CLIFF – GRADS

Climate, Food and Farming Network

GRA Development Scholarships

Round 4 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 month) scientific training and research on the measurement, modelling 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). Research will be conducted in association with CCAFS and GRA scientists.

The deadline for Round 4 CLIFF-GRADS student applications is the 1st April 2020.

Grants of $12,000 USD will be awarded to PhD students from developing countries for research stays that will be completed before the end of 2021.

Eligibility

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

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 CCAFS Low Emissions Development Flagship. CLIFF-GRADS builds capability in early-career scientists from developing countries to conduct applied research in agriculture greenhouse gas emission quantification and mitigation.

[1] As defined by the International Monetary Fund https://www.imf.org/external/pubs/ft/weo/2018/02/weodata/groups.htm#oem

In the first three rounds of CLIFF-GRADS, a total of 73 PhD students received grants, furthering their research skills and strengthening international agriculture emission research networks.

Application instructions

Aapplicants' must complete the CLIFF-GRADS Round 4 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.

- 1-2 page motivation letter *(described below)*
- 1-page academic curriculum vitae (CV / Resume) that includes your contact details
- Letter of support from your PhD supervisor at your current host university

Motivation Letter

Your motivation letter should be no more than two pages, 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.
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. Successful applicants will be matched with a project and notified by email by late June, 2020.

Applicants are selected based on three criteria:

1. overall level of research experience,
2. relevance of PhD thesis topic or other research experience to the CLIFF-GRADS objective, 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 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 CCAFS 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 and the CGIAR Trust Fund donors.

Additional information

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

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

GRA: https://globalresearchalliance.org/

CCAFS: https://ccafs.cgiar.org/themes/low-emissions-agriculture

List of Research Stays

1. Advances in global mapping of soil carbon sequestration potential and links with drought conditions

Keywords: 4 per 1000, carbon sequestration, mitigation, digital soil mapping, statistical modelling

Brief research stay outline:

Soil organic carbon (SOC) sequestration can make a significant contribution to offset CO2 increase in the atmosphere by transferring it into long-lived soil C pools. The initiative "4 per 1000 carbon sequestration in soils for food security and the climate" was launched with the intent to increase global SOC stocks by 0.4% per year. In order to achieve the aspirational 4 per 1000 target, the annual soil sequestration rate should be 0.6 t C ha−1 y−1 globally. However, this C sequestration rate cannot be reached everywhere due to the high spatial heterogeneity of SOC stocks and soil-specific sequestration potential.

Different approaches to model and map soil carbon sequestration potential have been tried and applied at different geographical extents. Soil water-holding capacity is also an important component of the water and energy balances of the terrestrial biosphere. It controls the rate of evapotranspiration, it is a key to crop production and can influence soil carbon sequestration potential. This project focuses on modelling soil carbon sequestration potential linked with soil hydraulic properties at the global extent. The project will link mechanistic with more data-driven approaches for soil carbon and water interactions.

ISRIC welcomes a CLIFF GRAD PhD-student with a soil background and competent in digital soil mapping and machine learning to apply for a research stay to work with the ISRIC team on the advancement and application of methods to improve the global mapping and modelling of soil carbon sequestration potential and links with water content.

Desired technical skills and/or experience:

- carbon sequestration mechanisms, digital soil mapping, geocomputation, machine learning, R scripting, remote sensing, soil organic carbon mapping, statistical modelling.

Host institution and location: ISRIC - World Soil Information, Wageningen, the Netherlands

Start and end month of research stay: March - September 2021.

2. Agricultural management potential effect on the soil carbon sequestration at national level

Keywords: agricultural systems, modelling, regional level

Brief research stay outline:

In recent decades, carbon sequestration in soil has been promoted to mitigate CO2 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, as well as crop management practices such as residues, rotations and cover crops, and proper irrigation management.

To date, there are many options to increase soil organic carbon in the agricultural soils, but not all of them are appropriate for all regions. Therefore, several field experiments are being carried out at the Environment and Agriculture Department of INIA under several different agricultural systems. Supported by those projects, the student will increase his/her knowledge on Mediterranean agricultural systems, soil sampling and laboratory analysis.

Field results, together with a literature review, will be applied to existing INIA research on common Spanish agricultural practices. By combining actual soil organic carbon at Spanish level under conventional agricultural management (for the different agricultural systems) and the potential soil organic carbon increase under different improved agricultural practices, the student will be able to estimate the potential effect of agricultural management on soil carbon sequestration at Spanish national level. Moreover, all the techniques learned during the six month research visit will be transferrable to the student's country.

This proposal includes field sampling, laboratory analyses and statistical modelling.

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, Madrid, Spain.

Start and end month of research stay: Flexible from June 2020 to November 2021

3. Alternatives for dairy effluent management to mitigate greenhouse gases emissions: environmental impact assessment.

Keywords: livestock, soil, N2O

Brief project outline:

The increasing amount of excreta generated by dairy production systems necessitates better manure management practices including its application in soils in the form of an organic fertilizer. However, livestock excreta results in high nutrient loading, especially N, and misuse implies a risk of environmental contamination by both N leaching to bodies of water and through N2O greenhouse gas (GHG) emissions from soil. Globally, 60% of N2O emissions are produced by agriculture, and in Argentina, 94% of N2O emissions are from agriculture activities.

N2O in the soil is produced as a by-product of the biological processes of nitrification and denitrification; both processes use N as a substrate. Therefore, an option to reduce N2O emissions is to increase excreta Nitrogen Use Efficiency. Efficiency can be increased by modifying the form of manure application to soil or by applying the residue jointly with a nitrification inhibitor.

This project aims to develop capacities and advance knowledge to determine better manure management practices aimed at mitigating GHG production. For this, an integrative analysis of the effect of dairy liquid manure application (applied with and without a nitrification inhibitor) to the soil surface or subsurface is proposed to better understand the physical, chemical and biological soil properties, and related GHG emissions. Activities for the CLIFF-GRADS student will include soil and GHG sampling, calibration of methodological gas sampling techniques, laboratory analysis and discussion of results. This study will contribute to new knowledge for decision-making on waste management and its potential environmental pollution effect and mitigation potential.

Desired technical skills and/or experience:

- Independent thinking and ability to resolve problems
- Organized and meticulous
- Effective teamwork and interpersonal skills
- Basic Spanish skills are desirable

Links to GRA/CCAFS research groups:

Integrative research group (IRG): Grasslands Research Network and Soil Carbon Sequestration Network.

Host institute and location:

National Institute of Agricultural Technology (INTA), Castelar, Argentina

National Institute of Agricultural Technology (INTA), Buenos Aires, Argentina

Start and end month of research stay: May to October 2021

4. Analyzing impacts of AWD implementation to rice production in upstream and downstream provinces of The Mekong River Delta, Vietnam

Keywords: Rice, hydrology, modeling, irrigation

Brief project outline:

Irrigated rice is known as a thirsty crop that consumes a high amount of irrigation water resources. As estimated, an average of about 3,000 liters of water is used to produce 1 kilogram of rice. Nearly 40% the total amount is required in the dry season, when irrigation mostly relies on the supply of the Mekong River. Reduced discharge due to upstream development as well as higher urban and industrial demand leads to burning issues of water-saving technologies in rice production.

The Alternate Wetting and Drying (AWD) is a water management practice for irrigated rice cultivation developed by IRRI, which could reduce 30% of total water use while also reducing CH 4 emissions. In the Mekong River Delta, AWD is being demonstrated and disseminated by local government organizations, formal extension agencies and NGOs. In order to further outscale this low-emission water management practice, adaptation co-benefits will be a key argument, particularly for local governments.

This project will apply hydrological modeling approaches to determine the implications of AWD implementation on water availability and salinity pressure in the Mekong Delta under different water-shortage scenarios.

Desired technical skills and/or experience:

- Knowledgeable about rice production in Mekong River Delta of Vietnam
- Good understanding of hydrological processes.
- Experienced in hydrological modeling preferred
- Independent and reflective thinking

Host institute and location:

International Rice Research Institute (IRRI), Hanoi, Vietnam

Start and end month of research stay: Flexible starting in the first quarter of 2021

5. Application of Biochar and Co-composted Biochar from Urban, Agricultural and Agro-industrial processing Organic Wastes: Promising Tool for Climate Smart Agriculture

Keywords: Soil, Biochar, Avocado Seed, Food security, Climate Smart Agriculture, Organic Waste

Brief project outline:

The 21st century global controversial challenge is coined in three interwoven arguments; Agriculture, Food Security and Climate Change. The world is looking to double food production by 2050, but due to soil degradation and climate change, a decline in agricultural productivity is being witnessed in some regions of the world. Further, a substantial reduction in atmospheric greenhouse gas (GHG) emissions remains to be seen.

In developing countries, climate change impacts and challenges of food security are more pronounced. Recently the Ethiopian population has exceeded 100 million and by 2050, is expected to be over 200 million. This will make Ethiopia one of the most populous countries in Africa. The increasing population, coupled with the increasing severity and frequency of climate change impacts results in decreased agricultural productivity and increasing food insecurity.

