricultural production systems in Africa" with a string focus on GHG emission measurements from these systems. This report provides an overview of the course structure and the content being taught during  $6^{th} - 14^{th}$  July 2019 at ILRI's Kapiti Research Station in Kenya.

# 1.1 Program

### SEACRIFOG summerschool on

# "Nutrient cycling in agricultural production systems in Africa"

Date: 6th - 14th July 2019

Location: Mazingira Centre, ILRI, Nairobi, Kenya and Kapiti Research Station, Kenya

#### **Overall Goal:**

To know and understand different measurement techniques (particularly greenhouse gas emission quantification) that enable researchers to understand nutrient cycling in agricultural production system in Africa

#### **Course Format:**

Theoretical courses combined with practical tasks including own measurements in the field and subsequent data analysis/data interpretation

#### **Program:**

Day 0 – 6<sup>th</sup> July: Arrival to Kenya for students outside of Kenya (check into hostel – share your travel (arrival/departure) information with Beth Njoroge and Lutz Merbold – this is needed to arrange for airport pickups

Day  $1 - 7^{\text{th}}$  July: 9a.m. Visit to ILRI's Mazingira Centre, 11:00 Drive to Kapiti Research Farm (Lunch in Kapiti), 14:00 – 15:00 Aims of Course, the SEACRIFOG project, Environmental Research infrastructures,

15:30 onwards: Students Project Presentations (come prepared (ie ppt slides) – 10min per person + 5min Q/A)

Day 2 – 8<sup>th</sup> July: Soil greenhouse gas (GHG) exchange – theory behind GHG chamber measurements (Pros/Cons), practical training on manual and automatic greenhouse gas chambers in the field, Flux calculations and interpretation

Day 3 – 9<sup>th</sup> July: Animal GHG emissions – Methods to quantify emissions from enteric fermentation, feed basket estimation, bite tracking, liveweight measurements, respiration chamber measurements etc. – from theory to practice

Day 4 – 10<sup>th</sup> July: Ecosystem GHG exchange measurements – What is the eddy covariance technique, Pros and Cons, Visit of the two EC sites and data download, Data Processing and Data Interpretation

Day 5 - 11<sup>th</sup> July: Remote Sensing - How to scale point or ecosystems information, different approaches of Remote Sensing, NDVI

Day 6 – 12<sup>th</sup> July: Isotopes as powerful tool to identify ecosystem processes/links between nutrient pools – Theory and practice based on data collected in Africa

Day  $7 - 13^{th}$  July: Experimental Design – Application the newly learned knowledge either within your own projects or within a pre-identified framework

Day 8 – 14<sup>th</sup> July: Day of Departure

# Whom is the course focused for?

The course aims at first year PhD students with a focus on environmental sciences or a related discipline,

### Fees:

The course will be free of charge, including accommodation, catering as well as transfers from ILRI to Kapiti Research Station and return to Nairobi at the beginning and end of the course!

Students must organize for their own travels to Nairobi – support can only be given in exceptional cases. In case this is necessary, kindly indicate this in your application.



#### Lecturers:

Dr. Sonja Leitner – Mazingira Centre, ILRI – (Soil Sciences, Soil Ecology),

Dr. Svenja Marquardt – Mazingira Centre, ILRI – (Animal Nutrition),

Dr. Alice Onyango – Mazingira Centre, ILRI – (Animal Nutrition),

Dr. Lutz Merbold – Mazingira Centre, ILRI – (Biogeochemistry, Nutrient cycling at various scales, Eddy covariance),

Prof. Janne Rinne – Lund University - (Eddy covariance, Atmospheric physics),

Ph.D. Rebecca Hood-Nowotny – University of Life Sciences BOKU, Vienna – (Isotopes),

Dr. Francesco Fava – Sustainable Livestock Systems, ILRI – (Remote Sensing)

Dr. Njoki Kiahu – Sustainable Livestock Systems, ILRI – (Remote Sensing)

Additional lectures were given by Prof. Wolfgang Junkermann (Air Chemistry) and Stuart Barden (Commercial farmer in Central Kenya)



#### **Content of the lectures** 2

The training course was organized in order to cover the dominant agricultural productions system found in Africa (cropping systems, mixed-crop livestock systems, rangeland systems, smallholder to large scale farming systems) while also bridging scales by introducing different approaches on measuring greenhouse gas emissions (process to leaf to ecosystem to region to continental scale). Each day consisted of theoretical and practical courses allowing sufficient time for questions and discussion. Moreover, the course provided insights into simple, cheap and yet robust GHG quantification methods as well as state-of-the-art gold standard measurement techniques.

