GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES

CGIAR Mitigate+: Research for Low-Emission Food Systems

CLIFF – GRADS

Climate, Food and Farming Network

GRA Development Scholarships

Round 6 Call for Student Applications: Capability Building through Research Stays for Low Emission Agriculture

The CLIFF-GRADS Programme invites applications from PhD students from developing countries[1] for short term (4-6 months) scientific training and research on the measurement, modelling quantification and mitigation of greenhouse gas emissions, or carbon storage in agricultural systems relevant to developing countries (this may be in the context of enhancing food security).

The deadline for Round 6 CLIFF-GRADS student applications is the 28 August 2023.

Grants of $14,000 USD will be awarded to PhD students from developing countries for research stays that will be completed before the end of 2024.

Eligibility

Individuals applying for the Programme must be **citizens of developing countries**[1], be undertaking their **PhD in a University based in a developing country** and must not have previously been awarded a CLIFF-GRADS grant.

Preference will be given to students applying for opportunities outside their home country/ country of study to encourage the building of global networks and connections through this programme.

Background

The Climate, Food and Farming, Global Research Alliance Development Scholarships Programme (CLIFF-GRADS) is a joint initiative of the Global Research Alliance on Agricultural Greenhouse Gases (GRA) and the One CGIAR Mitigate+ Initiative on Research for Low-Emission Food Systems (Mitigate+). CLIFF-GRADS builds capability in early-career scientists from developing countries to conduct applied research in agriculture greenhouse gas emission quantification and mitigation.

[1] Applicants with passeports from countries listed as "low-income economies", "Lower-middle-income economies", "upper-middle income economies" and "Latin America and the Caribbean" by the World Bank https://datahelpdesk.worldbank.org/knowledgebase/articles/906519

In the first five rounds of CLIFF-GRADS, a total of 176 PhD students received grants, furthering their research skills and strengthening international agriculture emission research networks.

Application instructions

Applicants must complete the CLIFF-GRADS Round 6 online application form and submit the following necessary documentation merged into a single PDF file. Applications must be in English and applications that are in any other language will not be accepted.

a. 1 page motivation letter *(described below)*
b. 1-page academic curriculum vitae (CV / Resume) that includes your contact details
c. Letter of support from your PhD supervisor at your current university

Motivation Letter

Your motivation letter should be no more than one page (A4, 11 – point Calibri, single spaced with 2.54 cm margins on either side), and must include the following:

1. Your name, nationality and your PhD country
2. Objectives of your graduate research
3. The specific research opportunity or opportunities (up to 3) in order of preference to which you are applying *(see list below)*. Please list the research stay name and number.
4. Your qualifications to conduct research on greenhouse gas emissions and/or soil carbon storage in agricultural systems, relevant to the research opportunity for which you are applying for.
5. A description of how scientific training received under the CLIFF-GRADS Programme will improve your graduate research and contribute to your career.

Selection process

Successful applicants will demonstrate the relevance of their PhD research for the project to which they are applying to. Successful applicants will be matched with a project and notified by email by **September 21, 2023**.

Applicants are selected based on three criteria:

1. Overall level of research experience,
2. Relevance of PhD thesis topic or other research experience to CLIFF-GRADS objectives, and;
3. The clarity of description of how the CLIFF-GRADS experience will improve the student's scientific capability and contribute to their career.

Duration

CLIFF-GRADS research stays are expected to be a minimum of 4 months and a maximum of 6 months. Students and research supervisors are welcome to extend the stay by mutual agreement if additional funding is available to support a longer stay.

Related Opportunities

The GRA and Mitigate+ may organise webinars, workshops and other activities for capacity building. These opportunities will provide professional experience and serve as networking and communication platforms for CLIFF-GRADS students to share research and experiences with each other. CLIFF-GRADS students are not expected to use their funding for these opportunities.

Funding

Funding for this CLIFF-GRADS call is provided by the New Zealand Government, Ministry for Primary Industries and the CGIAR Trust Fund Donors, and contracts are administered by the Ryan Institute of the National University of Ireland, Galway.

Additional information

Programme coordinator: all enquiries relating to this call for applications should be directed to the cliffgrads@globalresearchalliance.org email address.

More information

CLIFF-GRADS: https://globalresearchalliance.org/library/cliff_grads-fellowship/

GRA: https://globalresearchalliance.org/

CGIAR Research Initiative on Low-Emission Food Systems: https://www.cgiar.org/initiative/low-emission-food-systems/

List of Research Stays

SOILS

1. Modelling of N2O and CO2 Emissions in maize-based cropping systems in Western Kenya

Keywords: CO2 and N2O emissions, DayCent, Modelling

Brief research stay outline:

Current reporting to the United Nations Framework Convention on Climate Change (UNFCCC) by most non-Annex 1 countries, including Kenya, is based on Tier 1 approach which relies on default IPCC emission factors. To develop a model-based approach for national reporting of N_20 emissions from agricultural soils, a well-calibrated and evaluated model for the cropping systems in Kenya would be needed.

The Alliance of Bioversity International and CIAT has been running two long-term experiments in Western Kenya that mainly focus on assessing the impacts of integrated soil fertility management and conservation agriculture practices on yields. Through these experiments, N_20 and CO_2 emissions for three distinct growing seasons have been collected and analyzed. In addition, soil organic carbon has been analyzed for a selected number of years from 2005 to 2015. These data sets provide a useful resource for calibrating and evaluating process-based models that can be used for tier 3 reporting of greenhouse gases emissions.

The research stay will involve measuring additional N_20 and CO_2 emissions in the two long-term experiments, calibrating and evaluating the DayCent model using all the available emissions data sets. The evaluated DayCent model will be applied in projecting the trend of the emissions under different climate change scenarios.

Desired technical skills and/or experience:

- Good understanding of the soil biogeochemical processes
- Modelling experience in soil carbon and greenhouse gases emissions
- Independent thinking and ability to solve problems.
- Field experience in greenhouse gases measurements
- Data management and evaluation skills
- Effective teamwork and interpersonal skills

Host Institution: CIAT, Kenya

The researcher will be based at the Alliance of Bioversity International and CIAT regional office for Africa in Nairobi with frequent field visits to Western Kenya to collect greenhouse gases in the long-term experiments.

Research Supervisor: Sylvia Sarah Nyawira

Start and end month: February 2024 – July 2024

Languages available: English

2. Soil carbon sequestration through diversified cropping systems

Keywords: sustainable cropping systems, stable isotope methods, GHG measurements, plant roots, field experiment

Brief research stay outline:

The project aims to better understand the impact of crop diversification on soil functioning and food quality. Furthermore, the potential synergies and tradeoffs arising from specific agricultural management systems are evaluated. The project is constructed around the central hypothesis that diversified cropping systems, due to their spatial and temporal niche complementarity, are more climate-smart and resilient cropping systems compared with monoculture systems.

Globally, climate extremes are projected to become more frequent and severe, and in the Nordic region spring droughts lead to a significant reduction in crop yields with negative economic consequences for farmers and society. The use of cover crops is a promising practice for enhancing net removal of atmospheric carbon dioxide, and crop diversification can further enhance soil carbon levels. Sustainable intensification, via practices such as crop diversification, is promoted by the EU Common Agricultural Policy reform. Adaptation of intercropping, cover crops and intraspecific diversity of cereal crops is attractive for farmers worldwide as it can easily be implemented at a low cost and leads to self-sufficiency.

The CLIFF-GRADS student will work with stable isotope methods to monitor GHG emissions and soil carbon sequestration in field and lab experiments. The systems studied in the project include increased intraspecific diversity of cereal crops with and without intercropping of legumes or cover crops.

Desired technical skills and/or experience:

- Having conducted research on carbon and nitrogen in soils
- Sampling in the field for soil, plants and GHG emissions
- Laboratory experience with soil, plants, or gas measurements
- Good skills in data analysis
- Good written and oral communication skills in a common language (English)

Host institution and location: Norwegian Institute of Bioeconomy Research, Ås, Norway

Research supervisor: Alice Budai, Dr., Norwegian Institute of Bioeconomy Research

Preferred duration of research visit: 6 months.

Start and end month of research stay: May through October 2024.

Languages available at the host institution: English and Norwegian

3. Refining Soil Conservation and Regenerative Practices to Enhance Carbon Sequestration and Reduce Greenhouse Gas Emissions (EJP-C-arouNd – Brazil)

Keywords: soil carbon persistence, agriculture intensification, sustainable development, nutrients cycling, carbon storage

Brief project outline:

The project C-around aims to investigate how short and long-term agricultural management practices affect SOM persistence in the soil profile. C-arouNd also aims to synthesize findings from a worldwide consortium of long-term agricultural field experiments with focus to contribute to inclusion of the effects in national inventories to inform policy to reduce net greenhouse gas emissions and mitigate global change.

The project C-arouNd was approved in late 2022 in European Joint Program, Second External Call, is formed by a consortium that include 37 long-term experiments with different agricultural management systems, distributed across 12 countries, in 4 of the 6 continents of the planet, comprising both North and South Hemispheres, with partners across Europe, South and North America, Africa, and New Zealand representing a wide range of pedoclimatic conditions. This transnational collaboration, involving the sharing of soil and management data, and other proximal data, is creating statistically meaningful data sets for helping to improve our understanding of mechanisms involved in C stabilization, while providing generalities within the soil-climate-management continuum. One of the C-arouNd goals is educating early-stage researchers in up-to-date methods of studying SOC sequestration and its side effects on various scales.

The research fellow will have the opportunity to train in flux measurement techniques, SOM fractionation, and familiarize with established and emerging concepts of SOC sequestration and persistence. @EJPSOIL @EJP_C_arouNd

Preferred student skills or experience:

- Expertise in lab analysis;
- Basic knowledge of excel;
- Writing science publications;
- Basic knowledge in statistical tools (as R, SAS, etc, for example).

Host institution and location: Brazilian Agricultural Research Corporation (Embrapa), National Rice and Bean Research Center (Embrapa Rice and Beans), Santo Antônio de Goiás, Goiás State, Brazil (16°30'13"S; 49°16'54"W).

Project leader and Research Supervisor: Mellissa Ananias Soler da Silva, PhD in Agronomy / Soil and Water, Embrapa Rice and Beans.

Preferred duration of research visit: 6 months

Preferred dates for research visit: February to July 2024 is preferable, but it could be moved to other dates during 2024, if necessary.

Languages available at the host institution: Portuguese, English

4. Long-term application of bone char application in high phosphorus fixing soils on mineral fertilizer induced N_2O emissions

Keywords: Acidic soil; Nitrous oxide; Phosphorous availability

Brief research stay outline:

It is apparent that the price of mineral fertilizer has risen dramatically and is expected to increase further in the near future owing to natural resource depletion and socio-political issues. Developing alternative phosphorus (P) fertilizers is therefore urgently needed to reduce farmers dependence on synthetic inputs, increase food production without exploiting the natural resources, and ensure farmers resilience to climate shocks.

Several studies have shown the importance of P fertilization to reduce fertilizer-induced N_2O emissions. Nevertheless, little is known whether alternative P fertilizers (i.e., bone char) reduces mineral fertilizer-induced nitrous oxide (N_2O) emissions after long-term application. This proposal is therefore aimed to investigate N_2O emission after long-term application of bone char and uncover the underlying mechanisms, using the permanent field plots commenced in 2012 at Jimma University research site (Ethiopia).

N_2O emission will be measured from maize fields that have been amended with (i) bone char, (ii) bone meal, (iii) mineral P fertilizer, (iv) bone char and mineral P fertilizer, and (v) bone meal and mineral P fertilizer since 2012. Chambers will be used to collect the gas samples, and the emissions will be quantified using either gas chromatography or Portable multi-gas analyzer. In addition, the student will perform incubation experiment to elucidate whether the bone char effect on N2O emission is related to its liming effect and/or P supply. At the end of this experiment, it is possible to determine whether: (i) long-term application of bone char reduces N_2O emissions, and (ii) N_2O mitigation potential of bone char in acidic soils is related to P supply and/or its liming effect.

Desired technical skills and/or experience:

- Basic knowledge in soil science or environmental sciences
- Practical experience in using gas chromatography or INNOVA
- Practical skill on incubation experiments
- Good communication and teamwork
- To work in intercultural environments
- Fluent in writing and speaking English

Host institution and location: Jimma University, Jimma, Ethiopia

Research supervisor: Abebe Nigussie (PhD, Assistance prof., Jimma University.

Preferred duration of research visit: 6 months

Start and end month of research stay April 2024 – September 2024

5. Greenhouse gas emissions from managed peatlands in Norway

Keywords: CO2, N2O, CH4, cultivated peatland, machine learning model, automatic chamber, soil carbon composition

Brief research stay outline:

The student will join the project "Monitoring, Reporting, and Verification of Soil Organic Carbon and Greenhouse Gas Balance" (MRV4SOC) under the Horizon Europe Framework Programme. The project aims to design a comprehensive and robust Tier 3 approach to estimate greenhouse gas (GHG) emissions and assess the results of traditional management practices and C farming in different ecosystems. MRV4SOC seeks to assimilate high-quality in-situ and remote sensing (RS) data into geostatistical and process-based models in 14 Demo Sites covering 9 land use/cover classes. As a partner of the project, NIBIO is running a Demo Site in a cultivated peatland in northern Norway to test how different water and fertilization management affect the greenhouse gas emissions. The project is linked to "The Peatlands Management Network" under the GRA research group "Croplands".

The CLIFF-GRADS student will be involved to setup and operate the automatic observation chamber system at the field site. At the same time, the student will also have hands-on opportunities to process relevant GHG flux datasets from the field and lab observations and analyze data using machine learning and causal models. The project also allows the student to work together and build connections with other scientists at NIBIO and collaborators across Europe.

Desired technical skills and/or experience:

- Experience of measuring gas flux using chambers.
- Basic knowledge of boreal peatland ecosystem
- Good English writing and speaking skills
- Familiar with the program R

Host institution and location: Norwegian Institute of Bioeconomy Research, Ås, Norway

Research supervisor: Dr. Junbin Zhao, Research Scientist, Norwegian Institute of Bioeconomy Research

Preferred duration of research visit: 6 months

Start and end month of research stay: May 2024 – October 2024

Languages available at the host institution: English, Norwegian, Chinese, French

6. Agronomic solutions to mitigate soil carbon losses in the agriculture-forestland frontiers

Keywords: Agronomic solution, soil carbon, deforestation, agricultural land

Brief project outline:

This activity is aligned with our five-year (2021 to 2025) NORAD funded project" REDD+ Participatory Forest Management (PFM)" being implemented in South-West (SW) Ethiopia. The overall aim of the project is to reduce and reverse forest loss through improving the rights and livelihoods of forest-dependent communities in SW Ethiopia.

Deforestation in the SW Ethiopia is mainly driven by land clearing for agricultural land expansion that tends to loss soil organic carbon and thus the available soil carbon in many of these agricultural fields are estimated to be much lower than in the neighbouring forest soils. The challenge on this point is to provide evidence-based solutions and mitigation strategies to reduce soil carbon loss due to agricultural deforestation on one hand and turning agricultural soil into a carbon sink on the other hand. Farmers are clearing forest and expanding farmlands, aiming to increase grain production and assure food security at household level and earn more incomes from agricultural commodities. This is going to be a continuous action at the study site unless otherwise appropriate strategies that reduce the rate of agricultural expansion and deforestation are being devised. One alternative strategy to this could be introducing a package of agronomic solutions (e.g., fertilization, improved crop variety, cover crops, tillage operation, double cropping, CSA technology, etc) that could sustainably increase productivity of agricultural soils and farmers' income, enhance agricultural soil organic carbon, and reduce greenhouse gas emissions.

There is limited empirical evidence on the interrelationship between agronomic interventions and reducing greenhouse gas emissions and its usage as a mitigation strategy. This project targets collecting dependable, and location specific data required to identify economically feasible, socially acceptable, and environmentally friendly agronomic solutions that best fit with the study site to mitigate soil carbon losses. Knowing the social, economic, and biophysical bases of the study site will also be determinant to identify the best available agronomic solutions and understand factors that hinder/promote the adoption of these agronomic solutions in the study site. The aim of this project is to identify and generate evidence-based agronomic solutions to soil carbon mitigation strategies on the agriculture-forestland frontiers in the Southwest Ethiopia.