Therefore, research on locally available, environmentally friendly and economically viable (low/no cost) feeds to produce biochar may contribute to these issues. Organic wastes from urban, agricultural and agro-industrial processing waste include: Avocado seed, coffee husk and corn cob, which may be converted to biochar. These waste by-products if utilized as biochar and feedstock may reduce emissions through increasing carbon sequestration. Therefore, biochar may provide a promising tool for climate smart agriculture with other co-benefits to crop productivity, soil fertility, and organic waste management. Particularly, converting avocado seed to Biochar is a new innovation, which may be more accessible for the poorer farmers of Ethiopia.

The research proposal comprises both laboratory and field work.

Desired technical skills and/or experience:

- Hands on experience measuring and analyzing agricultural emissions
- Laboratory skills in characterization of biochar (proximate and ultimate), co-composted biochar;
- Characterization of nutritional quality of crops grown under different soil treatments;
- Physiological and biochemical characterization of crops grown in different soil treatments and their changes in phytohormone patterns in the laboratory;
- Interpretation/analysis of data collected from laboratory;
- Writing skills (ideally successfully accepted and published manuscripts);
- Project management and teamwork.

Host institution and location: Hawassa University, Ethiopia.

Start and end month of research stay: July 2020 - December 2020.

6. Assessing the soil organic carbon sequestration potential of planted forages in Rwanda and Kenya

Keywords: Soil Organic Carbon, Forage grasses, Climate mitigation

Brief research stay outline:

Land degradation caused by continuous cropping is a major problem in sub-Saharan Africa (SSA). Planting perennial forage grasses is now widely promoted in the smallholder livestock production systems in SSA. The main objective of introducing forage grasses is to increase livestock productivity. Potential co-benefits include land restoration and carbon sequestration. Increased soil organic carbon (SOC) is linked to the conversion of cropland to forages or contour planting of forages. However, evidence on the SOC sequestration benefits of planted forages in SSA remains scarce. Through field and laboratory work, this project aims to quantify SOC sequestration potential of planted forages in Kenya and Rwanda.

Farmers that have planted forages, preferably Brachiaria, next to maize plots more than 5 years ago will be identified in the two countries. The student will collect soil samples from minimum 60 sets of paired sites, Brachiaria and maize, at depths of 0-20 and 20-50 cm and determine the SOC stocks, texture, and SOC content for different aggregate fractions. Data on the above- and below- ground biomass for the grasses will also be collected. Using the maize plot as the reference plot, the data will be used to quantify the SOC sequestration for the forages. The collected data can later be used to calibrate and validate biophysical models (e.g. DayCent) to estimate the long-term SOC sequestration potentials of forages under different climate change scenarios. The project results will highlight the role perennial forages can play in restoring degraded lands and mitigating climate change through SOC sequestration.

Desired technical skills and/or experience:

- Strong background on tropical agricultural systems
- Strong Analytical and problem-solving skills
- Previous field experience would be highly valued.
- Excellent written and oral English language

Host institution:

Alliance of Bioversity International and CIAT, Kasarani Rd., ICIPE Complex, Nairobi, Kenya

Start and end month of research stay: October 2020 to March 2021

7. Assessment of low-carbon certification schemes for rice production in Vietnam

Keywords: Rice, label, certification, low-carbon

Brief research stay outline:

Rice production is a large emitter of the greenhouse gas (GHG) Methane (CH4). It is estimated that rice production in Vietnam emits around 10% of global CH4 emissions from rice. GHG mitigation technologies are available, however, they are not adopted by rice farmers at the large scale. One reason is the limited benefit farmers experience from adoption of those technologies. Certification, a label or branding could create an additional benefit but limited questions around the feasibility of such schemes within smallholder rice systems remain.

This project will look into options of labeling rice products as “certified low-emission”, e.g. through production schemes such as the standard of the Sustainable Rice Platform (SRP), VietGAP or the ‘1 Must Do, 5 Reductions’ package. It will assess opportunities and barriers, transaction costs and market options. This study will be conducted in collaboration with the Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD) in Hanoi.

Desired technical skills and/or experience:

- Socio-economic background
- Basic knowledgeable about rice production
- Independent and reflective thinking

Host institute and location:

International Rice Research Institute (IRRI), Hanoi, Vietnam

Start and end month of research stay: October 2020 to March 2021

8. Assessment of nitrous oxide emissions and nitrate leaching in pasture soils modified with the addition of woodchips.

Keywords: fertiliser, N2O, soil

Brief project outline:

Nitrogen (N) is the major nutrient element that most strongly regulates plant production, but it is also identified as a key contaminant contributing to degradation of surface and subsurface environment in New Zealand agricultural systems through either the release of nitrous oxide (N2O) or the leaching of nitrate (NO3-) down to subsurface or groundwater. Sharp increases in fertiliser N inputs since the 1990s to grazed pastures in New Zealand has thus rekindled the debate on its impact on environment.

The addition of woodchips in the subsurface layer of soils can have a substantial influence on the reduction of NO3- leaching and N2O emissions from soils. Moreover, the presence of woodchips provides additional energy source for the microbial population that can help mitigate N leaching through its transformation to N2O and eventually to benign dinitrogen.

The CLIFF-GRADS student will participate in the field and laboratory work to collect data on NO3- leaching and N2O emissions in soils with addition of woodchips. This project is linked with sustainable farming funded project "Opportunities of Shelterbelt in pastoral Systems" looking into differences in soil C stocks and N2O emissions on farms with and without shelterbelts.

Desired technical skills and/or experience:

- A good understanding of implications of added nitrogen on grazed farms
- Familiarity of dairy and beef farm systems
- Skills to follow good laboratory practices
- Problem solving, decision making and team player

Host institute and location:

School of Agriculture and Environment, Massey University, Palmerston North, New Zealand

Start and end date of research visit: Flexible before December 2021

9. Bayesian estimation of greenhouse gas emissions and SOC stocks from man-managed systems through application of first-order compartmental decomposition models

Keywords: SOC modelling, CO2 emissions, agroforestry, SOC stocks, Bayesian model calibration

Brief research stay outline:

The student will adapt a first-order compartmental SOC model to a system of choice. The student must be able to estimate the inputs of C to the system over time, and must also understand the system enough to be able to estimate input history (over the previous decades). The system could be an agricultural system or an agroforestry system. The data needed for the project will be a) SOC over time, b) C inputs over time (or a proxy) c) past history of the system before current management and d) weather data over time (temperature, precipitation, solar radiation and wind speed). Data from multiple sites with the same management will be available, since some will be used for model calibration and some for validation. The model will be constructed starting from ICBM (http://www.oandren.com/ICBMpres.pdf).

The model will be constructed in a Bayesian framework, and then constrained on the measured data to produce estimates on future C trends. The calibrated model will represent a tool to predict the consequences of a certain agricultural management or land use on C stocks and CO2 emissions.

An example of a similar completed project: https://www.slu.se/globalassets/ew/org/andra-enh/uadm/global/agrifose/outputs/briefs/agrifose-brief-icbma.pdf.

Desired technical skills and/or experience:

The student must have basic scientific programming knowledge in R and/or Python. This implies a bit more advanced level than just running basic statistical tests, including some confidence with 'for example' loops, writing functions and other basic algorithm development tools. Advanced programming is not needed.

The student must have a sound training in soil science, in particular biogeochemical cycles, and be well acquainted with the laws governing SOC decomposition (temperature and moisture limitations) as well as a basic understanding of the microbial processes behind it.

A basic grasp of the principles behind differential calculus are also a requirement (there is no need to be able to differentiate or integrate, the computer will do it for us). The student must be able to intuitively understand the meaning of a differential equation or an integral).

The student must above all have a strong personal interest in modeling and must be able to have fun with scientific programming, because most of the activities will include long and tedious debugging of the unavoidable errors in the code.

English language proficiency is a basic requirement.

Host institution and location: Ecology Department, Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden

Start and end month of research stay: Flexible from June 2020 to end of 2021

10. Climatic niche shift and potential future distribution of Balanites aegyptiaca and Ricinodendron heudelotii: implications for conservation and domestication

Keywords: Modelling

Brief research stay outline:

Climate change is predicted to increase average temperatures by 2-4°C over the next 50 years and cause considerable changes in regional and seasonal patterns of precipitation. Effective conservation action of threatened species requires an evidence-based understanding of key population parameters such as geographic distribution and habitat requirements. Habitat suitability models are a group of mechanistic statistical models widely used in ecology, which relate the occurrence of species to a set of environmental variables in order to generate predictions of locations where species are expected to occur. Natural ecosystems including populations of Balanites aegyptiaca and Ricinodendron heudelotii, hold important plant genetic resources for food and medicine and contribute to enhance ecosystem resilience by fighting soil degradation while offering sinks for carbon sequestration. The main objective of this project is to map suitable areas for the conservation and domestication of B. aegyptiaca and R. heudelotii under future climate scenarios. Specifically, the research aims to: (i) assess the current distribution of B. aegyptiaca and R. heudelotii in Benin, and (ii) forecast the future distribution of B. aegyptiaca and R. heudelotii under different seed dispersal.