The first two days included a visit to ILRI's Mazingira (Swahili word for environment) Centre in Nairobi, Kenya – a state-of-the-art environmental and education facility in East Africa which was followed by a general overview session on the global cycles of carbon and nitrogen (Dr. Lutz Merbold). Following this, a whole day was spent on soil/manure greenhouse gas emissions which included the individual processes in the soil/manure contributing to GHG emissions and highlighting typical abiotic and biotic drives of these processes (Dr. Sonja Leitner). The afternoon of the second day was spent in the field where groups of three students each were taking their own GHG concentration measurements in the field using static as well as automatic greenhouse gas chambers. Following the sample collection and analysis, GHG fluxes were calculated and the data interpreted and discussed (Dr. Sonja Leitner).

The third day was purely focusing on the different methods (direct and indirect) of quantifying methane emissions from livestock, particularly ruminants. This topic was chosen, since livestock is the largest contributor to GHG emissions originating from agricultural sector in most African countries. Similar, to the second day, a set of theoretical lectures were given by Dr. Svenja Marquardt and Dr. Alice Onyango whom both have long-term experience in this field of research. Practical tasks were distributed across the day and included live weight measurements and bite tracking of individual animals as well as milk analysis using a portable analyser. All data were then integrated jointly in order to calculate individual animals' methane emissions.

Day 4 aimed at bringing the previous days topics together by introducing ecosystem-scale GHG emissions using the eddy covariance technique. The course involved the theory behind the eddy covariance (EC) technique given by Prof. Janne Rinne, its advantages and disadvantages and current application worldwide by Dr. Lutz Merbold as well as a visit to two EC sites which were recently set up by ILRI and its collaborators in two totally different agricultural productions systems (a large scale dryland crop farming system and a rangeland that is characterized by livestock and wildlife grazing). Insights into large-scale dryland farming were provided by Stuart Barden a commercial farmer in Kenya.

The following day, the students were able to go further up in scale with having a whole day being spent on different remotes sensing approaches. The courses were given by two experts, Dr. Njoki Kahiu and Dr. Francesco Fave, whom run the Indexed Based Livestock Insurance Program at ILRI. With this the students were not only able to hear about the different remote sensing approaches itself (Pros and Cons), but also to get insights into an everyday application of remote sensing for



pastoralists. In particular this included the assessment of rangeland productivity at larger scales and how such data can be linked to GHG emissions.

The following day aimed at tools that enable researchers to identify individual processes that contribute to GHG emissions, namely stable isotopes. The course encompassed all the theory about stable isotopes and was amongst other approaches taught with chocolate coated candies and beans. The practical part consisted on how to derive representative samples in the field and subsequent data interpretation from previously collected samples in Kenya.

The last day of the course was purely about the experimental design and how to formulate a precise research question. For this each student had to define a specific research question from their respective PhD projects and the whole group (students and lecturers) discussed jointly on how to improve the original research question. This activity also led to further developing existing ideas and some changes in the individual PhD projects.

Additionally, and during the course of the week each student had to present their own PhD project to the group. The participants were allowed to choose the medium they wanted to present on (ie slides, flipcharts etc.) and some chose to present in outside as can be seen in the impressions.

Feedback from the participants was extremely positive with a joint statement on "When is the next training"? and "Will such trainings be carried out regularly so that other colleagues can also profit"?

All lectures are available under:

https://1drv.ms/u/s!Agcpz\_WTsf8Pl5sY4PGJu6BYMtdpPw?e=GApvar

PW: mazingira



# 3 Impressions



Soil greenhouse gas emissions measurements using static chambers in the field.



Each student had to present their PhD project and this was done both in and outdoors with Kapiti Research Station offering some of the best lecture halls in Kenya (left and right).





Dr. Rebecca Nowotny-Hood enlightening the attendees on the power stable isotopes to identify biogeochemical processes and much much more (left). Students discussing individual results in the lecture room (right).



The training school participants showing their intellectual and physical commitment to the

SEACRIFOG project.