The CLIFF-GRADS student could work together with us and our ground project implementer partner – Ethio-Wetland and Natural Resource Association (EWNRA).

Desired student skills or experience:

- Expertise in soil carbon measurement at the agricultural soils
- Basic knowledge of agronomic and socioeconomic data collection and analysis
- Basic knowledge of Geospatial data handling and analysis would be desirable
- Writing science publications
- Good English writing and speaking skills

Host institution and location: Alliance of Bioversity International & CIAT, Addis Ababa office, Ethiopia

Project leader/research supervisor: Dr. Getachew Tesfaye, Alliance of Biodiversity International & CIAT

Preferred duration of research visit: 6 months

Preferred dates for research visit: April 2024 to September 2024

7. Evaluating a potential pathway of nitrous oxide reduction to dinitrogen in agricultural soils

Keywords: Denitrification, Ferrous ion, Anaerobic condition, Nitous Oxide, Nitrate Leaching

Brief project outline:

Denitrification is a microbially mediated process and under complete anaerobic conditions leads to the reduction of nitrate (NO_3^-) to dinitrogen (N_2). Identifying specific soil conditions that facilitate this reduction is very crucial. The presence of ferrous ions (Fe^{2+}) under anaerobic conditions in soil could be responsible for the reduction of NO_3^- to benign N_2 during denitrification. Our previous lysimeter study has shown, a very significant effect of soil's inherent Fe^{2+} content on its N_2O emission (Abhiram et al., 2023). Our aim is to further study agricultural soils amended with different levels of Fe^{2+} concentrations and other amendments on their denitrification potential. The student will participate in soil incubation and lab column study to assess various soil conditions and amendments (fertiliser treatments, moisture levels, Fe concentrations, etc.) on its NO_3^- leaching and N_2O emission.

The results of this experiment will assist us to identify soils with naturally high capacity for reducing N_2O to benign N_2. This would also help us to detect the combination of soil and management practices to reduce NO_3^- leaching from common pasture soils with high Fe content. The student can benefit by learning techniques related to designing the soil incubation and column study, learning the techniques of gas sampling and analysis, and laboratory analysis of soil and leachate. This study will contribute to gaining new knowledge of mitigating the NO_3^- leaching and N_2O emissions from inherently high Fe-content soils.

Desired student skills or experience:

- A good understanding of nitrogen transformation processes on a grazed farm
- Familiarity of grazed pasture systems
- Skills to follow good laboratory practices
- Problem solving, decision making and team player

Host institution and location: Massey University, Palmerston North, New Zealand

Research Supervisors: Dr. Abhiram Gunaratnam, Uva Wellassa University, Sri Lanka; Dr. Neha Jha, Massey University, New Zealand; Dr. Paramsothy Jeyakumar, Massey University, New Zealand,

Preferred duration of research visit: 6 months

Start and end month of research stay: Feb 2024 to July 2024

Languages available at the host institution: English

8. Biochar and Organic Fertilization to Promote Greenhouse Gases Mitigation and Soil Health in Agroecosystems

Keywords: Soil organic matter, C sequestration, food security, soil fertility, crop production.

Brief project outline:

This project is focused on enhancing techniques to promote alternatives to mineral fertilization, including biochar fertilizers (N-enriched biochar) and the re-utilization of organic waste products. The activities of this project will directly support the development of Sinograin III, a new step of a long-term collaboration between NIBIO and the Chinese Academy for Agricultural Sciences (CAAS) funded by the Norwegian Ministry of Foreign Affairs through the Royal Norwegian Embassy in Beijing. Activities will also support the AgroComposit project, financed by the European Joint Program (EJP Soil).

Synthetic inorganic N fertilizers in agriculture are a major concern worldwide due to several economic and ecological problems caused by their excessive use. As N sources for inorganic fertilizers production are limited, alternative fertilization methods using organic sources are increasingly important for promoting sustainable agriculture. Therefore, our main goal is to create a climate-smart composite fertilizer product by co-composting various regional organic wastes with biochar. We aim to reduce waste production and greenhouse gas (GHG) emissions while increasing productivity, C storage, and soil biodiversity. We will combine experiments on different scales, including laboratory-scale incubation, greenhouse pot, and field experiments.

The CLIFF-GRADS student would work with the Department of Biogeochemistry and Soil Quality in NIBIO, mainly supervised by Dr. Thiago M. Inagaki and Dr. Eva Farkas. The student would also be in contact with an international group of project partners of Sinograin III and AgroComposite, which include researchers from Norway, China, Hungary, and Switzerland.

Preferred student skills or experience:

- Background in Agronomy, soil fertility, and related areas.
- Experience in measuring greenhouse gas emissions at the lab or field scale.
- Experience with general soil analyses
- Writing science publications
- Good English writing and speaking skills.

Host Institution and Location: Norwegian Institute of Bioeconomy Research (NIBIO). Department of Biogeochemistry and Soil Quality. Høgskoleveien, Norway

Project Leader/Research Supervisor: Thiago M. Inagaki

Preferred duration of the research visit: 6 months

Preferred dates for research visit: June 2024 to December 2024.

Languages available at the host institution: English

9. Co-compost with biochar as soil amendment in low-input cropping system

Keywords: Compost, biochar, bioslurry, co-compost, GHG measurement

Brief project outline:

This project aims to assess the effectiveness of compost made from a blend of cattle bioslurry, biochar, and garden waste as a soil amendment for boosting crop production and minimizing greenhouse gas (GHG) emissions in low-input cropping systems. Previous studies have shown that using biochar, compost, or cattle manure individually can improve soil fertility and reduce GHG emissions in crop fields. However, the co-composting of cattle manure, biochar, and garden waste could provide even more benefits, such as reducing pathogens, lowering GHG emissions during composting and from soil application, and creating a more nutritious soil amendment.

The project will have two activities:

1) Evaluate GHG emissions during compost preparation from cattle bioslurry and garden waste with or without biochar addition,
2) evaluate crop yield and GHG emissions from maize fields amended with different rates of biochar, compost, and co-compost with biochar.

Soil characteristics, crop yield, and GHG emissions, including CH_4, N_2O, and CO_2, will be directly measured using static chamber and lab analytical techniques. The student will be provided with the opportunity to participate in an ongoing project that focuses on circular farming systems.

Desired technical skills and/or experience:

- Experience of working in laboratory settings, field tests and use of GHG measurement techniques.
- Experience in data collection, management, processing, and analysis.
- Dedicated and organized with deadlines
- Used to writing scientific papers and reports
- Desire to learn and develop technical and personal skills
- Effective teamwork and interpersonal skills

Host institution and location: Arba Minch University, Ethiopia

Research Supervisor: Akiber Chufo Wachemo, Daniel Girma Mulat

Duration of research visit: 6 months

Start and end month of research stay: Flexible start date, however, preferably start in early 2024.

Languages available at the host institution: English

10. Investigation of biochar applications on C and N dynamics and the rhizosphere microbiome in agricultural peatlands.

Keywords: Peat soil, biochar, greenhouse gas emissions, priming, microbial community structure

Brief project outline:

Peatlands represent a larger carbon (C) sink than any other terrestrial ecosystem. Globally, peatlands have been exploited for agriculture, turning them from C sinks to C sources, contributing significantly to global greenhouse gas emissions and climate change. Raising the water table and applying organic amendments are potential strategies to restore C in peatlands.

An ongoing UKRI Greenhouse Gas Removal-Demonstrator project "Greenhouse Gas Removal by Accelerated Peat Formation" (https://www.ggrpeat.org) is assessing potential strategies to increase C accumulation through the management of the water table and the addition of organic and inorganic amendments to support greenhouse gas removal by agricultural lowland peatlands. As an organic amendment, biochar has been shown to improve soil's physicochemical properties and its microbial community and is a source of recalcitrant C that can be stored in the soil long-term. However, there has been little research on the effects of biochar applications on C and N dynamics and microbial-plant interactions in productive lowland agricultural peatlands.

This research aims to use laboratory-incubation experiments to investigate the effects of biochar application on C and N dynamics, greenhouse gas emissions, physicochemical and biological properties in agricultural peat soils. The CLIFF-GRADS student would have the opportunity to acquire skills in radioisotope tracing, DNA sequencing and greenhouse gas analysis techniques.

Desired technical skills and/or experience:

- Practical field and lab work experience
- Organized and meticulous
- Effective teamwork and interpersonal skills
- Basic knowledge of field of soil science and statistical analysis

Host institution and location: Soils and Ecosystems Research Group, Environment Centre Wales, School of Natural Sciences, Bangor University, UK.

Research supervisors: Dr. Jeewani Hemamali, School of Natural Sciences, Bangor University.

Duration of research visit: 6 months

Start and end month of research stay: March 2024 to August 2024

Languages available at the host institution: English

11. Greenhouse gas emissions from an organic vineyard in central Chile

Keywords: organic vineyard, reduced tillage, cover crop, nitrous oxide

Brief project outline:

During the research stay the student will collaborate with the activities of the TrueSoil project (https://truesoil-project.net), whose aim is to better understand the processes and drivers of soil C sequestration/persistence and GHG emissions across a wide range of climates, soils and agroecological practices. As part of this project, an experiment is carried out at an organic vineyard in Chile, where the effects of reduced tillage and the use of cover crops are being sampled to estimate their GHG emissions of CO_2, CH_4 and N_2O. Field measurements are performed bi-weekly using a Picarro analyzer.

The trainee is expected to help during field measurements of GHG fluxes and do post-processing analysis of data. Other activities to participate in during the stay is one campaign of biomass sampling and performing laboratory soil analyses. A summary of the results of the stay should be presented to the research group.

Desired technical skills and/or experience:

- Knowledge on agricultural systems
- Capacity to carry out field work
- Statistical analyses.

Host institution and location: Faculty of Agricultural Sciences, University of Chile, Santiago, Chile.

Research Supervisor: Jorge Perez-Quezada, Professor, Department of Environmental Sciences and Renewable Natural Resources, University of Chile.

Duration of the research visit: 6 months

Start and end month of research stay: June-November 2024

Languages available at the host institution: Spanish, English

12. Advanced Tools to Soil Carbon Sequestration Analysis from Agricultural Integrated Production Systems

Keywords: integrated crop-livestock-forest systems, soil C market, photonic techniques, LIBS, NIRS.

Brief project outline:

The Brazilian Agricultural Research Corporation (Embrapa- www.embrapa.br) has developed a relevant agenda on soil carbon sequestration and agricultural greenhouse gas mitigation. One of these recent results is based in photonic techniques to soil Carbon quantification (Villas-Boas, P.R. et al, 2020. - Eur. J. Soil Sci. 71, 805) to reduce cost analysis and have faster measurements than the reference method CHN analyser, to facilitate consolidation of soil C carbon market.

In this proposal, Ph.D. students have the opportunity to use laser-induced breakdown spectroscopy (LIBS) and Near Infrared Spectroscopy (NIRS) on soil C quantification analysis from long-term field experiments with agricultural integrated production systems. Also, laser-induced fluorescence spectroscopy (LIFS) will be utilized to evaluate soil organic matter stability (Tadini et al., 2021- Soil & Tillage Research 21, 105001). Embrapa Instrumentação Center is the home of Agri-photonic Brazilian National Laboratory (Lanaf) with several spectroscopies tools available (https://www.embrapa.br/en/laboratorio-nacional-de-agro-fotonica-lanaf).

There are several scientists with international experience in photonics, soil organic matter research and agricultural production systems, pos-docs, and PhD students that are members of Lanaf and able to teach and give all laboratorial support to those interested to be part of these advanced research activities.

Desired technical skills and/or experience:

- Soil sciences or environmental sciences or biology or chemistry or physics with interest to perform research on soil Carbon using photonics techniques.

Host institution and location: Embrapa Instrumentação Centre (www.embrapa.br/instrumentacao) , São Carlos, São Paulo State, Brazil.

Research Supervisor (name, title, affiliation, and email address): Ladislau Martin-Neto, PhD in Physics (USP-IFSC, Brazil) and Pos Doc in Soil and Environmental Science (UC Berkeley, USA), Embrapa Instrumentação

Start and end month of research stay: April to October, 2024

Languages available at the host institution: English, Spanish and Portuguese

13. Assessing soil nitrogen fluxes and GHG mitigation in integrated crop-livestock production systems

Keywords: Crop-pasture rotations, N use efficiency, modelling, soil C storage, long-term experiments

Brief project outline:

The aim of this Project is to contribute to nitrogen (N) use efficiency and soil carbon balance in crop-livestock production systems, reducing fertilizer needs, N export to surface and underground water, greenhouse gas (GHG) emissions and natural resources degradation. Specifically, N balance and its components will be assessed under a gradient of soil use and managements intensification alternatives in long-term experiments, varying from continuous grain cropping to pasture beef systems.

This Project contributes to build capacity at the regional level, providing local field data in South American production systems, and to develop assessment tools for soil use and management decision effects on N environmental fluxes, GHG emissions and carbon and N balances. Results will therefore contribute to policy development for climate mitigation actions and support countries nationally determined contributions implementation based on local data.

The CLIFF-GRADS student would work on field measurements, quantifying soil N2O flux, soil mineral N availability, and N leaching. Soil carbon and N balances will be assessed by applying biophysical simulation models, and observed data will be compared with model estimations. Depending on the interest of the student and data availability, data collection and analysis from more than one experiment and commercial farms may be possible.

Preferred student skills or experience:

- Expertise in measuring N fluxes and GHG emissions at the field level, in crop and beef cattle production systems
- Basic knowledge of biophysical simulation models is desirable but not essential
- Basic knowledge of Excel
- Writing science publications
- Language skills: good English writing and speaking, and basic Spanish is desirable

Host institution and location: Instituto Nacional de Investigación Agropecuaria (INIA), Treinta y Tres, Uruguay, in collaboration with INIA La Estanzuela in Colonia, Uruguay.

Research Supervisor: Dr. Virginia Pravia, Investigador Adjunto, INIA Treinta y Tres

Área RRNN, Producción y Ambiente, Programa de Investigación en Pasturas y Forrajes

Start and end month of research stay: April 2024 to September 2024

Languages available at the host institution: Spanish, English

14. Use of rhizobia to mitigate soil N_2O emissions

Keywords: Legume crops, rhizobia inoculation, N_2O mitigation, field measurement

Brief project outline:

This project contributes to the GRA flagship project " REDUCING N_2O EMISSIONS AND IMPROVING ACCOUNTING" (https://globalresearchalliance.org/flagship-projects/n-fertilisers/).

The use of rhizobial inoculants to mitigate N_2O emissions has been identified as an emerging option for mitigating N_2O emissions from food production by manipulating the soil microbiota. However, currently very few field scale results dealing with the use of rhizobia for mitigating soil N2O emissions have been reported. We have developed a multiscale approach (genotypic and phenotypic) to screen strains from culture collection and then detected legume-rhizobia associations capable of reducing N_2O on the field scale. This approach has been applied in a whole for soybean and partially for different legumes (Henault et al., 2022).

The aim of this project is to participate to two field experiments measuring N_2O emission mitigation thanks to the inoculation of a pea crop with a rhizobia symbiotic strain able to reduce N_2O. The first field experiment will be conducted in a farm in Burgundy and in this situation N_2O emission will be measured using the manual chamber method with a GC analysis of gas samples. The second field experiment will be conducted in a electrified experimental site and in this situation N2O emission will be measured using automatic chambers. Experiments will also include nodule characterization and N_2O abatment modeling parametrization.

Desired technical skills and/or experience:

- Field experiment experience
- Knowledge in soil science and biogeochemical cycles
- Microbial skills will be also appreciated
- Knowledge of Excel
- Writing science publications
- Good French or English writing and speaking skills

Host institution and location: UMR AgroEcologie, 21000 Dijon, France

Project leader/research supervisor: Dr. Catherine Hénault, INRAE

Preferred duration of research visit: 6 months

Preferred dates for research visit: April 2024 to September 2024

Languages available at the host institution: French, English

15. Assessing the effect of nanobiochar on soil carbon cycling and soil and plant health

Keywords: Biochar, carbon turnover, soil organic matter, greenhouse gas emissions

Brief project outline:

The application of biochar, the product of pyrolysis of organic biomass, to soil, is a method of potential carbon (C) sequestration, offsetting greenhouse gas emissions, to potentially mitigate the effects of anthropogenic climate change. This project contributes to the UKRI GGR-D project "Biochar Demonstrator Addressing Key Deployment Barriers for Carbon Sequestration" (https://biochardemonstrator.ac.uk/)

One of the aims of the project is to identify the impact of biochar application on soil and plant health. However, there may be additional co-benefits to applying biochar to soil. Nano-biochar (< 100 nm particle size) has been proposed as a potential method of novel fertiliser delivery, improving crop productivity. As, in theory, reducing biochar particle size increases surface area and therefore the number of surface functional groups and active sites (particularly for nitrogen (N) sources). This is likely to lead to lower rates of nitrate leaching and nitrous oxide emission. However, little emphasis has been put on the effect of nano-biochar on soil health, and the C balance of the system.