This proposal includes both field and laboratory work. Occurrence data will be collected on B. aegyptiaca and R. heudelotii, across their geographical distributions. Available bioclimatic and soil data layers will be used with maximum entropy approaches.

Desired technical skills and/or experience:

- Ecological niche modelling skills (MaxEnt, QGIS and R softwares)
- Familiarity with IPCC, GBIF and AfriClim databases and with forest inventory technics
- Effective teamwork, independent and reflective thinking

Host institution and location:

LABEF - Laboratory of Biomathematics and Forest estimations Campus of Abomey-Calavi, Building of CBIG (2nd Floor), Republic of Benin

Start and end month of research stay: October 2020 to March 2021

11. Co-design and dissemination of options to mitigate the impact of livestock on Climate Change

Keywords: livestock

Brief research stay outline:

In many developing countries, ruminant farming in pastoral and agro-pastoral systems accounts for a large share (around 90%) of the total greenhouse gas (GHG) emissions that contribute to climate change. Current work places the (agro) pastoral livestock farming systems of Sahelian countries as the most emitting GHGs per unit of product in the world. In most of these Sahelian countries, pastoral farming occupies an important place in society. Hence, the need to reflect on new pastoral strategies enable to contribute to the mitigation of climate change and food security for populations. This is the context for the research and development initiative called, "Carbon Sequestration and greenhouse gas emissions in (agro) Silvopastoral Ecosystems in the Sahelian CILSS States" (CaSSECS), which objective is to co-design and disseminate new options for mitigating climate change by drawing on the knowledge and practices of pastoralists and agro-pastoralists. Very specifically, these livestock options aimed to:

I. improve the ruminant feeding system;
II. improve the sustainable management of resources on a regional scale;
III. improve animal productivity, incomes of pastoral populations and carbon storage.

To date, there are some interventions aimed to promote such options with a strong potential for climate change mitigation and carbon storage. But they remain little adopted by pastoral populations. This project focuses on supporting pastoral populations to adopt breeding practices favorable to the mitigation of climate change. The student will conduct surveys of pastoral populations, set up, monitor and evaluate devices for experimenting with innovative practices by mobilizing companion modeling.

Desired technical skills and/or experience:

- Hands on experience with livestock system, particularly pastoralist livestock system
- Independent thinking and ability to resolve problems
- Organized and meticulous
- Effective teamwork and interpersonal skills
- Basic English skills are desirable but not essential

Host institution and location: Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), Montpellier, France

Start and end month of research stay: February to July 2021.

12. Combining mitigation strategies to enhance soil carbon sequestration without compromising yields in Mediterranean woody cropping systems

Keywords: soil carbon sequestration, inter-cropping, CO2

Brief research stay outline:

Agriculture contributes 25% of global greenhouse gases (GHG) emissions. Given soils account for the majority of agricultural emissions, adopting climate-smart agricultural practices such as reducing or halting tillage, compost application, inter-cropping, growing cover crops, and implementing crop residue retention measures, can be powerful mitigation strategies to decrease greenhouse gas emissions. Moreover, increasing soil organic carbon can yield co-benefits, such as enhanced fertility and productivity, increased water infiltration and reduced erosion. However, to date, no single strategy has been identified as consistently cost-effective in mitigating climate change in Mediterranean agroecosystems.

CEBAS-CSIC is currently involved in a H2020 project (DIVERFARMING-Crop diversification and low-input farming across Europe: www.diverfarming.eu/index.php/en) leading two case studies specifically focused on improving crop productivity and reducing environmental impact through crop diversification and climate-smart agricultural practices in semiarid Mediterranean conditions. This project will provide information on the effects of combining different climate-smart agricultural practices (i.e., reduced tillage, diversification) on the mitigation potential of rain-fed and irrigated Mediterranean agroecosystems.

The student will conduct measurements of soil carbon stocks, CO2 emissions, carbon losses by erosion, and crop yields in rain-fed and irrigated mono-cropping and multi-cropping systems under different management strategies. The outcomes of the project will help to update emission factor values and to identify the most cost-effective management strategies in Mediterranean conditions. This proposal includes both laboratory and field work as well as training on different methodologies to estimate greenhouse gas emissions, carbon sequestration rates and carbon balance assessments from the agricultural sector.

The research stay will enable the student to interact with relevant research groups working in greenhouse gas emission mitigation strategies and soil carbon storage in agricultural systems across Europe. This CLIFF-GRADS research stay will contribute to the GRA research agenda relating to 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
- Data management and analyses
- Good team player
- Basic Spanish skills and driving licence are desirable but not essential

Host institution and location: Soil and Water Conservation Research Group, Centro de Edafología y Biología Aplicada del Segura (CSIC, Spanish Research Council), Murcia, Spain (www.cebas.csic.es; www.soilwaterconservation.es)

Start and end month of research stay: 6 months, preferably September 2020-February 2021

13. Defining the most appropriate dairy cattle genetics for high altitude Andean small-holder systems: Reducing CH4 emission intensity through improved feed efficiencies and rumen function management.

Keywords: Livestock, enteric methane, small-holder dairy systems, genetics, rumen function

Brief project outline:

Note that the "Defining the most appropriate dairy cattle genetics for high altitude Andean small-holder systems" research stay proposal has two projects. Please see the following proposal.

Accelerated climate change (CC) in the high Andean zones makes crop production very risky; while small-holder dairying is becoming the most important activity, socio-economically. However, the productivity and profitability of the current dairy farming system is questionable. The high altitude Andes have severe limitations, both biotic (e.g., seasonality of forage production) and abiotic (accelerated CC, hypoxia, high UV radiation, etc.), for dairying. Current animal genetics are imported from systems dissimilar to those at the Andes. Severe altitude, thermal, nutritional and water stress result in low productivity and profitability, and result in high environmental impacts, poor animal welfare and poor quality of life for farmers.

The Peru-New Zealand Dairy Support Project (funded by NZAID), working in the above described system, has shown (with nil or little investment) rapid increases in profitability of up to 150%, and improved animal welfare and quality of life. The producer-to-producer extension of good farming practices is used to create awareness and motivation for change. Farmers first apply the most accessible livestock management practices (systemic conception, record taking and management, animal health management, permanent provision of drinking water, rotational grazing on leafy pasture, increased grazing hours and reduction of hours in sheds). However, from experience, it has been concluded that current animal genetics limit further system production improvements. In addition to altitude, nutritional, cold temperatures and water stressors (which increase metabolic energy requirements for the animals), the large size of the animals (600-700 kg bodyweight) mean that a high portion of feed consumption is used for maintenance and activity, leaving little for production and reproduction requirements.

Large animals also affect pasture and soil by trampling and compaction. Animal genetics with superior productive and functional characteristics, demonstrated in the conditions of the high Andean environment, would facilitate the design of appropriate production systems. Here we propose to elucidate the characteristics of that 'ideal' animal by evaluating the effects of prevalent Andean factors on productivity and fertility, profitability, physiology, animal welfare and environmental impact of four genotypes of cattle (including Creoles) and alpacas (adapted to Andes). The information obtained will serve to recommend the most appropriate animal genetics ('best bet'), to develop a technological proposal to improve dairy farming production and at the same time conserve native genetic resources (camelids) and Creole cattle.

This application is for a student to support feeding and rumen function management strategies for reduced CH4 emission intensities from high altitude grazing systems. The project is partially funded by NZ Ministry for Primary Industries and should contribute to determine emission factors of methane from small holder dairying.

Desired skills and experience:

- Awareness/experience in extensive free-range small-holder livestock farming systems

- Skills in measurements of rumen function and methane emission in vivo
- Good interpersonal skills, knowledge of Spanish not strictly essential
- Physically fit to spend most of the time at high altitude (3,700-4,200 masl).

Host institution and location: Instituto Veterinario de Investigaciones Tropicales y de Altura – IVITA Marangani, Faculty of Veterinary Medicine, Universidad Nacional Mayor de San Marcos, Peru. The research station is located in Sangarara, Cusco, Peru.

Start and end month of research stay: Flexible from July 2020 to December 2021.

14. Defining the most appropriate dairy cattle genetics for high altitude Andean small-holder systems: Determining feed energy partitioning to CH4, stress response and energy expenditure, and their ratios to milk energy.

Keywords: Small-holder livestock systems

Brief project outline:

For information on "Defining the most appropriate dairy cattle genetics for high altitude Andean small-holder systems", please see the project outline from the previous research stay proposal.

This application is for a student to support establishing the ratio of CH4 energy, energy cost of stress and energy expenditure to milk energy in dairy cattle genotypes at high altitude grazing systems. The project is partially funded by the New Zealand Ministry for Primary Industries and should contribute to determine emission factors of methane from small holder dairying.