This project aims to assess the impact of nano-biochar and N saturated nanobiochar application in the agroecosystem through a series of laboratory-based assays, examining the response of soil biology, physicochemistry, as well as the C and greenhouse gas balance of the soil, and the impact on plant health.

The CLIFF-GRADS student would have the opportunity to acquire skills in radioisotope tracing, soil and greenhouse gas analysis.

Desired technical skills and/or experience:

- Expertise in laboratory analysis of soil
- Knowledge of soil-biochar interactions
- Basic knowledge of R
- Writing science publications
- Good English writing and speaking skills

Host institution and location: Bangor University, Bangor, Wales, UK

Research supervisor: Dr Robert Brown, School of Natural Sciences

Preferred duration of research visit: 6 months

Preferred dates for research visit: March 2024 to August 2024

Languages available at the host institution: English

16. Management of nitrogen fertilization to mitigate greenhouse gas emissions: environmental impact assessment

Keywords: Grassland, soil, mitigation strategies, farm-level

Brief project outline:

The growing world demand for food leads to an accelerated increase in agricultural production. Nitrogen (N) fertilization is an alternative to maximize productivity and enhance the quality of pastures, which in turn, impacting better meat quality. However, when plants do not absorb the N, it remains available in the soil with the risk of environmental contamination by leaching into bodies of water and greenhouse gas (GHG) emissions from the soil. Therefore, an option to reduce GHG emissions (especially nitrous oxide) is to increase N use efficiency by focusing on N application to soil. Such efficiency can be increased by modifying the form of the fertilizer applied (organic or inorganic) to the soil or by applying the fertilizer together with other products (nitrification inhibitors, Zeolites, bio-carbon).

This project aims to generate capacities and advance knowledge to find N fertilization alternatives to mitigate GHG production from the soil. For this, it is proposed to carry out an integrative analysis of the effect of the application of organic and inorganic fertilizers, alone and applied with other products to the soil; and evaluate the effect on physical, chemical, and biological soil properties and mainly in the GHG emission. Activities include soil and GHG sampling, calibration of methodological gas sampling techniques, laboratory analysis, analysis, and discussion of results.

This study will provide advances in knowledge for decision-making on N fertilization alternatives and their potential to reduce environmental impacts.

Preferred student skills and/or experience:

- Expertise in GHG emission measurement from soil
- Independent thinking and ability to resolve problems
- Effective teamwork and interpersonal skills
- Basic knowledge of Excel
- Statistical analysis of the data
- Writing science publications
- Basic Spanish skills are desirable

Host institute and location: National Institute of Agricultural Technology (INTA), Buenos Aires, Argentina

Research supervisor: Vanina Cosentino (PhD in Agricultural Sciences, INTA); Marcelo Beltran (PhD in Agricultural Sciences, INTA); Romina Romaniuk (PhD in Agricultural Sciences, INTA)

Preferred duration of research visit: 6 months.

Preferred start and end month of research stay: July to December 2024

Languages available at the host institution: English, Spanish

17. Mountain grassland soil organic carbon sequestration

Keywords: grassland, mountain, fertilization, productivity, soil C sequestration

Brief project outline:

Grasslands supply ecosystem services like feedstock production and erosion control that are tightly connected to soil organic carbon (SOC) stocks and their turnover processes, while supporting a high biological diversity. Because the huge SOC stock of grasslands also contributes substantially to the terrestrial greenhouse gas sink, pastures and meadows are coming into the focus of scientific attention.

Despite their importance, the mechanisms that connect ecosystem nitrogen availability, plant productivity and the soil C budget, are only poorly understood. Most research focusses on the SOC budget of cropland monocultures. These are difficult to interpret because the plowing frequently disturbs biological processes. They are also unsuitable for generalization because the productivity response (primary source of SOC) of genetically homogenous crops is not representative for the diverse plant community found in grasslands.

In a multitude of grassland management experiments in the Swiss mountains, we investigate ecosystems that have received very conservative treatments for decades. Thus, these systems are in a steady state, where the most important discontinuous factor is the differences in the annual weather.

In an ongoing study, the candidate is invited to work on the question whether or not increased N fertilization favors SOC sequestration via increased plant productivity (higher C input from organic material) or reduces SOC sequestration via increased decomposition through less N-limited microbiota.

Research skills to be acquired include net ecosystem CO_2 exchange (NEE) measurements and establishing an NEE balance. Also soil C content analysis and soil density fractionation will be applied.

Desired technical skills and/or experience:

- Background on soil organic C cycling
- Robust enough to work long hours at the field site during measurement campaigns
- Some experience with measurement instrumentation handling
- Tidy working in the soil lab
- Data management and evaluation skills, basic statistic

Host institution and location: Climate and Agriculture Group, Agroscope, Zurich, Switzerland. Agroscope is the Swiss Federal Research Institute for Agriculture.

Research supervisor: Matthias Volk, PhD., Senior Scientist

Start and end month of research stay: Six month between March and October 2023

Languages available at the host institution: English

18. Soil organic carbon stock on Spanish agricultural soil: Temporal change over the last 20 years

Keywords: agricultural systems, modelling, Soil carbon sequestration, Spatial and temporal variation

Brief project outline:

In past decades many regions in the world have suffered permanent SOC loss. These changes in land use have been responsible for about 140 Pg C being released between 1850 and 1990. In recent decades, carbon sequestration in soil has been promoted to mitigate CO_2 emissions. One of policymakers' objectives in 4per1000 project is to implement soil management techniques to increase organic C inputs and to reduce soil organic carbon losses, such as application of organic waste, reducing tillage intensity, leaving crop residue, including crop rotation and cover crops, and proper irrigation management. On the other hand, land abandonment has been indicated as the main potential to carbon sequestration in soil, but this potential for carbon sequestration is a finite process.

The main goals of this Research Stay Proposal are i) analyse the spatial variability of soil organic carbon in relation to the influence of land use and land management on entire surface of the Community of Madrid (CAM); ii) assess the temporal changes in soil organic carbon in agricultural soils after 20 years under Mediterranean climate. CAM presents a great variability in lithologies and edaphic characteristics that can be a reference when considering extrapolating results to the rest of Spain. Supported by those projects, the student could increase his/her knowledge about Mediterranean agricultural systems, soil sampling and laboratory analysis.

This proposal includes field sampling, laboratory analyses and geostatistics modelling work.

Desired technical skills and/or experience:

- Basic experience with large databases
- Basic experience in field and laboratory.
- Independent thinking and ability to resolve problems
- Organized and meticulous
- Effective teamwork and interpersonal skills
- Basic Spanish skills are desirable but not essential

Host institution and location: Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria, INIA-CSIC, Madrid, Spain.

Research supervisor: José A. RODRÍGUEZ MARTÍN and José L. GABRIEL, INIA-CSIC.

Start and end month of research stay: 6 months, adaptable from January 2024 to June 2024.

19. Effects of livestock grazing management on soil carbon sequestration

Keywords: soil carbon sequestration, natural climate solutions, carbon ranching, livestock

Brief project outline:

Rangelands are the most widespread terrestrial biome in the world, but little is known about how livestock management decisions (*e.g.* timing and intensity) affect soil carbon sequestration. We have initiated a factorially designed field experiment testing the effect of grazing intensity (moderate, severe) with grazing season (June, October/November).

Experimental paddocks (60 × 30 m, 20 total paddocks) were arranged in a grid in a randomized complete block design with 5 replications ([2 grazing intensities × 2 grazing seasons × 5 replications] + 5 ungrazed controls = 25 sampled areas) in a northern mixed-grass prairie. Cattle (*Bos taurus*) grazing intensities approximated recommended (*i.e.* moderate; 1 AUD/ha) and severe (1.5 AUD/ha) stocking rates, with an estimated 656 and 309 kg/ha of post-grazing residual standing biomass, respectively. Soil cores were collected pretreatment in 2013, 2018, and will be collected in 2024. Samples will be used to estimate soil organic carbon (kg/m^2 to 60 cm depth), test for treatment effects, and guide recommendations to land managers.

Previously, we reported short-term effects of grazing season and grazing intensity treatments on soil carbon sequestration (https://www.sciencedirect.com/science/article/pii/S0016706122003688).

Desired technical skills and/or experience:

- Data collection,
- Data analysis, and possibly additional analyses of a related dataset (i.e. spatial analysis, sampling intensity)
- Background in soil science (or related fields),
- Statistical skills,
- Pro-active attitude.

Host institute and location: USDA-ARS, Fort Keogh Livestock & Range Research Laboratory, Miles City, MT USA

Research supervisor: Dr. Kurt Reinhart, kurt.reinhart@usda.gov

Preferred duration of research visit: 6 months

Preferred dates for research visit: between March 2024 and December 2025.

RICE

20. AI-enabled satellite remote sensing for estimation of emissions intensity of rice cropping systems under different CSA mitigation approaches.

Keywords: rice, emissions, satellite remote sensing, machine learning, neural networks, CSA

Brief project outline:

The visiting PhD student will join the ongoing TAPAS project which is using AI-enabled satellite remote sensing for measurement of crop growth cycles, with a particular focus on rice systems in collaboration with CGIAR (Alliance Bioversity-CIAT). Using the TAPAS satellite-remite sensing prototype system combined with ground-truth data obtained from CGIAR (MITIGATE+, AMD, IRRI e.g. RIICE project and national partners), the student will estimate the emissions intensity differences between different rice cropping systems to assess the relative contribution of (a) varieties e.g. hybrids vs OPVs, NUE varieties (b) nutrient regimes e.g. urea deep placement (c) cropping systems e.g. AWD and (d) different irrigation regimes.
The research will be conducted in partnership with MITIGATE+, AMD and IRRI. The research will contribute to the Science Foundation Ireland (SFI) funded TAPAS project, which is led by Uni of Galway in partnership with Bioversity Alliance-CIAT.

Desired technical skills and/or experience: Satellite remote sensing, ArcGIS, R studio, life cycle analysis, machine learning, statistics, programming, climate, and crop modelling.

Host institution and location: Agriculture, Food Systems and Bioeconomy Research Centre, Ryan Institute, University of Galway, University Road, Galway H91 REW4, Ireland. www.ryaninstitute.ie

Research supervisor: (name, title, affiliation, and email) Dr. Peter McKeown, Agriculture, Food Systems and Bioeconomy Research Centre, Ryan Institute, University of Galway, University Road, Galway H91 REW4, Ireland.
& Prof. Charles Spillane, Agriculture, Food Systems and Bioeconomy Research Centre, Ryan Institute, University of Galway, University Road, Galway H91 REW4, Ireland.

Start and end month of research stay: (must be before end of 2025): Anytime from Jan 2024

Languages available at the host institution: English

21. Effect of green manure in Costa Rican rainfed rice system on soil erosion and nitrogen mineralization

Keywords: Erosion, green manure, 15N, N2O, rice

Brief project outline:
Rice plays a crucial role in ensuring food security in Costa Rica. Currently, the rice sector is implementing the NAMA-rice of Costa Rica as a strategy to reverse the decline in rice production in the country, and a key aspect is the incorporation of green manures into the annual cycle of rice. Therefore, it is relevant to investigate the effect of the incorporation of green manure on profitability and productivity as well as issues like erosion, N-mineralization and carbon sequestration, aspects currently unknown in Costa Rican rice crop.

The student would conduct an experiment to compare three different green manures against usual commercial practice in a rainfed rice system. The intern will participate in a field trial to measure soil carbon lost due to erosion. Also, the student will carry out incubations of treated soil to monitor and model $^{15}N_2O$ emissions and the rate of organic mineralization and nitrification. Additionally, the student will learn about constructing static chamber, measuring greenhouse gases fluxes and carbon sequestration. The proposed internship also includes laboratory work and learning about modern equipment such as isotopic analyzers and cavity ring-down spectrometers.

As part of the International Coordinated Research Project Developing Climate Smart Agricultural practices for carbon sequestration and mitigation of greenhouse gases (CRP D1.50.20 IAEA-FAO), this research will provide new knowledge about the effects of different green manure species on the mitigation of Costa Rican rice carbon footprint. Finally, it is expected that the results will be published in a paper.]

Host institution and location: [Universidad de Costa Rica, Montes de Oca, San José, Costa Rica]

Research Supervisor (name, title, affiliation, and email address): [Ana Gabriela Pérez Castillo, Coordinator Laboratory of Greenhouse Gases and Carbon Sequestration, Center for Research on Environmental Pollution.

Preferred duration of research visit: 6 months

Start and end month of research stay: March 2024-August 2024

Languages available at the host institution: English, Spanish

22. Measuring, modelling and mitigation of GHG emissions from rice cultivation through agronomic strategies

Keywords: Greenhouse gas emissions, measuring, modelling, mitigation and rice

Brief project outline:

Greenhouse gas (GHG) emissions from agriculture sector play an important role for global warming and climate change. Thus, it is necessary to find out GHG emissions mitigation strategies from rice cultivation. The efficient agronomic strategies could mitigate greenhouse gas (GHG) emissions and reduce environmental pollution. This project contributes to GRA/Mitigate project "Measuring, modelling and mitigation of GHG emissions from rice cultivation through agronomic strategies". The aim of the project is to measure the GHG emissions from rice field, modelling for future prediction/sustainability, identify the most cost-effective options for farm-level GHG mitigation strategies and provide evidence-based policy recommendations.

A detailed measuring, modeling, calibration and mitigation strategies of agricultural GHG remains a challenge in global climate research. The costs of implementation, measuring, analysis and realization of GHG mitigation strategies at the farm level are not yet well-known. Furthermore, the data needed to calibrate model is often not available or not comparable. Countries urgently need cost data to make decisions on climate mitigation measures and funds required for best implement their nationally determined contributions (NDCs).

This project aims to measuring, modelling and mitigation of GHG from rice fields to tackle burning climatic issues. It will investigate the feasibility and cost-effectiveness of GHG mitigation strategies at the farm level. It aims to identify the most cost-effective agronomic strategies, technology options and to reduce possible barriers in order to adopt evidence-based policy recommendations on GHG mitigation strategies.

Student skills or experience:

- Expertise in GHG emission measurement at the farm level in rice cultivation systems
- Modeling for GHG emissions
- Expertise in statistical analysis, excel, data collection, data manipulation, data visualization
- Writing science and policy publications
- Effective leadership and teamwork skills
- Good English writing and speaking skills

Host institution and location:
Department of Agronomy, University of Agriculture, Faisalabad Pakistan

Host research supervisor: Dr. Khalid Hussain, Associate Professor at University of Agriculture Faisalabad, Pakistan

Preferred duration of research visit: 6 months

Start and end the month of research stay: June to December, 2024

Languages available at the host institute: English and Urdu

23. Achieving low greenhouse gas emissions in non-flooded rice system through hybrid selection and N management

Keywords: rice, furrow irrigation, N fertilizer, CH4, N2O, CO2

Brief project outline:
Rice paddies are one of the major sources of anthropogenic methane (CH_4) emissions. Non-flooding practice has been shown to reduce CH_4 emissions but can increase N_2O emissions and yield loss if water and fertilizer N are not appropriately managed together. Additionally, several studies have shown hybrid rice cultivars reduced CH_4 emissions while sustaining high grain yields. The practice of furrow irrigation combined with high yielding hybrid cultivars and effective N fertilization may reduce greenhouse gas (GHG) emissions and yield penalty in rice system. This study will be conducted in two field trials in Northeast Arkansas (USA) to assess the mitigating potential of hybrids and fertilizer N on GHG emissions and yield loss. Main plots will be irrigation practice (continuously flooded vs furrow irrigation) and sub-plots will be four cultivars and two N fertilizer treatments. GHG emissions will be measured using flux chamber method. Grain yield and GHG emissions from various cultivar and N treatments with furrow irrigation will be compared with continuously flooded rice irrigation. This study will show mitigating potential of hybrid cultivars and N fertilizer in non-flooded rice. Also, datasets generated from this study can be used to validate GHG model validations and emission factors in rice systems.

Host institution and location: Delta Water Management Research Unit, United States Department of Agriculture, Agricultural Research Service

Research Supervisor Arlene Adviento-Borbe, Research Agronomist, DWMRU, USDA-ARS.

Start and end month of research stay: April to September 2024

Languages available at the host institution: English, Filipino

24. The Effects of Pyramiding Bacterial Blight Resistance Genes on Root-Associated Methanotrophs

Keywords: Rice, methane emission, methanotrophs, plant defense genes

Brief project outline:
Rice cultivation is one of the major contributors of methane emissions accounting for 10% of the total global methane emissions. Rice planting is done in flooded fields which promotes anaerobic conditions thereby promoting anaerobic microbial communities such as methanogens to proliferate. The activity of methanogens can be counteracted by another microbial community in the soil: the methanotrophs. These are aerobic to micro-aerophilic bacteria which can oxidize and utilize methane. Naturally, plants can recruit microorganisms at the vicinity of its roots through root exudates and other recruitment factors.

Gene pyramiding is defined as the process of stacking two or more genes from multiple parents and introducing them into a single genotype to produce elite lines or varieties. This strategy has been used to develop rice lines with desirable agronomical traits and at the same time possessing disease resistance against pathogens such as *Xanthomonas* oryzae (bacterial blight) and *Magnaporthe grisea* (rice blast). These resistance genes vary in protein structures and functions. There are proteins that could facilitate signaling cascades, transport sugars, and hypersensitive response. Consequently, introduction of multiple genes could influence the ability of the resulting pyramided line to recruit different set of microorganisms in the soil.

In this study, we will explore a possible relationship between increased plant immunity against bacterial blight of rice due to the introduction of multiple genes in one genotype with methanotrophic community in the rhizosphere. Our hypothesis is with the introduction of resistance genes, there could be changes in terms of recruited microorganisms due to possible alteration in the composition of root exudates or reception of certain microorganisms due to introduction of cell wall receptor kinases. This could ultimately influence the levels of methane emission of the pyramided line.

Understanding the influence of plant defensive genes on the recruitment of methanotrophs and the methane emission will enable the development of disease-resistant and low methane-emitting rice varieties.

Preferred student skills or experience:

- Basic Knowledge in plant microbiome
- Knowledgeable in plant pathology and disease resistance genes
- Expertise in GHG emission measurement at the field or greenhouse
- Basic knowledge in R studio
- Excellent scientific writing skills
- Good English writing and speaking skills

Host institution and location: International Rice Research Institute, Philippines

Project leader/research supervisor: Dr. Van Schepler-Luu, lead plant pathology and Host plant resistance group

Preferred duration of research visit: 6 months

Preferred dates for research visit: Feb 2024 to July 2024

25. Tier 2 methane and nitrous oxide emission factors from rice cropping systems in Colombia and validation of mitigation strategies.

Keywords: rice, GHG, Tier 2, mitigation strategies

Brief research stay outline:
This project contributes to the CGIAR initiative MITIGATE+, and the Green Climate Fund Project "Climate-smart initiatives for climate change adaptation and sustainability in prioritized agricultural production systems in Colombia (CSICAP)". The project aims to quantify Tier 2 greenhouse gas emission factors in the rice cropping system in Colombia and validate mitigation strategies.

The agricultural sector is the second largest source of greenhouse gas (GHG) emissions in Colombia, accounting for 30% of total emissions. Emission sources in the agricultural sector include enteric fermentation produced by livestock, manure handling, rice cultivation, and the use of synthetic fertilizers. Colombia is committed to reducing GHG but currently has limited information on GHG emissions baseline and low-carbon technologies. Information is needed to improve national inventories and implement programs to minimize GHG emissions in rice cultivation. In this regard, it is necessary to collect primary and local data on GHG emissions by characterizing conventional production systems and alternative mitigation scenarios, including water management, efficient fertilizer use, and low-emission planting materials. Quantification of Tier 2 EF includes i) Identifying production typologies; ii) Implementing productive plots to monitor conventional system vs. mitigation alternative; iii) Collecting information on activity data; iv) Installation and monitoring static chambers to collect soil emission.

This project aims to fill the data gap in the GHG National Inventories by providing GHG emission factors to the national authorities to improve reporting and national mitigation strategies for rice crops. The CLIFF-GRADS student would work together with one National Rice Grower Federation in Colombia (Fedearroz).

Desired technical skills and/or experience: interest in agro-food systems and climate change mitigation strategies, expertise in GHG emission measurement at the farm level, basic knowledge of Excel and R, writing science publications, good English writing and speaking skills.

Host institution and location: Alliance Bioversity International and International Center for Tropical Agriculture, Palmira, Colombia.

Research supervisor: Miguel Antonio Romero Sanchez, Research Fellow, Alliance Bioversity International and International Center for Tropical Agriculture.

Start and end month of research stay: Flexible.

Languages available at the host institution: English, Spanish

LIVESTOCK SYSTEMS

26. Development of farm typologies and emission factors for enteric fermentation and manure management to support Tier 2 methodology development of governments

Keywords: Livestock, greenhouse gas emissions

Brief project outline:
The project aims to develop farm typologies and emission factors for enteric fermentation and manure management in livestock systems, which can be used to support Tier 2 methodology development and update of governments East African governments.

The objective of this study is to develop farm typologies and emission factors for enteric fermentation and manure management. The project will leverage farm activity data collected under previous and on-going projects by the International Livestock Research Institute's Mazinigra Centre in Kenya. The student can conduct the analysis on livestock species (cattle or small ruminants) and systems (smallholder or pastoral systems) that they are most interested in.

The selected student will determine farm typologies. The analysis can be based on livestock species (cattle or small ruminants), systems (smallholder or pastoral systems) and countries (Kenya, Ethiopia, Uganda, Burkina Faso) that the student is most interested in. Emission factors for enteric fermentation and manure management systems will be calculated using Intergovernmental Panel on Climate Change (IPCC) Tier 2 methodology. Findings will be summarized in a manuscript.

The CLIFF-GRADs student will work with the Mazingira Centre, Todd Rosenstock from CIAT and Andreas Wilkes form NZARGC, as well as with local stakeholders and governments.

Preferred student skills or experience:

- Expertise in GHG emission measurement at the farm level in cattle production systems
- Basic knowledge of statistical analysis using software such as R
- Basic knowledge of Excel
- Writing science publications
- Proficient English writing and speaking skills

Host institution and location: Mazingira Centre, International Livestock Research Institute (ILRI), Kenya

Project leader/research supervisor: Claudia Arndt, Senior Scientist & Team Leader of the Mazingira Centre, ILRI

Start and end month of research stay: Flexible

Languages available at the host institution: English

27. Evaluation of the mitigation potential and feasibility of silvopastoral practices in rural Lao PDR

Keywords: Livestock, land use change, GHG emissions, farm-level, socio-economic analysis

Brief project outline:
The objective of the research stay is to quantify GHG emissions and sinks in silvopastoral systems in Northern Laos and evaluate the impacts of locally relevant silvopasture practices on GHG sinks.

Cattle rearing is increasing in Laos due to growing regional market demand, improved infrastructure and physical market access, coupled with favourable government policies and trade agreements. Cattle rearing offers alternative livelihoods to farmers who struggle with increasingly variable weather, declining crop yields and farm labour shortages. Nevertheless, livestock expansion – without policy restrictions and technologies for sustainable intensification – also drives forest clearing, GHG emissions from land use change and animals' metabolic processes, and erosion risks on the steep highlands.

Silvopasture is recognized as a key opportunity for reducing GHG emissions from crop-livestock systems, and pilot studies in Colombia show that well managed silvopastoral systems can even be net GHG sinks. Silvopasture is well aligned with Lao government's green growth agenda and NDC targets on increasing forest and tree cover and is already promoted in provincial strategies. However, the potential of silvopastoral systems to mitigate climate change has not been quantified which hinders policy implementation and opportunities to participate in carbon markets. At farm level, information is lacking on how to design and establish silvopastoral systems with rural households so as to optimize the use of scarce resources (labour, land, cash) for increasing productivity and carbon sinks.

The CLIFF-GRADS student will collect data on land use, animal and crop management data in mixed crop-livestock, pastoral and silvopastoral systems. Using the CLEANED model (https://ciat.cgiar.org/ciat-projects/environmental-assessments-of-livestock-systems-using/), the student will evaluate the baseline carbon footprint of the different livestock production systems and estimate the potential of selected silvopasture practices (e.g. tree and forage species selection, tree densities, and planting techniques, to reduce crop-tree competition and grazing damage) to contribute to carbon sinks in Northern Laos. In addition, the student will evaluate the feasibility of the practices for smallholder adoption through a socio-economic analysis at different scales, including analysis of mid-term costs, benefits and capacity for initial investment; and complementarity with overall household resources (land, labour, capital) and livelihood strategies. Implications of these economic incentives for intensification and risks of expansion will be assessed. Depending on student interest, she/he can also contribute to a complementary remote sensing analysis of land use changes driven by livestock expansion in the study area. The proposed project is part of the OneCGIAR Initiative on Sustainable Intensification in Mixed Farming Systems (https://www.cgiar.org/initiative/mixed-farming-systems/). The student will work as part of an international research team with multi-disciplinary expertise and will gain experience in research design, field research, data analysis and writing scientific articles.

Preferred student skills or experience:

- Expertise in measuring and analysing farm-level GHG emissions in cattle production systems
- Experience in conducting and analysing socio-economic field surveys
- Knowledge of remote sensing or other spatial analysis methods is preferred
- Basic knowledge of agroforestry/forestry/silviculture is preferred
- Fluency in speaking and writing English
- Professional awareness: initiative, organizational skills, cultural sensitivity

Host institution and location: Alliance of Bioversity International and CIAT, Laos Country Office, Vientiane, Lao PDR

Project leader/research supervisor: Dr Riina Jalonen, Scientist, and team of subject matter experts available at the Alliance

Preferred duration of research visit: 6 months

Preferred dates for research visit: January to June 2024

Languages available at the institution: English, Lao, Spanish

28. Marginal Abatement Cost Curve of livestock production in East Africa

Keywords: Livestock, mitigation strategies, farm-level, MACC

Brief project outline:
Livestock play a crucial role in the livelihoods of people in many regions of Africa, providing a source of income, food, and nutrition, as well as draft power and manure for crop fertilization. However, livestock systems are also a major contributor to GHG emissions in most African countries, accounting for around 33% of all emissions on average.

The objective of this research project is to conduct a Marginal Abatement Cost Curve (MACC) analysis for a ruminant livestock species (e.g., cattle, sheep, or goats) in an East African country (e.g., Kenya, Ethiopia, etc.) to identify the most cost-effective mitigation options and provide evidence-based policy recommendations. The project will leverage farm activity data collected by the International Livestock Research Institute's Mazinigra Centre in Kenya under previous and on-going projects, such as the Programme of Climate Smart Livestock and the Climate-Smart Agropastoral Ecosystem Transformation In East Africa. The MACC analysis can be done on livestock species (cattle or small ruminants) and systems (smallholder or pastoral systems) that the student is most interested in.

The selected student will calculate farm emissions using typologies and feed baskets that were derived from the collected activity data by the Mazingira Centre using Agrecalc, GLEAM-i or another appropriate tool. They will also determine effective mitigation strategies and associated costs by conducting stakeholder consultations or workshops. Once all the data have been collected, the student will investigate the feasibility and cost-effectiveness of GHG mitigation strategies at the farm level. They will summarize their findings in a draft manuscript under the guidance of the research team.

Overall, the project aims to identify the most cost-effective mitigation options in Eastern African livestock systems. It will generate information that provides evidence for countries to make informed decisions on which climate mitigation measures to support and fund to best implement their nationally determined contributions (NDCs).

The CLIFF-GRADs student will work with Bangor University, the Mazingira Centre, and local stakeholders and governments.

Preferred student skills or experience:

- Expertise in GHG emission measurement at the farm level in cattle production systems
- Advanced knowledge of Excel and R
- Basic knowledge of economic analysis at the farm level in cattle production systems is desirable
- Strong writing science publications
- Proficient English writing and speaking skills

Host institution and location: Bangor University

Project leader/research supervisor: James Gibbons

Preferred duration of research visit: 6 months

Preferred dates for research visit: Flexible

29. On-farm assessment of emissions in pastures part of the NAMA program for livestock in Costa Rica

Keywords: Biomass, rotation, grazing, intensification, sustainability

Brief project outline:
This project will consist of on-site assessments of GHG emissions in pastures together with a characterization of the management practices implemented by livestock producers who are enrolled in the NAMA livestock program in Costa Rica. To assess the emissions of GHG, our team at the University of Costa Rica has two portable chambers to measure CO_2 (Department of Animal Sciences) and CH_4 (Department of Agronomy) in-situ. Besides the assessments of GHG with the chambers, the person will collect data about the management of the pastures (rotation, fertilization, chemical and physical analyses, stocking rate, stocking density), agronomic traits (biomass pre and post-grazing, canopy height, plant components [leaf, stem and dead material]) and type of livestock (live weight, daily gain or milk production, supplementation) that will be used to estimate the GHG of N_2O with the IPCC method. The data collected will complement the whole analysis to develop a model to assess the impact of the guidelines given to livestock producers that are part of the NAMA in the GHG emissions in pasturelands.
In case of being selected, this project will be registered in the Research Office of the University of Costa Rica, where the PI has developed numerous projects (researcher profile).
With this proposal, we aim to provide recommendations for the NAMA livestock program.
The CLIFF-GRADS student would work with researchers from UCR and extension agents from the Ministry of Agriculture.

Preferred student skills or experience:

- Experience with portable chambers to measure GHG at the farm level in cattle production systems
- Expertise collecting samples in pastures.
- Strong background in statistics to develop multiple regression models.
- Basic knowledge of Excel
- English writing and speaking skills for both general public and science publications.

Host institution and location: University of Costa Rica, San José, Costa Rica

Project leader/research supervisor: Dr. Luis A. Villalobos V, Department of Animal Sciences and Research Center for Animal Nutrition at the University of Costa Rica.

Preferred duration of research visit: 6 months

Preferred dates for research visit: May 2024 to October 2024

30. The effects of seasonal wetlands on greenhouse gas emissions in tropical sub-Saharan Africa

Keywords: livestock grazing, seasonality, methane, nitrous oxide

Brief project outline:

Wetlands are important sources of methane (CH_4) at the landscape level. At the same time, they store large amounts of soil organic carbon (SOC). In seasonal wetlands in sub-Saharan Africa (SSA), the water table will decline in the dry season, allowing the wetland to be used for agriculture such as livestock grazing. This will reduce CH_4 fluxes but may lead to large fluxes of nitrous oxide (N_2O) and CO_2 due to animal excreta input. In the rainy season, the water table will rise again, and wetlands return to inundation. The still existing excreta from the grazing are now becoming carbon sources for CH_4 production. Despite the relevance of these seasonal wetlands for GHG budgets, GHG measurements for the pan-tropics and particularly SSA are scarce.

In this study, seasonal wetlands in Southern Kenya will be selected, and GHG fluxes will be measured with static chambers in the dry season and floating chambers when the wetlands are flooded. In addition, soil and water samples will be taken for analysis of extractable and total carbon, nitrogen, and phosphors.

To understand land management and grazing practices, a short household survey will be conducted in the nearby villages. These data will help to better quantify GHG emissions from seasonal wetlands in the tropics and to understand effects of seasonality (especially the drying and flooding) on wetland biogeochemical nutrient cycling.

Desired technical skills and experience:

- Experience in GHG emissions measurement and soil, water and manure analysis
- Knowledge of biogeochemical processes in grassland and wetlands
- Experience in setting up and conducting field experiments
- Excellent written and spoken English is a requirement; experience with peer-reviewed publications would be a plus
- Data analysis (preferably with R)
- Data visualization and presentation

Host institution: International Livestock Research Institute (ILRI), Nairobi, Kenya

Research supervisor: Dr. Yuhao Zhu, Mazingira Centre, International Livestock Research Institute, Nairobi, Kenya.