Desired skills and experience:

- Awareness/experience in extensive free-range small-holder livestock farming systems.
- Skills in energy partitioning and metabolism or stress response or animal genotyping.
- Good interpersonal skills, knowledge of Spanish not strictly essential.
- Physically fit to spend most of the time at high altitude (3,700-4,200 MASL).

Host institution and location: Instituto Veterinario de Investigaciones Tropicales y de Altura – IVITA Marangani, Faculty of Veterinary Medicine, Universidad Nacional Mayor de San Marcos, Peru. The research station is located in Sangarara, Cusco, Peru.**Start and end month of research stay:** Flexible from July 2020 to December 2021.

15. Development of nitrogen-urea-milk content as an indicator of temporal and spatial distribution of N2O emissions.

Keywords: Dairy, livestock, N2O

Brief research stay outline:

In Uruguay, agricultural activity contributes more than 75% to total national greenhouse gas (GHG) emissions. Methane (CH4) and nitrous oxide (N2O) are the main gases emitted by the agrciulture sector. In the case of N2O emissions, agricultural activity contributes more than 90% of total emissions and over 80% of this is ammoniacal nitrogen (N-NH4+) contained in urea of the urine deposited on soils by grazing ruminants, from beef and dairy production systems. Particularly, the dairy sector, predominantly based on grazing, is known for high levels of emissions and variable N2O emissions intensity per unit of milk production. Such variability is affected by the geographical and seasonal changes of grass protein content.

The strong relationship between the nitrogen intake (i.e. protein) by ruminants and the nitrogen-urea content in milk and excreted in urine has been well documented. Therefore, we hypothesized that milk N-urea content is a good indicator of the potential emission of N2O from the urine-N deposited on soils.

The objective of this project is to develop an indicator to monitor the geographical and temporal variations of potential N2O emissions, in real time, according to the urea content in milk recorded in dairy farms from different production regions of Uruguay. This monitoring would inform the mitigation of N2O emissions from animal production systems.

This proposal includes both laboratory and field work.

Desired technical skills and/or experience:

- Hands on experience with animals, particularly dairy cows
- 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 Agropecuaria. Estación Experimental INIA-La Estanzuela, Colonia (Uruguay).

Start and end month of research stay: Sep 2020 – Feb 2021

16. Directed evolution of rumen microbial cultures towards the identification and stimulation of electron sinks alternative to methanogenesis

Keywords: rumen, methane, enteric fermentation, in vitro, microorganisms, metabolism

Brief project outline:

The student will conduct experiments that form part of a 3-year project that began in 2019. Inhibiting rumen methanogenesis of in vitro cultures results in a consistent decrease in the recovery of metabolic hydrogen, which is in part redirected towards unidentified CH4 sinks. It is important to identify these sinks under different situations so as to understand their potential nutritive value for the ruminant host animal. The objective of this project is to identify and stimulate electron sinks alternative to that provided by methanogenesis in rumen fermentation through microbial manipulation.

We propose directing the evolution of rumen microbial communities in vitro by conducting sequential transfers of batch cultures, both in the presence of and absence of methanogenesis inhibitors. In each series of transfers, we will select cultures based on their fermentation products. In this way we will learn which electron disposal pathways alternative to methanogenesis have the greatest potential to be stimulated. The knowledge generated in this proof of concept experiment will be useful to design strategies to stimulate electron sinks alternative to methanogenesis in rumen fermentation that can at the same time enhance ruminant productivity.

Desired technical skills and/or experience:

- An inclination to work in the laboratory
- Independent thinking and ability to resolve problems
- Organized and meticulous
- Basic Spanish skills are desirable but not essential

Host institute and location:

Instituto de Investigaciones Agropecuarias INIA Carillanca, Temuco, Chile

Start and end month of research stay: June through November 2021

17. Effect of legumes on reducing N2O and NH3 losses following application of faeces and urine to soil from cows fed with legume diet

Keywords: legumes, gaseous losses, GHG, N2O, NH3.

Brief project outline:

Gaseous emission to the atmosphere is important in livestock production, especially in locations like Southern Chile where livestock feeding is based mainly on gramineous permanent grassland systems. This proposal focused on reducing N2O and NH3 losses following application of faces and urine to soil from cows feed with diets based on pasture and supplemented with legumes. This study is part of the international project 'Sustainable Intensification of Livestock Systems with Legumes: Latin American and Caribbean Cooperation Platform' funded by FONTAGRO, PROCISUR and MPI-NZ, which main objective is to improve livestock production systems through the adoption of forage legumes. The faces and urine will be also collected from a precedent and related study of this project evaluating the effect on enteric CH4 emissions, so the study will have a system approach considering the effect of a legume as a GHG mitigation option on dairy cows' diet and its faces and urine, having and integrate approach.

This proposal contemplates both laboratory and field work, using published techniques for gaseous emissions and the infrastructure of Institute for Agriculture Research (INIA-Chile). The candidate will have also training in different GHG techniques, interacting with our research team with experience in GHG studies.

Desired technical skills and/or experience:

- Hard interest for laboratory and field work.
- Effective teamwork.
- Basic Spanish or English skills are desirable but not essential.

Host institution and location:

Instituto de Investigaciones Agropecuarias (Institute for Agriculture Research, INIA), Centro Regional de Investigación Remehue (Remehue Research Centre, INIA Remehue), Osorno, Chile.

Start and end month of research stay: Flexible from June 2020 to November

18. Effects of inhibiting methanogenesis on propionate production in the rumen

Keywords: livestock, rumen, enteric fermentation, methane, propionate, tracers, dairy cattle

Brief project outline:

It is hypothesized that inhibiting rumen methanogenesis shifts fermentation from acetate to propionate. To date, several experiments have studied the response of the concentration of volatile fatty acids (VFA's) to the inhibition of rumen methanogenesis, but the effects on the actual rate of rumen VFA production have not been measured. The objective of this experiment is to determine the effects on inhibiting methane formation in the rumen on the rate of propionate production in dairy cattle rumen.

The student will conduct an experiment with four ruminally-cannulated dairy cattle fed a mixed diet in a Digestion and Metabolism Unit. The experiment will comprise a baseline period followed by a methanogenesis-inhibition period. In the last 6 days of each period, production of methane will be measured using the sulfur hexafluoride marker gas (SF6 tracer technique). Feed, refusals and feces will be weighed, sampled and analyzed for proximal composition to determine digestibility of different feed fractions. Urine will be collected and nitrogen content analyzed to conduct a nitrogen balance. 13C-labelled sodium propionate will be treated in the rumen and rumen samples will be collected at different time points, and the abundance of 13C-propionate will be measured to model propionate production kinetics.

Desired technical skills and/or experience:

- A focus in research in animal digestion and metabolism
- Ability to work independently and resolve practical problems
- Organized and meticulous
- Experience with digestion and metabolism experiments with ruminants desired but not essential
- Basic Spanish skills are desirable but not essential

Host institute and location:

Instituto de Investigaciones Agropecuarias INIA Remehue, Osorno, Chile

Start and end month of research stay: February through July 2021

19. Effects of essential oils on rumen fermentation, microbial diversity in rumen and methane emission in tropical systems

Keywords: livestock, CH4, NGS, *Citrus sinensis, Citrus aurantium, Cinnamomum verum*

Brief research stay outline:

Ruminant husbandry is one of the largest contributors to greenhouse gas emissions from the agriculture sector, particularly of methane, which is a byproduct of the anaerobic fermentation of structural and non-structural carbohydrates in the rumen. The livestock sector seeks natural feed additives for ruminants that improve feed efficiency, nutrient utilization and thus reduce methane emissions.

Essential oils are composed by groups of monoterpenes, oxygenated monoterpenes, sesquiterpenes, oxygenated sesquiterpenes, and other oxygenated compounds. Essential oils may cause changes in the ruminal archaeal and protozoal communities decreasing methanogen abundance, and consequently methane production. Understanding the ruminal microbiome and its modifications (due to essential oils, in this case) is crucial due to its central role in the ability of these microorganisms to produce high quality proteins with low quality inputs. The student will conduct an experiment that aims to evaluate the effects of essential oil additions to rumen bacteria and methanogenic archaeal communities through Next Generation Sequencing (NGS). This study will provide experience and the opportunity to strengthen understanding on the use of essential oils as an additive in cattle feed.

Desired technical skills and/or experience:

- Experience with tropical livestock
- Organized and motivated
- Effective teamwork and interpersonal skills

Host institute and location: CIAT, Palmira, Valle del Cauca, Colombia

Start and end month of research stay: July 2020 – December 2020

20. Energy use efficiency of dairy cows fed by-products in early lactation

Keywords: livestock, CH4, respiration chambers

Brief research stay outline:

Dairy production in Argentina represents an important economic activity, producing 10.3 billion kg of milk per year in 2019 (Observatorio de la Cadena Lactea Argentina). In fact, Argentina is one of the main milk producers and exporters worldwide. Methane is produced by ruminants during the digestion process and contributes 14% to Argentina's total GHG emissions. There is a huge focus therefore to reduce GHG emission intensity of the livestock sector. Dairy cattle in early lactation have a negative energy balance (NEB), which may compromise their productive efficiency throughout the lactation.

The aim of this project is to find feeding alternatives to reduce the NEB of lactating cattle and improve the entire energy use efficiency during their productive cycle. For that, an experiment will take place at the Methane lab of INTA Balcarce to measure CH4 emissions from lactating cows in respiration chambers. Two treatments will be set to test the impact of feeding by-products to lactating cows on their enteric CH4 emissions, nitrogen balance, and milk quality.

The student will participate in daily activities during the experiment, and it is expected that they will gain experience in the whole research process including sampling, diverse laboratory techniques, data analysis, and publication.

Desired technical skills and/or experience:

- Experience in field work, mainly dairy cows.
- Knowledge of livestock production systems and nutrition, enteric CH4 production and measurements techniques.
- Good English (speaking and writing), Spanish (speaking) would be preferable.
- Team collaboration

Host institution and location:

INTA Balcarce, Buenos Aires Province, ARGENTINA.

Start and end month of research stay:

6 months from March to August, 2021

21. Evaluating innovative strategies for ruminant methane abatement

Keywords: livestock, methane conversion, feed, ruminants

Brief project outline:

Globally, ruminant food production is responsible for ~9% of anthropogenic CO2 emission and 37% of CH4 emissions. Inefficient feed and low methane conversion rates result in 6-12% less energy being available to the animal. Ruminants also contribute N2O within the environment, a persistent gas in the atmosphere which has 298 times more warming potential than CO2.

The CLIFF-GRADS research stay supervisor Professor Sharon Huws is the network leader for the GRA Rumen Microbial Genomics network and currently leads multiple collaborative projects in the area of ruminant methane abatement.

Projects she is leading include RumenPredict and MASTER, which are focussed on evaluating effects of diet and host genetics on the rumen microbiome and host phenotype. Recently, Professor Sharon Huws has secured funding to evaluate and develop macro algae based technologies for ruminant methane reductions. These projects in their entirety will enhance innovative capacity and allow integration of new knowledge with existing research to devise geographic and animal-specific solutions to reduce the environmental impact of ruminants. The successful student will play an integral part in developing these research projects, alongside aligned members of staff, who will provide the necessary training.

Desired technical skills and/or experience:

- Some Microbiology or bioinformatics skills (additional extensive training will be provided)
- Hands on experience with ruminants (additional extensive training will be provided)
- Independent thinking and ability to resolve problems
- Organized and meticulous
- Effective teamwork and interpersonal skills
- High level of written and spoken English

Host institute and location: School of Biological Sciences/Institute of Global Food Security, Queens University, Belfast, UK

Start and end month of research stay: Flexible

22. Evaluation of field measurements focussing on the impact of rice varieties on GHG emissions in combination with advanced mitigation technologies

Keywords: rice, CH4, N2O, mitigation, Laser Levelling, AWD, MRV

Brief research stay outline:

This research stay will be closely linked to IRRI's activities in the Thai Rice NAMA project that forms an integral part of the bilateral project portfolio under the CGIAR Climate Change Agriculture and Food Security (CCAFS) research programme. Six target provinces in Central Thailand are dominated by irrigated rice systems and offer tangible entry points for changing crop management toward low-emission practices.

The project approach focuses on the combination of Alternate Wetting and Drying and Land Laser Levelling (AWD+LLL) as the most efficient technology to reduce emissions. At this point, however, the project does not consider the important role of rice varieties as a modulator for baseline emissions, as well as their possible interaction with mitigation technologies.

Field measurements on CH4 and N2O emissions are to be conducted by project staff in the late rice season 2020 and early rice season 2021. The objectives of this research stay are:

- Compiling a comprehensive data base on field measurements and establishing user-friendly routines for searching of different experimental settings (incl. plant varieties)
- Assessing emission impacts associated with the most dominant rice varieties in each province in combination with AWD+LLL
- Extrapolating GHG emissions for all 6 provinces under present distribution of varieties using a GHG calculation tool
- Quantifying the amplification of mitigation impacts through targeted dissemination of low-emission varieties in the project area
- Documenting all research findings in a comprehensive form that can be used in the MRV (Measurement, Reporting, Verification) system of the project to take account of variety effects

Desired technical skills and/or experience:

- Thorough understanding of GHG field measurements based on the closed chamber technique
- Good skills and experience in database management
- Knowledge on agronomy of rice production (ideally including mitigation technologies)
- Familiarity with GHG calculation tools (based on IPCC Tier 2 accounting)

Host institution and location:

International Rice Research Institute, Project Office located in Thai Rice Department, Bangkok

Start and end month of research stay: Flexible between September 2020 to July 2021.

23. Feed gaps and associated greenhouse gas emission intensities of smallholder dairy systems in Tanzania and Rwanda

Keywords: livestock, feeding, forages, methane emissions, East Africa

Brief project outline:

Feed is a critical limiting factor in productivity gains of smallholder dairy systems in East Africa. In addition, livestock contributes around two thirds of greenhouse gas emissions (GHG) in these agricultural systems through enteric fermentation and manure management, making it a main focus for mitigation. Poor feed quality is the main driver of livestock methane emissions in East Africa, making GHG emission intensities among the highest worldwide.

Modeling emissions following the IPCC accounting guidelines relies heavily on activity data collected in surveys, which poses a risk given farmer feed data is known to be error prone than other variables, which combined, lead to high uncertainties of the GHG emission modeling results of these nations.

The CLIFF-GRADS student would first conduct field work to extend an existing, empirically collected dataset of feed quantities and qualities across various agro-ecological zones, over a diverse range of smallholder dairy systems in both the wet and dry seasons in Tanzania and Rwanda. Feed gaps in crude protein and metabolizable energy between current levels of production and potentially attainable milk production levels will be calculated. Options to close such feed gaps, including by the inclusion of improved forages, will be explored.

In the next phase, this collected data will be utilized to improve modeling of enteric fermentation emissions from East African smallholder dairy systems using the Ruminant model, which will greatly improve emission estimation precision due to the higher quality of available data.

Results of this project will contribute to better targeting improved livestock feeding, which is essential to increase dairy production efficiencies and decrease GHG emission intensities. The research project closely aligns with interests of the GRA Livestock Research Group (LRG), especially the Feed and Nutrition Network.

Desired technical skills and/or experience:

- Proven background in livestock science and animal nutrition
- Experience conducting field work in smallholder farm conditions
- Strong analytical, data management and computer skills
- Excellent written and oral English

Host institution:

Alliance of Biodiversity International and CIAT, Kasarani Rd., ICIPE Complex, Nairobi, Kenya

Start and end month of research stay: September 2020 to February 2021

24. Functional value validation of active compounds from trees and shrubs introduced and native in livestock systems as an integrated strategy to rumen ecosystem and its sustainable contribution on eco-systemic services of dairy systems from Cundinamarca-Colombia

Keywords: dairy system, agroforestry, biodiversity, ecosystem services, GHG

Brief research stay outline:

The application of silvopastoral system to production agriculture and the possibility that such system might reduce the environmental footprint of animal agriculture whilst boosting productivity is of great significance.

This is particularly important in tropical countries where environmental supply and payment for ecosystem services present great opportunities to increase production that incorporate native and adapted natural resources, and business sustainability values. The project aim is to validate the functionality of active compounds from trees and shrubs used in dairy farming systems, their role in ecosystem services as reducing GHG emissions, and consequently their response to mitigation and adaptation of dairy production systems. This research considers the tree to the rumen ecosystem, from a production point of view, to capture their ecosystem co-benefits at local and regional levels, in order to restore and enhance ecosystem services for sustainable livestock in Colombia.

The study will be conducted in three livestock provinces of Cundinamarca, located in the Andean Region of Colombia. The materials will be sampled with attributes for environmental services and forage potential. The interaction between the active compounds of trees and shrubs with the rumen system will be determined by anaerobic fermentation *in vitro* and at farm level using dairy cows grazing in three silvopastoral system. Weather information will be taken and crossed with animal production responses. Feed intake under grazing will be determined using external and internal markers, enteric methane emission estimates using the methane laser detector technique. The dynamics of microbiome change will be sequenced by MiSeq in specialized laboratories. Evaluation of methane and nitrous oxide flows in soils using static closed chamber techniques will consequently determine the soil-plant-animal-rumen microbiome interactions.

The student will conduct one experiment at farm level to validate the functionality of active compounds from trees and shrubs (introduced and native) for application in livestock systems. This applied project will provide the effectiveness and adding value when including silvopastoral system as an integrated strategy to rumen ecosystem and its sustainable contribution on eco-systemic services of dairy systems from Cundinamarca-Colombia.

At Agrosavia we have a well-developed program on rumen microbiology, GHG emission from ruminants and the effect and characterization of natural products and forages (https://alimentro.agrosavia.co/Home/Index?ReturnUrl=%2f) on the rumen ecosystem, and the project is funding by COLCIENCIAS and Agriculture ministry.