Duration of research stay: Flexible start date but preferably start in early 2024 with a duration of 6 months.

31. Monitoring deforestation leakage associated with scaling of sustainable land use systems in Colombia

Keywords: silvopasture systems, livestock, agroforestry, deforestation, scaling

Brief project outline:
This project contributes to Mitigate+, the CGIAR Initiative on Low-Emission Food Systems (https://www.cgiar.org/initiative/low-emission-food-systems/). The project focuses on monitoring and reporting of deforestation associated with the scaling of cacao agroforestry systems (AFS) and silvopasture systems (SPS) in Colombia and developing scientific evidence-based policy recommendations.

AFS and SPS have been promoted for widescale adoption due to their potential to improve livelihoods, conserve and restore ecosystem services, and serve as carbon sinks. As part of the COP25 Joint Declaration signed in 2019, Colombia committed to placing 147,000 ha under sustainable cattle ranching systems with zero deforestation. Furthermore, cacao agroforestry systems have been promoted in conflict-affected areas of Colombia as sustainable and profitable zero-deforestation alternatives to coca production. Yet, little is known of the potential impacts of scaling of these systems. Some evidence from Colombia suggests that increased animal production in SPS is leading to displacement of male cattle to the forest frontier, potentially driving deforestation.

This project aims to employ spatial analysis and modeling to monitor deforestation leakage (when deforestation is displaced to other regions) due to farm-level changes in herd composition associated with SPS or economic incentives promoting adoption of cacao AFS. This will contribute to the development of safeguards to reduce the risk of unintended consequences of scaling.-

The CLIFF-GRADS student would work together with us in Colombia with an interdisciplinary and multicultural team.

Desired technical skills and/or experience:

- Experience with spatial analysis and modeling and their application in monitoring land use change
- Intermediate to advanced knowledge of GIS software/programs (e.g. QGIS, ArcGIS, Google Earth Engine)
- Experience with GPS and drone management is advantageous but not required
- Basic knowledge of land use change in the tropics
- Basic knowledge of agroforestry and livestock systems is desirable but not essential
- Knowledge of Excel and MS Word
- Writing scientific publications
- Good English writing and speaking skills
- Willingness to do fieldwork in tropical areas
- Basic knowledge of Spanish is desirable for fieldwork carried out in Colombia

Host institution and location: The Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT), Cali, Colombia

Research supervisor: Dr. Augusto Castro-Nunez Senior Scientist, Low-Emission Food Systems, Climate Action Lever The Alliance of Biodiversity International and CIAT

Preferred duration of research visit: 6 months

Start and end month of research stay: April 2024 to September 2024

ENTERIC METHANE

32. Effect of fermentation intermediates due to methane inhibition on the health and functioning of rumen epithelium

Keywords: rumen physiology, digestive physiology, fermentation, methane inhibition

Brief project outline:

The rumen is the defining part of the ruminant gastrointestinal tract (GIT) where feed is fermented and most of the methane formed. Use of seaweed and chemicals have shown promise to mitigate methane emissions from ruminants; however, their use results in an buildup of unusual fermentation intermediates including alcohols. The effects of large quantities of these intermediates on the rumen heath and function of young and adult ruminants is largely unknown.

Our lab recently developed 2D and 3D cell lines (*Ruminoids*) using developing and mature rumen. This provides the opportunity to test the effects of various fermentation intermediates and end products on the functioning and health of rumen epithelium.

This project will aim to investigate the effects of various ratios of volatile fatty acids and alcohols on the health and functioning of the GIT.

Knowledge generated enhances our understanding of how methane inhibition influences the health and functioning of the rumen in young and adult ruminants and therefore understand the effects of methane mitigation strategies on animal physiology and welfare and production. During the stay the candidate will also be exposed to other methane measurement research.

Preferred student skills or experience:

- Rumen and digestive physiology
- Animal physiology
- Lab skills with cell culture, cell biology, histology or molecular biology
- Writing science publications
- Good English writing and speaking skills
- Good skills working with diverse people

Host institution and location: Animal Nutrition and Physiology Team, AgResearch Limited, Palmerston North, New Zealand

Project leader/research supervisor: Dr. Ajmal Khan, Senior Scientist, AgResearch Limited. Email. ajmal.khan@agresearch.co.nz

Preferred duration of research visit: 6 months

Languages available at the host institution: English

Preferred dates for research visit: March 2024 to August 2024

33. Investigating the influence of microbiomes on ruminant phenotypes: methane emissions and more.

Keywords: ruminants, microbiomes, methane, mitigation, management

Brief project outline:
This project will contribute to the HoloRuminant EU Horizon 2020 project https://cordis.europa.eu/project/id/101000213. Ruminant livestock production is estimated to be responsible for 14% anthropogenic methane released annually. In domesticated ruminants, the gastrointestinal tract microbiome plays a key role in both nutrient utilisation and feed conversion efficiency, associated with methane emissions. There are a lack of high-resolution longitudinal studies investigating the links between ruminant microbiome establishment and animal phenotypes.

The HoloRuminant project aims to improve our understanding on how we can harness these microbiomes to improve the efficiency and sustainability of livestock production systems. This project will include intervention studies exploring influences of early life programming, management systems, diet and environments on dairy cattle microbiomes. A variety of ruminant body sites will be investigated from birth until first lactation, to explore how the microbiomes link to conditions including diarrhoea, acidosis, mastitis and methane emissions. It will identify microbiomes associated with greater environmental efficiency (better feed utilisation, reduced methane emissions) in correlation with breed, giving insights into mitigating methane emissions through management practices and better animal productivity.

The student will be hosted by the Huws Lab based at the IGFS at QUB, ranked 1*st* in the UK for Agriculture, Veterinary and Food Science.

Host institution and location: Institute of Global Food Security, Queen's University Belfast. Belfast, Northern Ireland.

Research Supervisor (name, title, affiliation, and email address): Joint supervised by Dr Katie Lawther (k.lawther@qub.ac.uk) and Professor Sharon Huws (s.huws@qub.ac.uk), IGFS Queen's University Belfast.

Start and end month of research stay: Dates are flexible, proposed dates January 2024- June 2024 (6 months)

Languages available at the host institution: English

34. Mitigation of enteric methane emissions in cattle and sheep production systems

Keywords: Livestock, greenfeed, metabolic chambers, methane inhibitors, volatile fatty acids

Brief research stay outline:
Projects at AFBI contribute to the GRA flagship projects "Technical guidelines to develop feed additives to reduce enteric methane" (https://globalresearchalliance.org/flagship-projects/feed-additives/) and "Expansion, analysis and exploitation of the Hungate rumen microbial culture collection" https://globalresearchalliance.org/flagship-projects/mining-rumen-data/).

The aims of the projects are to evaluate feeding practices and additives, and to generate new knowledge on the rumen microbiome to reduce enteric methane emissions from ruminant livestock.

Ruminal microorganisms turn indigestible plant materials into nutrients for animal production; however, they are also responsible for methane production. The need to reduce enteric methane in ruminant livestock systems is one of the key global targets. Understanding the rumen microbiome is essential for developing technologies and practices that can support efficient global food production from ruminants, while minimising GHG emissions. Feed additives have shown potential to reduce methane emissions in livestock ruminants. However, their suitability to suppress enteric methane in different ruminant livestock farming systems is limited and constraints to their widespread usage must be elucidated.

Projects in Ruminant Nutrition at AFBI aim to assess the use of methane-suppressing feed additives under varied feeding management indoors and outdoors. They aim to evaluate the effects feed additives have on animal performance (i.e. feed intake, growth, milk production, etc.), GHG, rumen fermentation and microbiome in sheep and cattle.

The CLIFF-GRADS student would work with us and, if required, our research partner Queen's University of Belfast. Depending on the interest of the student, data collection and sample analysis from the experimental studies.

Desired technical skills and/or experience:

- Experience in handling sheep and cattle
- Good English writing and speaking skills
- Project management
- Team collaboration
- Knowledge on methane emissions measurements in cattle and sheep production systems would be desirable but not essential
- Basic knowledge of Excel
- Statistical analysis
- Writing science publications
- Laboratory experience may be preferred but not essential

Host institution: Agri-Food and Biosciences Institute (AFBI), Hillsborough, Northern Ireland United Kingdom

Research supervisor: Dr. Omar Cristobal Carballo, AFBI Hillsborough

Preferred duration of research visit: 6 months

Preferred dates for research visit: May 2024 to October 2024

35. Microbial Engineering to Mitigate Methane Emission in Ruminant Livestock.

Keywords: Rumen methane, hydrogen, acetate, mitigation

Project Outline:
This project contributes to the GRA flagship project "mining rumen data to reduce methane" https://globalresearchalliance.org/flagship-projects/mining-rumen-data/. The aim of the project is to mitigate methane emission in cattle by diverting the key substrate "Carbon dioxide and Hydrogen" of methane production to making acetic acid/acetate. The acetic acid can then be used by cow to produce meat and milk.

Methane emission from ruminant livestock is one of the main contributors to global warming. The methane production depends on the microbial interactions and concentration of carbon dioxide and hydrogen, which are key metabolic intermediates. It has been proposed that hydrogen could be an inhibitor of the methane production but could also influence the bioproduction of acetic acid; however, the effect of high hydrogen concentration on rumen methane production and other microbial interactions is not yet known.

The goal of this project is to evaluate the effect of hydrogen concentrations on methane production and the synthesis of acetic acid in microbial communities in bioreactors. The expected results will provide new alternatives to mitigate global warming by reducing methane emissions and redirecting carbon sequestration. Furthermore, through the identification of microorganisms and their metabolic processes, we will suggest which microorganisms in the rumen environment need manipulation to develop long-term methane mitigations.

The CLIFF-GRADS student will gain skills in measuring methane, hydrogen, and acetate, culturing oxygen-sensitive microorganisms, and learning how to operate a bioreactor that might be applicable to their home institution.

Host institution and location: The University of Connecticut. Department of Molecular and Cell Biology. 91 N Eagleville Rd, Storrs, CT 06269. USA.

Research Supervisor
Dr. Michel Geovanni Santiago-Martínez. Assistant Professor.
Department of Molecular and Cell Biology. The University of Connecticut.
Email: geo_santiagom@uconn.edu

Start and end month of research stay: [January – June 2023]

Languages available at the host institution: English, Spanish.

36. Testing combinations of feed additives to reduce enteric methane production

Keywords: rumen, methane, additives, in vitro, in vivo

Brief project outline:

Recent literature indicates that the methane feed additive pipeline is still poorly prepared to achieve a substantial reduction in global livestock emissions in the next years. This is because of a slow process of development, a poor level of understanding about emerging additives, unrealistic expectation of co-benefits, and lack of clarity regarding potential off-farm financial rewards. This project aims to explore how to increase the potential of existing (or developing) additives by maximizing the possible synergistic effects across those that have different modes of action to reduce methane production (i.e. decreasing H_2 production, inhabiting achaeal enzymatic machinery or diverting H_2 to other metabolic routes).

The project will use a platform of in vitro (batch culture and fermenters) and in vivo (respirometry chambers) tools to assess the effect of multiple combinations of additives, dosages and dietary conditions. The early career scientist will have full access to the lab and field work facilities and will interact with an international network of scientists working in the field of animal nutrition and modulation of rumen microbial fermentation. The activity to undertake is directly linked to the Horizon Europe project 'Re-Livestock' (Facilitating innovations for resilient livestock farming systems, https://re-livestock.eu) and the GRA flagship project on 'technical guidelines to develop feed additives to reduce enteric methane emissions' (https://globalresearchalliance.org/flagship-projects/feed-additives/), both led by CSIC.

Desired technical skills and/or experience:

- Background in ruminant nutrition and rumen fermentation

Host institution and location: Estación Experimental del Zaidin, CSIC, Granada, Spain

Research Supervisor: Dr. David Yáñez-Ruiz, Spanish Research Council (CSIC), and Dr. Eva Ramos-Morales.

Start and end month of research stay: February to July 2024

Languages available at the host institution: Spanish and English

37. Explore the syntrophic relationships of rumen methanogens and bacteria in lignified forages

Keywords: Microbiota, methane emission, in-vitro, NGS, polysaccharides

Brief project outline:
Developing countries host most of the world's livestock production, but methane mitigation strategies are poorly adapted to these countries, particularly because they rely on extensive farming systems. A key aspect of these extensive systems is the proportion of grazing or forage feeding versus concentrate feeding. Lignin, a structural plant polysaccharide, develops as the plant matures and prevents the access to cellulose by rumen microbiota. It also slows down the passage rate of feed, thus favoring the growth of microbes that produce hydrogen, which is used for methanogenesis. Recent studies are beginning to highlight the high abundance of hydrogen producers, such as Christensenellaceae, in ruminants fed highly lignified products. Their syntrophic relationship with Methanobrevibacter species has been shown in pure culture but such relationships have never been demonstrated in rumen fluid. The objectives of the student will be to demonstrate that *i*) lignified forages induce an enrichment of such syntrophic relationships *in-vitro* and *ii*) this leads to increased methane production. Isolation of microbes from these syntrophic relationships could be considered to further deepen the understanding of the function of the rumen microbiome.

The student will set up *in-vitro* experiments of rumen fluids incubated with a graded level of the lignified substrate. Methane production will be measured by gas characterization of the headspace of the in vitro incubator. The microbiota of rumen fluid or solid particles will be characterized by Next Generation Sequencing.

This work will provide a better understanding of the microbial processes leading to methane emission in animals reared in extensive systems. Ultimately, such knowledge would pave the way for the design of targeted microbial strategies to reduce methane emissions in developing countries.
This project will contribute to the GRA flagship project “Mining rumen data to reduce methane” (https://globalresearchalliance.org/flagship-projects/mining-rumen-data/)

Desired technical skills and/or experience:

- meticulous and organized
- hands-on experience in classical microbiology
- basic experience with R appreciated
- integration in multi-cultural work environment

Host institution and location: INRAE, UMR Herbivores, Clermont-Ferrand, France

Project leader/research supervisor: Simon Roques, INRAE Auvergne-Rhône-Alpes.

Duration of research visit: 6 months

Start and end month of research stay: February 2024 to July 2024

Languages available at the host institution: French, English

38. Mathematical modelling of the synergistic effect of the macroalgae *Asparagopsis taxiformis* with phloroglucinol on in vitro rumen fermentation and methanogenesis

Keywords: hydrogen control, mechanistic modeling, methane inhibition, phenolic compounds, rumen fermentation, seaweed

Brief project outline:

The macroalgae *Asparagopsis taxiformis* is a potent inhibitor of methane produced by ruminants. Two recent studies conducted by INRAE (France) and CSIC (Spain) showed that *A. taxiformis* acts synergistically with the phenolic compound phloroglucinol to reduce methane and improve volatile fatty acid production [1,2]. This positive effect results from the capability of phloroglucinol of being a hydrogen acceptor and directing hydrogen to other pathways beneficial for the animal.

This project aims to incorporate the effect of phloroglucinol into a mechanistic mathematical model developed by the host team (MoSAR, INRAE) that accounts for the effect of *A. taxiformis* on rumen *in vitro* fermentation [3]. The model will be calibrated with data from our collaborators at INRAE (Milka Popova, Diego Morgavi) and CSIC (David Yáñez-Ruiz) produced within the EU Horizon 2020 project MASTER (https://www.master-h2020.eu/readmore.html). The resulting model will provide a useful tool to evaluate optimal methane mitigation strategies using *A. taxiformis* and phloroglucinol. This project will contribute to the GRA flagship project *Feed additives to reduce methane* (https://globalresearchalliance.org/flagship-projects/feed-additives/).