Desired technical skills and/or experience:

- Knowledge in rumen microbiology
- Hands on experience with animals, particularly dairy cows
- 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: Agrosavia (https://www.agrosavia.co/); Corporación Colombiana de Investigacion Agropecuaria. CI Tibaitata, km 14 via Mosquera, Bogota, Colombia.

Start and end month of research stay: October 2020 to March 2021.

25. Generating canopy shade and microclimate advice to improve coffee productivity and quality in the face of climate change in southwest Ethiopia

Keywords: Climate change, coffee quality, elevational gradients

Brief research stay outline:

Coffee is highly sensitive to increasing temperatures, making its cultivation vulnerable to the changing climate. IPCC (2018) projections encompass a global temperature rise of 2-4°C and anticipate changing precipitation patterns by the end of this century. Regional warming and erratic rainfall have already increased the frequency of poor harvests and thus affected coffee productivity. Rising temperatures, frequent droughts and increasingly erratic weather patterns are predicted to reduce the overall land suitable for growing Arabica coffee in Ethiopia by 50% between 2040-2070 (Moat et al., 2017; Ovalle-Rivera et al., 2015).

One of the suggested solutions to the negative effects of extreme temperature and frequent drought on coffee is to improve the microclimate buffering caused by shade tree canopies. Significant research efforts have been undertaken to investigate the anticipated impact of climate change on Arabica coffee, based on modelling from downscaled global climate models (Davis et al. 2017; Moat et al. 2017; Rodrigues et al. 2016). However, in-situ data collected on smallholder farms in Ethiopia is rare and very little is known on how shade levels determine microclimate buffering and impact coffee quality.

The focus of this research visit will be on microclimate measurements (soil temperature, surface soil humidity, air temperature, and humidity under the forest canopy). Relative humidity is the ratio of the partial pressure of water vapour to the equilibrium vapour pressure of water at a given temperature. Relative humidity is a contributor to (given water vapour is a greenhouse gas) and measure of greenhouse gases and leads to further increases in the surface temperature.

Hence, to build a climate resilient Ethiopian coffee production system, good and reliable field based data is required to generate integrated knowledge along the coffee supply chain which will ensure the sustainability of yield and improved bean quality in the face of climate change. This PhD work includes both field and laboratory work. For more information, see www.eiar.gov.et.

Desired technical skills and/or experience:

- Excellent experience in scientific writing
- Modest experience in crop growth modeling
- Statistical skills: research methodology, experimental designs (CRD, RCBD, factorial, Split-split plot), cross-sectional, time-series & longitudinal data analysis, ANOVA, PCA & redundancy analysis, systematic review & meta-analysis, multilevel modeling, applied linear & non-linear regression and structural modeling.
- Independent thinking and ability to solve problems in skillful manner
- Effective teamwork and interpersonal skills
- Excellent written and verbal communication in English language

Host institution and location: Jimma University, Jimma, Ethiopia

Start and end month of research stay: Flexible after October 2020

26. Greenhouse gas emissions and carbon sequestration in diversified rice systems

Keywords: rice, CH4, soil, N2O, rotation

Brief research stay outline:

Despite contributing about 11% of anthropogenic methane emissions, intensive irrigated rice systems are important for food provisioning in Asia. These systems are, however, undergoing large changes driven by shortages of water and labour, as well as changing diets, which have resulted in increased diversification as well as mechanization. This has led to the introduction of an extended soil aerobic phase compared to the traditional continuous rice-rice system that are continuously flooded. While continuous submergence promotes stabilization of soil organic carbon, the introduction of an aerobic phase can promote decomposition of organic carbon under diversified rice systems.

Methane emissions are reduced when aerobic phases are introduced, while there can be tradeoffs with nitrous oxide emissions being increasing. While several studies have reported reductions in methane emissions but increased nitrous oxide emissions when continuous rice is converted to rice-upland rotation, most have been observed in short-term experiments. Therefore, we propose an evaluation of methane and nitrous oxide emissions in a long-term experiment (26 years) with contrasting tillage and residue management practices.

The student will measure methane and nitrous oxide emissions in a 2*2*2 factorial experiment; rotation (rice-rice vs rice-maize), tillage (conventional puddling vs no tillage), and residue management (removal vs incorporation). These greenhouse gas measurements will provide an idea of how management can alter the emissions from rice-rice compared to rice-upland cropping systems.

Desired technical skills and/or experience:

- Major in soil- or environmental sciences
- Independent and reflective thinking
- Basic knowledge of soil-nutrient cycling

Host institution and location:

IRRI, Los Banos, Philippines

Start and end month of research stay: July to December 2020

27. Greenhouse gas emissions from dryland cropping systems under two tillage and crop rotations

Keywords: soil organic carbon, conventional tillage, CO2, CH4, GRACEnet, N2O.

Brief research stay outline:

Tillage results in decomposition of soil organic C (SOC) and accelerates CO2 emissions, while conservation tillage, especially no-tillage, reduces SOC losses and CO2 emissions. A CLIFF-GRADS student will obtain experience in collecting Greenhouse Gas (GHG) samples using removable vented static chambers and GRACEnet protocols from the USDA-Agricultural Research Service. In addition, the student will have the opportunity to sample soils in wheat-fallow, wheat-wheat-sorghum, and wheat-wheat rotations, and shadow a physical science technician and become familiar with techniques employed to process samples and report gas emissions. Soil gas samples will be analyzed by Gas Chromatography (Scion-456-GC, with ECD, TCD and FID), and data will be processed and analysed using several models (e.g., HM, HMR) to calculate GHG fluxes. Soil gas samples (CO2, N2O, and CH4) are collected weekly during the growing season, and periodically after harvest.

Specifically, the PhD student will:

(1) participate in field studies to collect GHG (CO2, N2O, and CH4) samples;
(2) process samples and quantify gas emissions;
(3) estimate the effects of tillage, crop rotation, and total precipitation on GHG flux;
(4) learn how to select the proper model for each individual gas;
(5) utilize existing experimental data from his/her experiment to integrate the information into a written report selecting the best management practices for the soil and climatic conditions.

Upon returning to his/her home country the student should be able to design experiments to improve SOC, reduce GHG emissions, transfer knowledge gained to their colleagues, and continue research collaboration with members of GRA Croplands Research Group (CRG).

Desired technical skills and/or experience:

PhD student competent in soil science with a good understanding of major factors influencing soil N2O, CH4 and CO2 emissions, and the role of soil water content, crop residues, soil organic matter, and N fertilizers in GHG emissions under dryland cropping system.

Host institute and location:

USDA-Agricultural Research Service - Soil and Water Conservation Research Unit, Pendleton OR 97801, USA.

Start and end month of research stay: October 2020-April 2021.

28. Greenhouse gas emissions from extensive livestock systems under Mediterranean conditions: On-site nitrous oxide quantification and C budget estimations by LCA

Keywords: Livestock, pastoral systems, Mediterranean, N2O, LCA, carbon budget

Brief research stay outline:

Information on greenhouse gas (GHG) budgets of agro-ecosystems under Mediterranean conditions is scarce. Most emission measurement initiatives have been focused on cropping systems, and there is a lack of livestock emission measurement initiatives. In the particular case of dehesa[2] ecosystems, data on GHG (N2O and CH4) fluxes is missing from inventories. With this work, we propose that the CLIFF-GRADS student will be involved in an existing multidisciplinary team aiming to measure on-site N2O fluxes from silvo-pastoral agro-ecosystems under Mediterranean conditions (i.e. dehesa ecosystems). Research results will be integrated in a full Life Cycle Assessment with the objective of estimating the carbon budget of these particular systems, and identifying potential CO2 sinks in dehasa ecosystems.

GHG fluxes will be measured using manual static chambers within a research team of the Technical University of Madrid with a combined 15 years' experience in this field. The research consortium in which the CLIFF-GRADS student will be integrated is also comprised of experts in animal behaviour (University of Cordoba, Spain), forest ecologists (University of Extremadura), whom belong to the Spanish research Network on GHG Mitigation in Agroforestry (Red REMEDIA).

Results from this research will also complete ongoing efforts by Spanish initiatives such as red NUEVA on improving national GHG inventories. The Network is led by researchers actively participating in GRA research activities.

Desired technical skills and/or experience:

- Hands on experience in field research measuring GHG fluxes
- 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:

Research Center for the Management of Environmental and Agricultural Risks (CEIGRAM), Universidad Politécnica de Madrid, Madrid 28040, Spain

Start and end month of research stay: October 2020-March 2021

[2] The dehesa is defined as an agroforestry system that is characteristic of the southwestern Iberian Peninsula, where grassland is combined with evergreen species of the genus Quercus. https://bioone.org/journals/Rangeland-Ecology-and-Management/volume-62/issue-2/07-135.1/Sustainability-in-Spanish-Extensive-Farms-Dehesas--An-Economic-and/10.2111/07-135.1.short

29. Greenhouse gas emission mitigation strategies in dairy production systems of Argentina.

Brief project outline:

In recent years, greenhouse gases (GHG) have gained international attention due to their significant contribution to Climate Change. Livestock production, in particular dairy cattle, is a worldwide recognized source of GHG emissions; however, little information exists on the emissions from dairy farms in Argentina. Although Argentina's dairy sector has experienced a strong development in the last years promoted mainly by a consistent farm intensification, dairy system pressure on natural resources remains high. Environmental pressure may be reduced through production efficiency gains and identification of best emission mitigation practices. To evaluate mitigation practices, dairy system researchers account for emissions using protocols to estimate both GHG emissions and carbon footprint (IPCC reporting guidelines or LCA).