References

1. Huang R, …, Popova M. Evaluating the effect of phenolic compounds as hydrogen acceptors when ruminal methanogenesis is inhibited in vitro – Part 1. Dairy cows. animal. 2023. doi:10.1016/J.ANIMAL.2023.100788
2. Romero P, …, Yáñez-Ruiz DR. Evaluating the effect of phenolic compounds as hydrogen acceptors when ruminal methanogenesis is inhibited in vitro – Part 2. Dairy goats. animal. 2023. doi:10.1016/J.ANIMAL.2023.100789
3. Muñoz-Tamayo R, *et al.* Modelling the impact of the macroalgae Asparagopsis taxiformis on rumen microbial fermentation and methane production. Peer Community J. 2021. doi:10.24072/PCJOURNAL.11

Desired technical skills and/or experience:

- Intermediate expertise in dynamic modelling and programing (Matlab, R)
- Knowledge on rumen fermentation
- Team collaboration
- Writing scientific publications

Host institution and location: INRAE (National Research Institute for Agriculture, Food and Environmen), MoSAR team (https://www6.jouy.inrae.fr/mosar_eng/). Location: Campus Agro Paris-

Saclay, 22 place de l'Agronomie, 91120 Palaiseau, France.

Research supervisor: Rafael Muñoz-Tamayo, PhD in applied mathematics, researcher at INRAE.

Duration of the research stay:

Start and end month of research stay: February 2024 to August 2024.

Languages available at the host institution: French, English, Spanish.

39. Assessing the greenhouse gas emissions of livestock investments

Keywords: GLEAM-i, livestock investments, national climate commitments, climate change, modelling

Brief project outline:
The project aims to assess the environmental impacts of a livestock investment project, using the FAO tool Global Livestock Environmental Assessment Model-*interactive* (GLEAM-*i*). GLEAM-*i* is an online and open access greenhouse gas (GHG) calculator used to assess the effects of livestock interventions (e.g. improved animal health, reproduction, feeding and manure) on GHG emissions and food security. It is based on IPCC Tier 2 methodology and uses a life cycle approach.

It is expected that the research stay will enhance the technical capacity of the candidate through hands-on training with GLEAM-*i*, which includes data collection, providing backstopping with the assessment of the project and preparing a knowledge product (e.g. a policy brief) that can be presented at COP28. A physical training may take place, depending on the capacity need by the project management team. The candidate is expected to join the trainings (whether online or physical). He/she will also support the development of training materials, organization of the training and reporting the training outputs.

The host is the co-lead of the Animal Health Network (AHN) of the GRA and expects that the research output will contribute to the development of a proposal by the network members through the evidence created on the impact of a package of interventions including improved animal health on the GHG emissions.

Desired technical skills and/or experience:

- At least 2 years of experience with greenhouse gas accounting tools
- Understanding of the IPCC methodology
- Proven track record in publishing research outputs in peer-reviewed articles and in conference presentations
- A solid understanding of mitigation and adaptation options available in the livestock sector
- Interest in climate policy related to livestock.

Host institution and location: Food and Agriculture Organization of the United Nations, Rome

Research Supervisor Şeyda Özkan, Livestock and Climate Change Specialist, FAO

Start and end month of research stay: January 2024-June 2024

Languages available at the host institution: English, French, Spanish, Arabic, Russian and Chinese.

40. Data Science for Greenhouse Gas Inventories

Keywords: Livestock, GHG Emissions, Data science

Brief project outline:
The project focuses on data science for developing emission factors in livestock systems and GHG inventories, supporting governments in adopting Tier 2 methodology to efficiently manage GHG emissions.

Drawing from the International Livestock Research Institute's Mazingira Centre and CGIAR Livestock and Climate Initiative data, the project will create tools for repeatable, robust Tier 2 emission estimates and associated uncertainties. This entails developing code and reproducible workflows, based on the IPCC Tier 2 methodology. The CLIFF-GRAD's data-driven approach will be documented in a manuscript and capacity building materials like videos and guidebooks.

Collaborating with the Data Science for Climate Action Team at the Alliance of Bioversity-CIA, Mazingira Centre at ILRI, and other partners, the CLIFF-GRAD will work with Todd Rosenstock from the Alliance, Claudia Ardnt from ILRI, and Andreas Wilkes from NZARGC to align with the latest science while being applicable to real-world decision-making context. The CLIFF-GRAD may train stakeholders on the developed tools for seamless integration into their workflow.

By emphasizing data science, this CLIFF-GRAD will lay a strong analytical foundation for countries to collect, analyze, and manage GHG emissions data. Developing repeatable workflows, code, and data-driven insights will equip the CLIFF-GRAD with skills and knowledge to contribute to global climate change mitigation efforts.

Preferred student skills or experience:

- Knowledge of GHG inventories
- Strong experience in R
- Knowledge of Excel
- Proficient English writing and speaking skills
- Ability to speak French, a plus

Host institution and location: Bioversity International, Montpellier, France

Project leader/research supervisor: Dr. Todd Rosenstock, Principal Scientist,

Start and end month of research stay: 6 months

Languages available at the host institution: English, French

41. Impacts of integrated soil and water conservation and forage production interventions for the restoration of degraded landscapes

Key words: soil and water conservation, forage, restoration, low emission, Ethiopia

Brief research stay outline:
In the agricultural systems in the mountainous areas of southern Ethiopia, steep slopes in combination with high livestock densities of low productivity result in high soil erosion rates and high GHG emission intensities. To address this issue, the international NGO, InterAide, has been piloting sustainable farming alternatives combining soil and water conservation with animal fodder production. This project aligns to the GRA flagship "Satellite monitoring to improve livestock management" and is designed to support the scaling of these technologies, practices, and tools to other sites. Detailed assessments of the impacts of land and water management options are needed to guide the scaling process. The focus will be on generating evidence and developing baselines for targeted scaling. The main objectives of the project is to provide recommendations for the upscaling of successful CSA technologies to new sites.

Envisioned activities include:

- detect and map the physical SWC and biological (forage grass) measures implemented in selected watersheds of Inter Aide sites;
- estimate the overall surface/area occupied by forage grass and trees over time including cumulative length of the grass planted on the contour lines;
- analyze the impacts of SWC and biological measures on soil erosion and carbon sequestration
- quantify the changes in feed availability (quantity and quality) and estimate the impact on livestock productivity and GHG emission intensity
- estimate the changes in overall carbon footprint
- advise on upscaling of successful intervention practices and/or technologies to new sites.

Desired technical skills and/or experience:

- Remote sensing analysis
- cloud computing field experience
- scientific writing

Host institution and location: Alliance Bioversity international and CIAT

Research supervisor: Kalkidan Ayele Mulatu, Dr., Alliance Bioversity and CIAT

Start and end month of research stay: January 2024- June 2024

Languages available at the host institution: English

42. Adaptive Production Practices to Increase Smallholder Dairy Farm Productivity through Low GHG Emission Feeds in Uasin Gishu County, Kenya

Keywords: Dairy production, GHG, mitigation, climate

Brief project outline:
Globally, dairy comprises 40% of agricultural GDP, employs 1.3 billion people and provides livelihoods to a billion of the world's poor. The combined effects of population increase and increasing standards of living in developing countries create a high demand for animal-derived protein by 2050. Dairy production is an important component of the agricultural sector in Uasin Gishu County in Kenya. There is need to explore a range of initiatives that will help to increase milk production which addresses macro- and micro-nutrient deficiencies in diets, especially among urban populations, where the demand for food is always high.

Throughout the world, as affluence increases, significant shifts toward diets dominated by higher intake of animal proteins has been reported. Food consumption patterns, particularly of animal-derived foods, have severe consequences on environmental sustainability. During the recent drought, animal feeds were not only limited but its utilization did not consider the reduction of GHG, of which most farmers are oblivious of the emissions and possible means of minimizing their discharge. The most significant impact of intensive dairy production is global warming because the silent by-products of animal protein production results in carbon dioxide and methane emissions.

The study will encompass two broad objectives; on farm decision making on feed management innovation for low emission development: on the understanding of the co-benefits among positive deviant on dairy cattle feeding and management. The second will entail the study of the impact of innovative feed management practices in semi-intensive dairy farming on gender relation: how positive deviant adaptive pioneers consider the impact on their families. The project seeks to address SDG numbers 1,2, 3 and 13.

Desired technical skills and/or experience:

- MSc in plant sciences/ Animal production

Host institution and location: University of Eldoret, Kenya

Research supervisor: Nicholas K. Rop, Dean, School of Agriculture & Biotechnology,University of Eldoret, Kenya

Preferred duration of research visit: 6

Preferred dates for research stay: March to September 2024

Languages available at the research institute: English

43. Tier 2 methane and nitrous oxide emission factors from cattle manure in smallholder systems in Colombia.

Keywords: livestock, manure, N2O, CH4, Tier 2, mitigation strategies

Brief research stay outline:
This project contributes to the CGIAR initiative MITIGATE+, and the Green Climate Fund Project "Climate-smart initiatives for climate change adaptation and sustainability in prioritized agricultural production systems in Colombia (CSICAP)". The project aims to quantify Tier 2 emission factors for CH_4 and N_2O in livestock production systems in Colombia and validate mitigation strategies.

The agricultural sector is the second largest source of greenhouse gas (GHG) emissions in Colombia, accounting for 30% of total emissions. Emission sources include enteric fermentation produced by livestock, manure management, rice cultivation, and the use of synthetic fertilizers. Colombia is committed to reducing GHG but currently has limited information on how this can be achieved. Information is required to improve the national inventories and implement programs that minimize GHG emissions in agriculture. In this sense, it is necessary to collect primary and local data on GHG emissions by characterizing conventional production systems (current management practices) and alternative mitigation scenarios including silvopastoral systems. Quantification of Tier 2 EF includes i) Identifying production typologies; ii) Implementing productive plots to monitor conventional systems and practices with mitigation potential; iii) Collecting information on activity data; iv) Installation and monitoring static chambers to collect soil emission.

This project aims to fill the data gap in the GHG National Inventories by providing GHG emission factors to the national authorities to improve reporting and national mitigation strategies. The CLIFF-GRADS student would work together with us and the National Livestock Federation (FEDEGAN).

Desired technical skills and/or experience: interest in agro-food systems and climate change mitigation strategies, expertise in GHG emission measurement at the farm level, basic knowledge of Excel and R, writing science publications, good English writing and speaking skills.

Host institution and location: Alliance Bioversity International and International Center for Tropical Agriculture, Palmira, Colombia.

Research supervisor: Sandra Guisela Durango Morales, Postdoctoral Fellow, Alliance Bioversity International and International Center for Tropical Agriculture.

Start and end month of research stay: Flexible.

Languages available at the host institution: English, Spanish

CROSS-CUTTING

44. Gap-filling carbon dioxide, methane, water and energy fluxes for improved Net Ecosystem Exchange quantification for agricultural systems in Africa

Keywords: Eddy covariance, Dryland ecosystem, Net ecosystem exchange, Carbon dioxide, Gap filling

Research stay outline:

The eddy covariance (EC) technique has been widely applied for monitoring energy and water fluxes as well as net ecosystem exchanges (NEE) of carbon dioxide and other trace gases such as methane (CH_4) between lands and the atmosphere. However, challenges and failures due to power outages, instrument malfunctions and maintenance, and data quality checks, data gaps occur during the half-hourly measurements that collectively lead to underestimation of ecosystem carbon at many long-term EC sites. For example, an average gap fraction of 30% has been reported to lead to an uncertainty of ±25 g C m^{-2} $year^{-1}$ for the annual NEE at forested sites, while some EC sites report much greater uncertainties. This is even more challenging for dryland ecosystems due to a comparative smaller CO_2 flux than in humid and forested ecosystems. Moreover, water potential of soils and plants directly controls the flow of water through the ecosystems and is a key regulator of plant mortality risk during extended droughts plays a significant role in how the ecosystems evolve seasonally as a carbon source and sink. However, observations of water potential are frequently scarce, inaccessible, and plagued by methodological challenges that hinder the synthetic research necessary to anticipate, and prepare for, climate change impacts in natural and managed ecosystems. Therefore, gap-filling is a critical exercise to help account for one large source of uncertainties in the annual NEE, together with other sources of uncertainties such as measurement errors and bias related to non-closure of the surface energy balance.

In this proposal, we will explore and develop robust NEE gap-filling approaches using data from four EC measurements in dryland ecosystems of Kenya (two under dryland agriculture and two in pastoral rangelands). The work will entail field visits for data collection, pre-processing of data, comparing methods and drivers of carbon uptake and release as well as uncertainty analysis. The outputs will provide critical results with implication on quantifying the annual and interannual variability of carbon budgets for dryland ecoystems.

Desired technical skills and experience:

- Experience with micro-meteorological measurements.
- Knowledge of programming in MATLAB, R or Python
- Experience up and conducting field experiments
- Excellent written and spoken English is a requirement; experience with peer-reviewed publications would be a plus

Host institution: International Livestock Research Institute (ILRI), Nairobi, Kenya

Research supervisor(s): Dr. Vincent Odongo, Dr. Sonja Leitner, Scientist, Mazingira Centre, International Livestock Research Institute, Nairobi, Kenya.

Duration of research stay: Flexible start date but preferably start in early 2023 with a duration of 6 months.

45. Synergies in integrated systems: Improving resource use efficiency while mitigating GHG emissions through well-informed decisions about circularity (SENSE-Brazil)

Keywords: Integrated systems, Circularity, GHG mitigation, Resource use efficiency

Brief project outline:
The overarching objective of the SENSE project (2022-2025) is to develop or enhance circularity of integrated crop-livestock-forestry and integrated crop-livestock systems to support net zero or low carbon emission targets. The SENSE project was approved in the 2021 ERA-NET Cofund call and integrates 9 research institutions from 7 countries in Europe and South America, the lead institute of the consortium being the James Hutton Institute (JHI) in the UK. The participation of the Brazilian institute, Embrapa, is being financed through GRA by the New Zealand government (SENSE-Brazil). In Brazil we evaluate the state of the art of circularity in integrated systems and develop and test the effect of short-term interventions on GHG emissions and soil C stocks in 3 sites, using a matrix of ecological and resource use efficiency indicators, developed by SENSE. The historical and collected data from these sites via soil and biomass sampling and soil and GHG sensors, will also feed in a High-Performance Computing (HPC)-based data analysis at JHI, supported by modelling and visualization to meet farmer's information needs to attain lower or net zero GHG emissions. The research fellow will have the opportunity to learn about integrated systems in Brazil and collaborate in sampling in the field, laboratory analysis as well as the calibration and use of the DNDC model. @GRA_GHG Circular Food Systems Network, @sense_eranet

Host institution and location: Brazilian Agricultural Research Corporation (Embrapa), National Rice and Bean Research Center (Embrapa Rice and Bean), Santo Antônio de Goiás, Goiás State, Brazil (16°30'13"S; 49°16'54"W).

Research Supervisor
Beata Emoke Madari, PhD in Agronomy / Soil Science, Embrapa Rice and Bean, beata.madari@embrapa.br

Start and end month of research stay: January to June 2024 is preferable, but it could be moved to other dates during 2024 if necessary

Languages available at the host institution: Portuguese, English, (Spanish)

CROPS

46. Sustainable utilization of digestate from farm biodigesters of cattle manure for forage grass production

Keywords: Digestate, organic fertilizer, greenhouse gas, forage grass

Brief project outline:
The project aims to evaluate the effectiveness of digestate as an organic fertilizer for forage grass production, and its potential to reduce greenhouse gas (GHG) emissions compared to chemical fertilizers. There is currently limited research on the quality of digestate from anaerobic digestion of manure in tropical livestock systems, their optimum application rates on farms, and their GHG emission reduction potential in comparison with chemical fertilizers. This project will fill the knowledge gap on these aspects by assessing the optimal application rates of digestate, its impact on soil characteristics, forage yield and quality, GHG emissions, including CH_4, N_2O, and CO_2, using both static and automatic chamber approaches. The study will use a forage demonstration plot amended with different fertilizers and application rates, including digestate, farm-yard cattle manure (FYM), mineral fertilizer, digestate or FYM mixed with mineral fertilizer, and a control group with no fertilizer addition.
The project seeks to fill the knowledge gap on digestate utilization in smallholder tropical livestock systems, promote sustainable agriculture practices and contributes to GHG mitigation. The project is linked to the CGIAR's LCSR and MITIGATE+ initiatives. Desired technical skills include experience in managing forage plot, GHG measurement and good communication skills.

Desired technical skills and/or experience:

- Lab and field work
- Presentation
- Writing scientific publications
- Team collaboration.

Host institution and location: International Livestock Research Institute (ILRI), Nairobi

Research Supervisor (name, title, affiliation,and email address): Chris Jones (PhD), a program leader for feed and forage development at ILRI in collaboration with research teams from Mazingira Centre, ILRI.