We are working on the quantification of GHG emissions in typical dairy farms in the Pampas Basin of Argentina and their evaluation against productive and economic performance indicators to identify high-production and low-emissions dairy systems, and the most promising mitigation options.

The PhD student will participate in data collection, technical analyses to estimate GHG emissions and carbon footprint at system level in order to select dairy farm practices environmentally friendly and economically sustainable as part of a GHG mitigation plan for Argentinean dairy farms.

Desired technical skills and/or experience:

- Good understanding of the environmental impacts of dairy production and gross margin estimation.
- Familiarity with IPCC and with LCA approaches
- Good ability to work with excel Independent and reflective thinking.

Host institute and location:

National Institute of Agricultural Technology (INTA), Balcarce, Bs As, Argentina (in collaboration with INTA-Rafaela, INTA-Paraná and National Technological University - Rafaela Regional Faculty).

Start and end month of research stay: Before July of 2021

30. Greenhouse gas mitigation from dairy and beef systems across a development gradient

Key words: Modelling, livestock, system boundaries, development gradient

Brief project outline:

The project would use the Bangor experience in farm management and LCA models that estimate the economic and environmental effects of reducing greenhouse gas (GHG) emissions by changing farm practices across a development and intensity gradient (e.g. Ethiopa to the Netherlands). This would contribute in training a PhD student to develop understanding in the requirements for data sources across the dairy and beef industry, the different GHG challenges in different countries and appropriate management practices to mitigate these challenges. The project will estimate country specific mitigation options for a range of agricultural management practices. This fits very much with the GRA Flagship on Agricultural GHG Inventories, particularly in sharing experience and knowledge, enhancing capability and capacity and in understanding the economic barriers to adoption. The project builds on the CLEANER COWS and SusCoRiDa projects evaluating the environmental and socio-economic effects of dairy intensification in the UK and Costa Rica respectively.

An important aspect of the project and the tools for which training is offered is the use of models that optimise either GHG emissions or farm-level economic returns and the consideration of the appropriate boundary for calculations. That is, on-farm adaptation and change can affect other production systems and total emissions in unpredictable ways. The student will estimate the potential for on-farm adaption across a development gradient as well as the wider system effects. For example, change in pasture management or change in animal numbers or breed may have different potential depending on the current intensity of production. The project would allow the application of these methods to developing and developed country dairy industries and illustrate ways to overcome the difficulties of working in data poor situations. The project outcome would be training and enhanced knowledge/capability for a developing country and the improved understanding of mitigating emission in developing countries

Desired technical skills and/or experience:

- Some experience of data handling and understanding of livestock systems

Host institute and location: Bangor University, UK

Start and end month of research stay: Flexible from July 2020 (to start sooner is preferrable)

31. Improved quantification and modelling of nitrogen transformation and loss pathways in 'hot spots' following urine deposition and fertilizer application

Keywords: ammonia, modelling, nitric oxide, nitrous oxide, reactive nitrogen

Brief project outline:

The deposition of ruminant urine, and the application of concentrated nitrogen (N) fertilizers such as urea, can generate a cascade of chemical and biological processes resulting in the emission of N-containing gases including nitrous oxide, nitric oxide and ammonia. These emissions, as well as other potential loss pathways occurring simultaneously, can significantly limit crop N uptake while also impacting atmospheric and ecological systems from local to global scales.

While it is well-known that the conditions created within urine or fertilizer 'hot spots' are conducive to potentially large reactive N losses in multiple forms, our understanding of how the underlying processes are affected by climatic and edaphic factors, as well as our ability to manage them, remains quite limited. Because the responsible processes involve interactions of chemical and biological pathways within a soil matrix, studies aimed at gaining new understanding of process regulation require expertise that encompasses soil chemistry and soil microbiology. For the same reason, such studies benefit from a range of experimental methods, including simultaneous measurement of multiple substrates, use of stable isotope techniques, and comparison against dynamic models that account for complex process interactions.

The objective of this research stay will be to conduct laboratory experiments to address specific gaps in our understanding of the transformation and fate of N in concentrated urine and fertilizer hot spots. The experiments will build upon recent findings and ongoing work that is suggesting new hypotheses regarding missing components of the N budget in soils subjected to large inputs of urea under a range of temperatures. A microcosm incubation system established in our lab capable of monitoring several N species will be utilized together with ^{15}N tracer methods and a newly developed dynamic model to test these hypotheses in a range of soil types obtained from both grazed and cropped fields. Potential outcomes include verification and quantification of specific loss and/or incorporation pathways, and a revised model that includes these pathways.

Desired technical skills and/or experience:

- Understanding of soil nitrogen cycling pathways
- Experience with methods for quantifying individual soil nitrogen species
- Familiarity with 15N trace techniques desirable but not essential
- Interest in dynamic simulation modelling desirable but not essential
- Independent thinking and ability to resolve problems
- Effective teamwork and interpersonal skills

Host institute and location: U.S. Department of Agriculture - Agricultural Research Service (USDA-ARS), Soil and Water Management Research Unit, co-located within the Dept. of Soil, Water and Climate, University of Minnesota, Saint Paul, Minnesota, USA

Start and end month of research stay: August 2020 to February 2021 (but flexible)

32. Improved soil carbon mapping in sub-Saharan Africa to support soil fertility and climate mitigation studies

Keywords: soil, modelling, digital soil mapping, sub-Saharan Africa, uncertainty, mitigation

Brief research stay outline:

Globally, 1500 Pg of soil organic carbon (SOC) is stored in the first meter of the soil. This massive storage of SOC plays a major role in climate regulation. SOC is also an important indicator of soil quality and agronomic productivity, as it influences important soil and agronomic processes. SoilGrids (www.soilgrids.org) is one of ISRIC's flagship products that stores soil properties for the whole world at 250 m resolution. SOC is one of the most important soil properties currently mapped by SoilGrids, and is among others used to derive fertilizer recommendation strategies in sub-Saharan Africa. SoilGrids uses parametric regression models and machine learning (e.g. random forests) to derive soil properties from environmental covariates. An on-going ISRIC project aims to improve SOC maps for (parts of) sub-Saharan Africa by taking into account that the SOC observations used to train the statistical model are not error-free and are not all equally accurate.

For instance, observations derived from proximal soil sensing are less accurate than wet chemistry laboratory observations, although the latter can have substantial errors too. How uncertainties in observations can be included in the machine learning models to improve SOC maps needs to be researched and tested. The selected PhD-student will work together with the ISRIC SoilGrids team to develop methods and test these for a region in sub-Saharan Africa.

Desired technical skills and/or experience:

- digital soil mapping, geocomputation, machine learning, R scripting, soil organic carbon mapping, statistical modelling.

Host institution and location: ISRIC - World Soil Information, Wageningen, the Netherlands

Start and end month of research stay: Flexible between September 2020 and December 2021.

33. Improving productivity and adaptive capacity of Coffee-based agroforestry systems for enhancing food security in a changing climate in Ethiopia

Keywords: Agroforestry

Brief research stay outline:

Smallholder farmers mainly produce coffee in Ethiopia under shade-tree agroforestry systems. This system presents a unique opportunity for meeting the food, cash crops and wood harvesting requirements of individual farmers while mitigating climate change through carbon sequestration and/or offsetting greenhouse gas emissions.

Coffee agroforestry land, however, is being degraded due to changes in biophysical and socio-economic conditions. These changes have led to a decline in productivity and profitability of coffee agroforestry. To cope with these challenges, farmers are focusing on other crops as sources of food and income (e.g., chat or *Catha edulis*). This shift in production systems is rapidly changing the structural diversity of coffee agroforestry, ecosystem sustainability and livelihoods of rural small-scale farmers. Therefore this research focuses on characterization of food and wood production strategies of coffee farmers and examines influence of these strategies on household income and food security, ecological functions and services. To improve the productivity and profitability of this system, farmers' adaptive capacity to the changes, necessary policy mechanisms, and agricultural interventions will be assessed and promoted.