Duration of research visit: 6 months

Start and end month of research stay: Flexible start date, however, preferably start February 2024.

Languages available at the host institution: English

47. Benchmarking nitrous oxide emissions in apple orchards

Keywords: N_2O, denitrification, greenhouse gases, orchard ecosystems

Brief project outline:
Plant & Food Research is undertaking an ambitious research programme to create a digital twin of an apple orchard ecosystem. This project on nitrous oxide (N_2O) emissions contributes to work developing a set of models that can describe soil processes in an orchard ecosystem and how they interact with the environment and management. We will use these tools as a platform to investigate the contribution of soil biogeochemical cycles to the orchard ecosystem and crop productivity.

There are significant knowledge gaps in our understanding of greenhouse gas emissions under apple production in New Zealand, including no published data on N_2O emissions in orchard ecosystems. This project will collect the first field measurements of N_2O emissions in New Zealand apple production and provide the successful candidate with hands-on experience in greenhouse gas emissions measurement using static chambers. The project will quantify seasonal N_2O emissions, and will examine the influence of management factors, such as irrigation, groundcover management and fertilisation, on N_2O emissions. Measurements of N_2O emissions will be supplemented with soil measurements of factors influencing denitrification (e.g., temperature, oxygen supply, carbon and nitrate availability). There is also the option to become involved in model development for a suitable candidate.

Desired technical skills and/or experience:

- Knowledge in soil science
- Hands on experience with field and laboratory work, particularly with soils
- Experience with Excel, data management and data analysis
- Fluent in writing and speaking English
- Good communication and teamwork
- Valid driving licence

Host institution and location: Plant & Food Research, Hawke's Bay or Lincoln, New Zealand

Research Supervisor (name, title, affiliation,and email address): Dr. Roberta Gentile, Plant & Food Research,

Duration of research visit: 6 months

Start and end month of research stay: October 2024 to March 2025

Languages available at the host institution: English

48. N_2O emissions in the hairy vetch-maize sequence: impact of crop management practices

Keywords: agroecosystems, nitrous oxide, cover crops, nitrogen fertilization

Brief project outline:
In Argentina, it is estimated that crops are responsible for 14% of the total greenhouse gas emissions (GHG), representing N_2O 60% of the mentioned value. Therefore, management practices in cropping systems tending to reduce N2O deserve to be assessed. Nitrogen (N) fertilization is a common practice used to enhance the grain yield of cereal crops. In recent years, cover crops, especially legumes such as hairy vetch, have been widespread as a sustainable option to reduce or even avoid N fertilization. Including hairy vetch in cropping systems would affect the N dynamic and different factors related to N_2O emissions, such as soil moisture content, temperature, soil N availability, and labile carbon content. As far as we know, the use of hairy vetch as a N source has not been compared to inorganic N fertilizers on their impact on maize productivity and N_2O emissions in the whole hairy vetch-maize sequence. This project aims to analyse the N dynamic in hairy vetch-maize sequences under contrasting management practices (i.e., hairy vetch termination date, N fertilization, and fertilizer source) and their effect on N_2O emissions.
This proposal includes field and laboratory determinations as well as data analysis.

Desired technical skills and/or experience:
- Have enthusiasm for research.
- Experience with field and laboratory determinations.
- Organized, meticulous, and hard-working.
- Ability to work both independently and in a research team.
- Basic Spanish skills are desirable but not essential

Host institution and location: Instituto de Innovación para la Producción Agropecuaria y el Desarrollo Sostenible, Balcarce, Argentina

Research Supervisor: Walter Carciochi, Dr., CONICET; National University of Mar del Plata;

Start and end month of research stay: January-June 2024

Languages available at the host institution: English, Spanish

49. Mitigating soil GHG emissions in semiarid croplands through improved management

Keywords: Crop management, soil N_2O emissions, soil C sequestration, tillage, cropping diversification

Brief project outline:
Mediterranean rainfed semiarid agroecosystems are constrained by low rainfall and high evapotranspiration rates. Under these conditions, the prevalent traditional management systems include low diversification and intensification together with the use of intensive tillage. In the project 'Sustainable intensification in Mediterranean field crops systems (SintMed)' (funded by the Spanish Ministry of Science, ref. PID2021-126343OB-C31) and 'Research-based participatory approaches for adopting Conservation Agriculture in the Mediterranean Area (CAMA)' (funded by the European Commission, PRIMA Programme), different alternative agricultural management strategies are being tested in semiarid rainfed conditions to determine not only the agronomic but also the mitigation potential of these alternative management systems.

Accordingly, the project aims to quantify and evaluate the effects of different management systems of soil N_2O emissions and soil C changes in Mediterranean semiarid rainfed systems. The research work will be performed in two experimental fields located in Zaragoza (Spain) in which the next management strategies are being evaluated:

- Cropping diversification: crop rotations with different crop species.
- Cropping intensification: suppression of long-bare fallow.
- Tillage reduction: implementation of no-tillage systems.

The project welcomes motivated CLIFF-GRADS students with interests in semiarid rainfed agroecosystems and, in particular, in the role of these semi arid systems in climate change mitigation. The CLIFF-GRAD project proposed here will contribute to the GRA reducing N_2O emissions Flagship and it is related with the activities of the Conservation Agriculture Network of the GRA.

Desired technical skills and/or experience:

- Expertise in soil sampling and GHG emission and soil C measurements.
- Knowledge of agricultural management systems in arid/semiarid conditions.
- Basic knowledge of Excel.
- Good English writing and speaking skills.

Host institution and location: Spanish National Research Council (CSIC), Zaragoza, Spain

Research supervisor: Dr. Jorge Alvaro-Fuentes and Dr. Laura Martínez-García

Preferred duration of research visit: 6 months

Preferred dates for research visit: May 2024 to October 2024

AGROFORESTRY

50. Assessing Carbon Balance in two pecan orchards with different management systems

Keywords: Carbon balance, pecan, management

Brief project outline:
Few food systems have the inherent duality of increasing carbon storage in the environment through C sequestration and providing nutrient-dense food, being the dried fruits-based systems important contributors to this matter. Pecan (*Carya illinoinensis [Wangenh*.| K. Koch) production is among these systems, and has this duality enhanced not only because produces a high-quality nut, but also sequesters C in its biomass (mainly in the trunk), and in the soil, given its strong association with ectomycorrhizal *fungi*. Many research efforts currently concentrate on pecan, and this growing interest is reflected in the publishing trend of the last decades, where studies about pecan have skyrocketed, mainly those focused on the nutraceutical properties of the pecan nut. Regarding environmental studies on pecan orchards, they are still few; even when pioneering studies have demonstrated that C sequestered by pecans may attain 7.9 to 10 Mg C ha^{-1} yr^{-1} and that the C balance tends to be positive, with a negative C footprint. However, this may vary according to some management practices, such as pruning and pruning residues management.

Therefore, this project focuses on determining C balance and its components (GHG emitted, soil organic carbon, C sequestration) in two pecan orchards with two pruning management systems, located at the Balcarce research station (Argentina). The student will conduct a field experiment aiming to evaluate GHG emissions, but also will take dasometric measurements in the pecan orchards. Our results will provide new knowledge about C balance in fruit crops.

This proposal includes both laboratory and field work.

Preferred student skills or experience:

- Hands on experience with research field work
- Critic thinking and ability to resolve problems
- Organized and meticulous
- Basic Spanish skills are desirable but not essential

Host institution and location: Instituto Nacional de Tecnología Agropecuaria, INTA Balcarce, Balcarce, Buenos Aires, Argentina.

Project leader/research supervisor: Sebastian Cambareri, INTA Balcarce

Preferred duration of research visit: 6 months.

Preferred dates for research visit: August 2024 to Dec 2024.

51. Testing different cost-effective mitigation strategies to increase soil carbon storage in organic rainfed almond orchards under semiarid conditions

Keywords: Rainfed woody crops; cover crops management; tillage; soil carbon sequestration efficiency; semiarid conditions; food security

Brief project outline:

Agriculture releases about 25% of global greenhouse gases emissions into the atmosphere, which exacerbates climate change. Since soils account for the majority of agricultural emissions, the adoption of climate-smart agricultural practices like reducing tillage, growing cover crops, and pruning residues retention, can be a powerful mitigation strategy by capturing carbon and decreasing greenhouse gas emissions.

The European Common Agrarian Policy (CAP) will subsidy those farmers that adopt agricultural practices that preserve soil resources while capturing CO2 from the atmosphere through the so-called eco-regimens, such as growing cover crops managed by brush-cutter to avoid tillage operations. However, to date, the cost-effectiveness of is this cover crop management practice has not been tested in semiarid calcareous soils, as it is the case of South-eastern Spain, where occasional tillage is sometimes necessary to ensure crop performance.

IFAPA-Camino de Purchil is currently involved in different regional and national projects focused on assessing the climate change mitigation potential and other environmental benefits of different cover crop management strategies (i.e., spontaneous vs seeded cover crops; mowing vs burial with a cultivator) in SE Spain, one of the largest areas in the world for the production of rainfed organic almonds. The student will conduct measurements of soil carbon storage, functional carbon pools, soil CO_2 emissions, crop residue decomposition rates, and crop yields, in 3 representative organic almond orchards where different cover crop management practices have been established. The outcomes of the project will help to update emission values and to identify the most cost-effective cover crop management strategies under semiarid Mediterranean conditions.

This proposal includes both laboratory and field work as well as training on different methodologies to estimate soil CO_2 emissions, carbon sequestration rates and carbon balance assessments from the agricultural sector. The stay will enable the candidate to interact with most relevant research groups working in greenhouse gas emissions mitigation strategies and soil carbon storage in agricultural systems in Spain. The CLIFF GRAD project proposed here will contribute to the GRA Research Flagships "Agricultural greenhouse gas inventories" and "Soil carbon sequestration".

Desired technical skills and/or experience:

- Hands on experience with field and laboratory work, particularly with soils & plant material
- Data management and analyses, and good team player
- Basic Spanish skills and driving licence are desirable but not essential

Host institution and location: Institute of Agricultural Research and Training, Fishing, Food and Organic Farming of Andalusia (IFAPA Camino de Purchil): https://ifapa.junta-

andalucia.es/agriculturaypesca/ifapa/web/personas-estructuras-y-servicios/centros-ifapa/centro-ifapa-camino-de-purchil

Research supervisor: Dr. María Almagro Bonmatí

Start and end month of research stay: 6 months (preferably February-July 2024 but flexible)

Languages available at the host institution: Spanish (preferably) and English

52. Comparative analysis of biomass and soils carbon stocks and greenhouse gases in various agroforestry systems with natural forest in Awi zone, Northern Ethiopia.

Keywords: Aboveground biomass, fruit, Acacia plantation, carbon

Brief project outline:

Recently, agroforestry is regarded as part of climate change mitigation measures under reforestation and afforestation programmes. Today, demand for short-term economic benefits has led the traditional multistrata agroforestry system to monoculture production, such as Acacia decurence and eucalyptus species. Most of the plantations have been established at the expense of forests.

Thus, this study aims at investigating biomass and soil carbon stocks of various agroforestry practices, natural forest and Eucalyptus plantation in Awi zone, northern Ethiopia. Two agroforestry systems, the fruit-based system (FAF) and the Acacia-based agroforestry system will be selected in the study region. While as control natural forest and Eucalyptus plantation will be selected for comparation. Out of each system, 10 smallholder farmers and plots will be randomly chosen, making a total of 40 farms (10 farmers x 4 land-use practices x 1 sites). A vegetation survey will be performed on randomly arranged plots with a scale of 20 x 20 m. Three nested plots of 1 x 1 m (1 m2) in the larger plot will be laid to collect litter samples and soil samples (0-30 cm depth, 30-60 cm depth and 60-90cm) to establish soil organic carbon (SOC) and other soil properties. Measurement and mitigation of greenhouse gases in tree crop-based farming will be done. Separate soil samples will be also collected from similar depths to account bulk density. New allometric equations will be developed to estimate aboveground biomass of acacia trees through destructive harvesting of 30 plants from three age classes. The spearman correlation and regression analysis will be used for analyzing the collected data.

Desired technical skills and/or experience:

- Lab and field work,
- Modelling, writing publications,
- Data visualization, presentations,
- Project management and team collaboration

Host institution and location: Bayero University,Kano New site, Nigeria

Research Supervisor: Mrs Desta GEBEYEHU

Start and end month of research stay: Feburary 2024 -Dec 2024

Languages available at the host institution: Amharic & English

53. Contribution of fruit trees to climate change mitigation

Keywords: Allometric equations, Carbon sequestration, Fractal Branch Analysis, Fruit trees

Brief project outline:

Fruit trees support smallholder farmers' livelihoods and play a critical role in the global carbon cycle. However, their relative contribution to climate change mitigation through carbon storage is not obvious because of limited information regarding their extent and inadequate methods for quantification. The latter is attributed to lack of reliable methods (e.g. allometric equations). However, the main method for developing allometric is to engage in destructive sampling. The main limitations of such a method are: (1) trees must be destroyed to create the allometric equation, and (2) the trees used to fit the equation may not be representative of other trees to which the resulting equation will be applied. Functional Branch Analysis (FBA) is a model-based method that combines measurements of tree branches with other data to characterize the fractal geometry of a tree's stem and derive the scaling coefficients of equations that relate tree size to tree mass. FBA can be combined with non-destructive methods (e.g. remote sensing) to estimate aboveground biomass without major ecological impacts on vegetation.

The student will (1) assess the suitability of FBA and other methods for estimation of carbon sequestration in fruit trees, (2) determine the spatial extent and proportion of fruit trees in the landscape, and (3) determine the contribution of fruit trees to climate change mitigation in Kenya. The study will answer the long-held question regarding the co-benefits of maintaining fruit trees on farms.

Desired student skills or experience

- Knowledge of greenhouse gas measurement
- Excellent written and oral English language
- Strong interpersonal skills
- Experience on monitoring plant growth and productivity would be highly valued.

Host institution: Jomo Kenyatta University of Agriculture and Technology (JKUAT)

Research supervisor: Dr. Shem Kuyah, JKUAT

Preferred duration of the research visit: 6 months

Preferred dates of the research visit: January 2024 to June 2024

ADDITIONAL RESEARCH PROJECTS

54. Greenhouse gas emissions from manure digesting biodigesters in smallholder farms

Keywords: Farm biodigester, Greenhouse gas, Climate mitigation, Manure, Anaerobic digestion

Brief project outline:

Livestock manure is being increasingly used for anaerobic digestion (AD) to create nutrient-rich digestate, biogas (clean energy) and reduce greenhouse gas (GHG) emissions. The UNFCCC recognizes AD as one of the fastest and most cost-effective ways to deliver the Global Methane Pledge targets, while local governments and donors are interested in promoting the commercial biogas sector in sub-Saharan Africa (SSA). As a result, there is a growing need for SSA countries to develop a localized emission accounting system that integrates the expected growth in farm-scale AD facilities.

This project aims to measure GHG emissions from three main steps in the handling and treatment of manure at farm-scale AD facilities: pre-storage of manure, biogas production, and digestate storage prior to land application. The project seeks to fill the knowledge gap by developing localized emissions factors for biodigesters in smallholder livestock systems in SSA, promoting circular economy and GHG mitigation. The project is linked to the CGIAR's MITIGATE+ initiative and African Biodigester Component (ABC, being implemented to construct at least 50,000 biodigesters in SSA by 2025). Technical skills required include experience in GHG measurement and modelling, familiarity with farm biodigesters, and good teamwork and communication skills.

Desired technical skills and/or experience:

- Familiar with manure management and biodigester in smallholder farms.
- Experience in GHG measurement and sample analysis.
- Experience in data collection, management, processing and analysis.
- Ability to work independently with minimal supervision in multi-disciplinary and multi-cultural environment.
- Excellent communication skills.
- Experience in writing scientific articles will be an added advantage.

Host institution and location: International Livestock Research Institute (ILRI), Nairobi

Research Supervisor: Daniel Girma Mulat (PhD), and Environmental Researcher and Laboratory Manager at Mazingira, ILRI.

Collaborator from universities (Akiber Chufo (PhD), Associate Professor at Arbaminch University, Ethiopia).

Preferred duration of the research stays: 6 months

Start and end month of research stay: Flexible start date but preferably from January 2024.

Languages available at the host institution: English

55. Regional databases to evaluate goodness of fit of GHG prediction models

Keywords: Livestock, modelling

Brief project outline:

Natural Grasslands based animal systems are the main production systems in Uruguay, providing both animal products and ecosystem services. These natural grasslands are composed of C3 and C4 plants which coexist in different proportions across the year, which is a very particular agroecological system.

Moreover, in these Uruguayan animal production agroecological systems, animals graze all through the year and pastures are often heavily grazed, due to a mismatch between forage demand and supply. It is important to know and monitor the energy balance and the forage intake of these animals. Hence, we have conducted several trials measuring animal feed intake and digestion on sheep fed with cut fresh natural grassland in metabolic crates. After a digestion trial we also measured enteric methane emissions using portable accumulated chambers. So, we have a reliable dataset of Uruguayan production systems agro-climatic regions of Campos Grassland.

In a context of climate and land use changes Campos Grasslands based animal production systems need to be assessed at a larger scale. Many prediction models have been developed to estimate potential impacts of changes in ruminant feeding strategies on GHG emissions from livestock. However, due to the large variability on characteristics of agricultural systems, there is a need to challenge these models to predict emissions from different agro-climatic regions.

The aim of this study will be to use dataset of Uruguay to perform an external validation of methane prediction models which was developed on ruminants fed with different breeds, diets, in temperate conditions in Europe (INRAE, 2018 model) or extant equations from the literature, specific to Uruguayan context. The predicting ability and accuracy of models will be assessed. This will be part of two projects (Sistema de apoyo a la toma de decisiones de manejo de campo natural) and the Eranet circularity project "INTEGRITY" (2022-2024).

Desired technical skills and/or experience:

- Knowledge of animal science, ruminant nutrition, livestock production systems
- Effective teamwork and interpersonal skills
- Good communication in English
- Basic Spanish or French desirable but not exclusive

The student will work with data (Uruguay) of methane emissions from sheep and model of INRAE (France). The student will gain skills of modelling, data analysis and publication.

Host institution and location: INIA Tacuarembó, Uruguay and short stay at INRAe UMRH, Theix, France.

Research supervisors: Thais Devincenzi, INIA Tacuarembó, Uruguay; Maguy Eugène, INRAe-UMRH, France.

Preferred duration of research visit: 6 months.

Preferred dates for research visit: in 2024

56. Research stay title: Budgeting net CO_2 uptake from cereal-legume mixture under conservation agriculture based mixed crop-livestock farming system of rainfed drylands

Keywords: Forage mixture, mitigation strategies, conservation agriculture, CO_2 flux

Brief project outline:

This project contributes to the one CGIAR initiative of Fragility to Resilience (F2R) CWANA WP3 https://www.cgiar.org/initiative/fragility-to-resilience-in-cwana/ and Excellence in Agronomy (EiA) https://www.cgiar.org/initiative/11-excellence-in-agronomy-eia-solutions-for-agricultural-transformation/ which focuses on identification and development of the agriculture innovations for zero or carbon neutral suitable for adaptation under climate change.

These initiatives aim to develop sustainable and resilient farming systems in rainfed drylands. Intensive soil tillage, removal of crop residues/over-grazing and continuous mono-cropping are declining soil health and crop productivity and sustainability of the agriculture system. Conservation agriculture (CA) practices, i.e., minimum soil disturbance and residue retention helps to improve soil health, water use efficiency, and overall crop productivity in such a production environment. Similarly, CA is also considered as an adaptation strategy for climate resilience which minimizes the CO_2 flux, increases carbon sequestration, improves soil health, and thus improves sustainability.

Also, in the dryland countries, cereal monocropping is the dominant system, whereas our on-going experiments in North Africa has shown that diversifying the cereal mono-cropping through inclusion of legumes in the cropping system can increase the resilience to variable climatic conditions. Such a kind of alternative system which increases system intensity (intensification) through diversification combined with CA practices is required. Further, in the region livestock is an integral part and to provide fodder to the livestock sustainable supply of forage and fodder is required, which can make some residue available to retain under CA system as it competes for residue as mulch and livestock feed. Hence, there is an urgent need for exploring alternative solutions for better integration of crops and livestock under CA-based system in such a production environment. Under those initiatives, the project is already evaluating the different combinations of cereal and legume forage mixture. Our preliminary result showed that the introduction of different forage combinations (cereal + legume mixture) can improve forage quality and quantity for livestock and can be grown under CA-based system. It is important to understand the effect of different combinations of cereal + legume forage mixture on agronomic, economic, and environmental benefits for its wider adoption. The current study missed the effect of different forage mixtures under CA systems on the CO_2 flux, which is important to understand the net budgeting of the CO_2 uptake and carbon sequestration. In most countries, the government supports (subsidy) the major cereal crops, hence more than 80% of the crop is under cereal monocropping. Also, Morocco Government has a plan to expand CA adoption to 1 M ha by 2030. Such findings will have policy implications for the sustainable adoption of CA at scale.

The CLIFF-GRADS student would work together in the one CGIAR initiative in Morocco, the dryland research platform of ICARDA where we have different sets of well-established experiments which compare different innovations under conventional agriculture and conventional tillage systems.

Preferred student skills or experience:

- Expertise in carbon sequestration and CO_2 emission measurement
- Basic knowledge of simulation modelling would be desirable but not essential
- Basic knowledge of statistical analysis
- Writing science publications
- Good English writing and speaking skills

Host institution and location: Rabat, Morocco

Project leader/research supervisor: Dr. Mina Devkota, International Center for Agriculture Research in the Dry Areas

Preferred duration of research visit: 6 months

Preferred dates for research visit: January 2024 to June 2023

57. Understanding the Relationship between Animal Health and Productivity in Livestock Systems, and Its Impact on Greenhouse Gas Emissions: A Literature Review and Expert Opinion

Keywords: productivity, sustainability, disease

Brief project outline:

Animal health is a critical component of livestock productivity, contributing to sustainability and profitability of livestock systems. At the same time, livestock systems are a significant contributor to greenhouse gas (GHG) emissions, particularly through enteric fermentation and manure management. Understanding the relationship between animal health, productivity, and GHG emissions is essential for effective mitigation strategies and promoting sustainable livestock production. However, there is a lack of comprehensive data on this relationship, particularly in low- and middle-income countries (LMICs).

This project aims to collect data on the relationship between animal health, productivity, and GHG emissions in livestock systems through a literature review and through interviews of leading researchers in that area. The project will focus on livestock systems in LMICs, with a specific focus on sub-Saharan Africa. The CLIFF-GRADs student will work with the research supervisor and other experts in the field of animal health, productivity, and GHG emissions in LMICs to gather information on the current state of knowledge, available data, and identify research gaps. The student will benefit from direct interaction with the GRA Animal Health and GHG intensity network and collaboration with researchers at the International Livestock Research Institute (Claudia Arndt and Anna Lacasta) will co-supervise the student.

Host institution and location: Edinburgh Napier University, Edinburgh, UK

Research Supervisor: Dr Nick Wheelhouse; Edinburgh Napier University

Start and end month of research stay: April-September 2024

Languages available at the host institution: English

58. Quantifying greenhouse gas fluxes from overlooked emission hotspots in pastoral systems of Kenya

Keywords: boma, manure, pastoral system, nitrous oxide, methane

Brief project outline:

In pastoral systems, livestock production is based on grazing. In the landscape, livestock congregate at locations like overnight enclosures (bomas, kraals, corrals) and watering points. Here, manure accumulates and is not removed. Manure is a source of methane (CH_4) and nitrous oxide (N_2O) emissions and water pollution. N_2O emissions from cattle bomas contribute 5% of N_2O emissions from the African continent. Similarly, water pans have CH_4 and N_2O flux rates orders of magnitudes higher than savanna soils because of excreta input and leaching. At the same time, bomas provide essential nutrients for plant growth and abandoned bomas are hotspots for plant and wildlife biodiversity.

In this study, we will measure CH_4 and N_2O emissions and soil carbon storage, compare the risk for nutrient leaching and water pollution, and monitor vegetation regrowth along a boma chronosequence.

To understand effects at the landscape level, we will use ground-based and remote sensing measurements. The study will be located at ILRI's Kapiti Research Station and Wildlife Conservancy in Kenya, which is a highly instrumented research station and satellite validation site. Results will be used to make recommendations for improved rangeland management and will be published in a peer-reviewed article.

The project is linked to the CGIAR Research Initiatives on Livestock and Climate and MITIGATE+, and the ESSA project for climate-smart agropastoral ecosystem transformation. In addition, the student will have the opportunity to learn about ongoing research activities at the Kapiti station (e.g., rangeland ecosystem carbon exchange via Eddy Covariance, vegetation monitoring via remote sensing).

Desired technical skills and experience:

- Experience in GHG emissions measurement and soil nutrient analysis
- Knowledge of pastoral livestock production systems in developing countries
- Experience in setting up and conducting field experiments
- Excellent written and spoken English is a requirement; experience with peer-reviewed publications would be a plus
- Data visualization and presentation skills
- Data analysis skills (preferably with R)

Host institution: International Livestock Research Institute (ILRI), Nairobi, Kenya

Research supervisor: Dr. Sonja Leitner, Scientist, Mazingira Centre, International Livestock Research Institute, Nairobi, Kenya.

Duration of research stay: Flexible start date but preferably start in April 2024 with a duration of 6 months.

Preferred duration of research visit: 6 months

Preferred dates for research stay: April 2024

59. Factors affecting the efficacy of inhibitors of rumen methanogenesis

Keywords: rumen, methane, inhibition, fermentation, in vitro cultures, microorganisms

Brief project outline:

Feed additives inhibitors of methanogenesis are the most effective strategy to decrease the emissions of enteric methane. However, their efficacy varies considerably across experiments. It would be important to mechanistically understand the factors causing such variation in order to maximize the inhibition of methanogenesis. The student will conduct in vitro experiments with rumen cultures seeking to understand some of the variables and mechanisms explaining the variation in efficacy of inhibitors of methanogenesis differing in their mode of action. The experiments will be entirely conducted in the laboratory (except for sampling animals for rumen inoculum) with rumen microbial cultures. Response variables to be analyzed will include gas production and composition, concentration of total and individual volatile fatty acids and ammonium, pH, reducing potential, apparent digestibility, and the composition of bacterial and archaeal communities.

Preferred student skills and experience:

- An inclination to work in the laboratory
- Independent thinking and ability to resolve problems
- Ability to work as part of a team
- Organized and meticulous
- Supervisor speaks English but basic Spanish skills are desirable to live and work in Chile

Host institute and location: Instituto de Investigaciones Agropecuarias INIA Carillanca, Temuco, Chile

Research supervisor: Dr. Emilio M. Ungerfeld, Instituto de Investigaciones Agropecuarias INIA (emilio.ungerfeld@inia.cl)

Completion date: anytime between August 2024 and December 2025. Stays must be 6 months long

60. Harnessing the Power of BNI

Keywords: Nitrogen-use-Efficiency, Ex-ante modeling, nitrification, Nitrogen losses, GHG emissions

Brief project outline:

Nitrogen (N) is an essential nutrient for plant growth and food production, but excessive use of N fertilizers lead to environmental problems, such as soil degradation, water pollution, and greenhouse gas emissions. Biological nitrification inhibitors (BNIs) are natural compounds produced by some plants that can help reduce nitrogen losses and greenhouse gas emissions in agricultural systems. BNIs work by inhibiting the activity of nitrifying bacteria, which convert ammonium to nitrate, a process that releases nitrogen into the atmosphere. By slowing down this process, BNIs can reduce nitrogen losses and increase NUE in crops.

Scientists are developing high BNI-enabled wheat varieties by transferring chromosomal regions carrying BNI traits from a wild relative of wheat into the elite wheat varieties. These BNI-enabled wheat varieties are expected to be deployed in the wheat production regions suitable for BNI activities leading to improved crop yields, reduced fertilizer use, and a lower environmental impact. However, quantifying such benefits at various spatial scale help countries to make informed decision on the adoption of these technologies commensurate with their food security, economic development, and environmental goals. Student under this CLIIFF-GRAD will be involved to quantify such benefits through foresight and ex-ante modeling approach for different wheat-producing regions of the world. Student will have access to latest global dataset on N input/output, wheat harvest areas and areas suitable for BNI-enabled wheat.

Desired technical skills and/or experience:

- Agronomy and N management,
- Nitrogen cycle and N losses,
- Data analysis and modeling,
- Spatial analysis,
- Communication and reporting

Host institution and location: International maize and Wheat Improvement Center (CIMMYT), Mexico

Research Supervisor: Dr. Tek Bahadur Sapkota, Senior Scientist and Climate Change Lead

Start and end month of research stay: September to December 2024

Languages available at the host institution: English and Spanish

61. Uncovering the Carbon Footprint of Food Systems and Opportunities for Climate Action at the National Level

Keywords:Food systems, Greenhouse gas emissions, mitigation strategies, big data analytics

Brief project outline:

The food system is a significant contributor to global greenhouse gas emissions, accounting for 20-35% of all emissions. At the national level, the extent of these emissions and the mitigation potential varies depending on the country's food production systems, land use, and dietary habits. Countries can employ various to reduce food system emissions and mitigate the impacts of climate change. Quantification of the current level of food system emissions enables countries and relevant stakeholders to identify suitable strategies for reducing food system emissions commensurate with their food security, economic development, and environmental protection goals.

The student under this CLIFF-GRADS will be involved in quantifying GHG emissions from food production systems, identifying major drivers of emissions, identifying suitable mitigation strategies and quantifying their mitigation potential at field, farm, and landscape level in Colombia, Kenya or Vietnam. This is mainly desk-based work for which students will have access to activity data, emission data, and relevant literature to start the work.

Desired technical skills and/or experience:

- Environmental science specifically on GHG emissions and Climate Change,
- GHG sources and mitigation strategies across the food systems,
- Familiarity with GHG accounting frameworks,
- Knowledge of GHG emissions modeling.

Host institution and location: International maize and Wheat Improvement Center (CIMMYT), Mexico

Research Supervisor: Dr. Tek Bahadur Sapkota, Senior Scientist and Climate Change Lead

Start and end month of research stay: September to December 2024

Languages available at the host institution: English and Spanish

62. Quantifying potential carbon sequestration from smallholder agroforestry

Keywords: Carbon sequestration, agroforestry, smallholder farmer, carbon credits

Brief project outline:
Agroforestry is gaining renewed momentum as a means to address multiple global issues and as such, agroforestry has been directly connected to the 2030 Agenda for Sustainable Development (SDGs) and other international commitments and frameworks, including reduced poverty, increased food security and climate change adaptation and mitigation. For example, several National Determined Contributions to the UNFCCC Paris Agreement include agroforestry as a transformative approach that reorganizes existing ways of production.

Recognized as a more sustainable agrifood system, agroforestry is often promoted to improve food security and livelihoods for smallholder farmers, as well as address land degradation. Smallholder farms (less than two ha) account for 84% of all farms and provide 35% of the world's food production (Lowder et al., 2021); therefore, wider uptake of smallholder agroforestry would have global benefits. However, converting to agroforestry has its challenges including delayed returns in comparison to conventional agriculture. As such, carbon sequestration and credits are promoted as an opportunity to incentivize smallholder farmers to convert to agroforestry and provide supplementary income, providing short-term income and a long-term economic safety net.

There is currently limited data on the socio-economic benefits from smallholder agroforestry systems in developing countries, including from carbon credits. This study will be based at FAO Headquarters in Rome, Italy and will estimate the carbon sequestration and income potential from smallholder agroforestry. It may also consider how to optimize carbon sequestration in agroforestry production systems, focusing on either specific countries of interest and/or systems.

Preferred student skills or experience:

- At least two years' experience with carbon accounting tools, ideally for agroforestry
- Knowledge of voluntary carbon markets and/or agroforestry design preferred
- Proven track record in publishing research outputs in peer-reviewed articles; experience with policy briefs a competitive advantage
- Strong team player and independent worker

Host institution and location: Food and Agriculture Organization of the United Nations, Rome

Research Supervisor Elaine Springgay, Forestry Officer (Agroforestry), Forestry Division, FAO

Start and end month of research stay: March 2024-September 2024

Languages available at the host institution: English (working level proficiency), French, Spanish.