Desired technical skills and/or experience:

- Hands on experience with agroforestry, particularly on interaction of components and adaptation strategies
- Independent thinking and ability to resolve problems
- Organized and meticulous
- Effective teamwork and interpersonal skills

Host institution and location: Mekelle University, Institute of Climate and Society, Main Campus, Mekelle, Ethiopia

Start and end month of research stay: September 2020- February 2021

34. Increasing farm productivity and carbon sinks on sandy soils

Keywords: Soil, N2O

Carbon sequestration on sandy soils presents synergies with soil fertility and food security. However, accumulation of biomass on sandy soils is constrained by low water and nutrient capacities. The new sub-surface water retention technology (SWRT), which is based on the subsurface installation of impermeable water-retaining membranes of linear and low-density polyethylene, reduces water and nutrient losses through deep percolation in coarse - textured soils. Reducing percolation and increased water and nutrient storage capacity by SWRT will result in more biomass growth and subsequently soil organic carbon. So far, there is no data on the role of sandy soils with SWRT on securing food supplies for poor farmers in sub-Saharan Africa nor its' contribution to climate change mitigation. This project aims to evaluate the effectiveness of SWRT to increase farm productivity and improve carbon sinks in sandy soils in Kenya.

Assessment of farm productivity and greenhouse gas emissions will be undertaken on sandy soils at sites where SWRT membranes are being installed. The student will determine soil carbon storage and measure trace gas fluxes using the flux chamber method in combination with gas chromatography. The project results will provide an evidence base; where through adoption of SWRT, carbon sinks in croplands with sandy soils could be improved while increasing farm productivity. By overcoming problems associated with sandy soils and climatic conditions in areas where sandy soils are dominant, decisions on maximizing the utility of these "problem soils" and guidance on further research may be made.

More information: https://doi.org/10.3389/fsufs.2019.00071

Desired technical skills and/or experience:

- Strong background on tropical agricultural systems
- Previous field experience would be highly valued.
- Excellent written and oral English language
- A team player with strong interpersonal skills

Host institute and location:

International Center for Tropical Agriculture (CIAT)

Jomo Kenyatta University of Agriculture and Technology (JKUAT), Nairobi, Kenya

Start and end month of research stay: September 2020 to February 2021

35. Institutional analysis of the role of irrigation governance on the uptake of low-emission technologies in Vietnam

Keywords: Rice, irrigation, institutional analysis

Brief research stay outline:

Traditional continuously flooded rice production is a significant contributor to global greenhouse gas emissions. Alternating between flooded and dry cycles throughout the growing period of rice reduces methane emissions significantly. Collective irrigation schemes and government subsidies are thought to affect the wide-scale uptake of this low-emission technology.

This project seeks to understand the effect of different irrigation service structures and fee policy reforms on institutional development and irrigation water management in The An Giang province in Vietnam. The analysis will collect information from different types of water user groups and irrigation management cooperatives to understand how the recent policy reform cancelling subsidies and decentralizing water management has had an effect on water pricing and irrigation.

Desired technical skills and/or experience:

- Socio-economic background (institutional and policy analysis preferred)
- Vietnamese language proficiency
- Basic knowledge about rice production
- Independent and reflective thinking

Host institute and location:

International Rice Research Institute (IRRI), Hanoi, Vietnam

Start and end month of research stay: First quarter of 2021

36. Managing nitrous oxide and carbon dioxide through improved agricultural liming practices

Keywords: liming, soil, N2O, CO2, pH, GHGs, isotope technique, farm management

Brief research stay outline:

Globally, lime (e.g. as crushed CaCO3) is commonly applied to agricultural land to ameliorate soil acidity and to create and maintain a soil pH favourable for optimal plant growth. The direct effect of liming on agricultural soils with respect to the final soil C balance, greenhouse gas emissions (GHGs) and associated economic and sustainability factors has remained under intense scientific scrutiny. These discussions have been further fuelled by recent studies, which suggest that consideration should be given to the fact that in agricultural systems, there is a clear interplay between liming (raising soil pH and associate C mineralisation) and mineral N fertiliser applications (optimising crop production and soil N status, but decreasing soil pH).

This interlinkage will be most critically displayed in trade-offs between the resulting soil N2O and CO2 emissions, after simultaneous temporal application of N fertiliser and Lime to soils. Indeed, recent studies have suggested that N2O emissions may decrease at higher soil pH because the reduction of N2O to N2 becomes more efficient. At the same time, C mineralisation can increase thereby enhancing CO2 emissions. Furthermore, it not clear how much of soil emitted CO2 is actually derived from the lime itself, when it is applied to agricultural soils, and there are discrepancies between direct CO2 emission factors from lime between IPCC (0.12) and EPA (0.06). Further uncertainties remain around mineral, organic and mixed N fertiliser application to agricultural soils, which have differential effects on plant growth, added C and N and soil pH change.

We will examine the direct and indirect effects of liming management on GHG emissions (N2O, CO2 and CH4) in agricultural lowland and upland soils from The UK, Germany and (potentially) some additional soils from the CLIFF-GRADS' country of origin. We will undertake a series of laboratory based incubation liming experiments to quantify soil N2O, CO2 and CH4 emissions, for a range of attained pH values, applied N fertiliser and soil moisture conditions. We will use natural difference in 13C between lime and soil to establish the direct contribution of CO2-C from lime vs that coming from the soil itself. This natural abundance 13C approach will also allow us to examine any soil C priming effects following liming. We will also collect the emitted N2O for natural abundance 15N, 18O and 15N isotopic analysis to determine how change in pH changes the soil N2O processing (nitrification, denitrification). In separate experiment, we will determine the fate of lime-C in soil and its microbial community using a separate tracing experiment in which we will add 14C labelled lime to soils.

The outcome of the study will be to provide information to help farmers globally to enable better farm scale management of nitrous oxide and carbon dioxide emissions from their agricultural soils through improved combination of liming and N fertiliser practices.

The CLIFF-GRADS student will be trained in the use of the 14C radio-isotope and will join a cohort of other PhD students with similar interests in reducing GHG emissions and developing strategies to increase C sequestration in soil.

Samples are to be analysed at Forschungszentrum Juelich (FZJ) Germany; please note that Dr. Roland Bol has 20% Bangor University position as Prof. in Biogeochemistry and 80% position research group leader position at FZJ.

Desired technical skills and/or experience:

- Practical field and lab work experience is desirable, particularly in the use of chamber technologies for measuring greenhouse gas emissions
- Independent thinking and ability to resolve problems
- Organized and meticulous
- Effective teamwork and interpersonal skills

Host institution and location:

Soils and Ecosystems Research Group, Environment Centre Wales, Bangor University, UK.

Start and end month of research stay: February 2021 – July 2021

37. Managing nitrous oxide emissions from small-scale farm features

Keywords: livestock, urine, dung, soil, N2O, nitrification inhibitor

Brief research stay outline:

Urine deposition on pasture is a known source of direct and indirect nitrous oxide (N2O) emissions and nitrification inhibitors reduce these gaseous losses. Congregation of animals in high occupancy zones can result in overlapping urine and dung patches, as well as soil compaction, favouring conditions for denitrification and subsequent high emissions of N2O. In this project, which links to an existing Marie Curie Global Fellowship project (Target-N2O, http://target-n2o.bangor.ac.uk/), we will quantify the excretal N and C loading onto soil around a small-scale farm feature, e.g. a gateway, and quantify the N2O emissions using non-steady state chambers along a transect away from the feature, relating emissions to soil physical and chemical properties. This information will be used to estimate the potential contribution of these high animal occupancy areas to the total N2O budget at a farm level using Tier 2 IPCC emission accounting methodology.

There is the potential to target these high animal occupancy zones with nitrification inhibitors, but the recommended dose of inhibitor to general pasture may not be sufficient, due to interactive effects of overlapping urine and dung patches and soil compaction. To determine the efficacy of targeted nitrification inhibitor applications to the soil around a gateway, intact soil cores from increasing distances from the feature will receive urine + ^{14}C-labelled DMPP at different doses, and N2O emissions measured in a lab-scale experiment. $^{14}CO_2$ measurements will be used to determine how rapidly the different DMPP doses degrade in the soil.

The CLIFF-GRADS student will be trained in the use of the ^{14}C radio-isotope. They will join a cohort of other PhD students with similar interests in reducing GHG emissions and developing strategies to increase C sequestration in soil.

Desired technical skills and/or experience:

- Practical field and lab work experience is desirable, particularly in the use of chamber technologies for measuring greenhouse gas emissions
- Independent thinking and ability to resolve problems
- Organized and meticulous
- Effective teamwork and interpersonal skills

Host institution and location:

Soils and Ecosystems Research Group, Environment Centre Wales, Bangor University, UK.

Start and end month of research stay: February 2021 – July 2021

38. Methane mitigation in rice systems - from field research to supply chain initiatives

Keywords: Rice, soil, CH4 emissions, food security, economic livelihoods

Brief research stay outline:

Rice is the staple food crop for more than half of humanity, but rice systems are also a significant source of global CH4 emissions. Innovative crop management strategies are needed to mitigate CH4 emissions without compromising food security or economic livelihoods of smallholder farmers. New scientific discoveries are unlikely to change farmer behaviour alone. Large-scale mitigation will only be possible if countries adopt new programs to increase sustainability throughout the food supply chain, connecting farmers to processors and to consumers.

This research stay will provide an integrated, interdisciplinary training in GHG mitigation spanning from field-based measurements to the implementation of sustainable food supply chain initiatives. The student will gain hands-on experience in GHG measurement in California rice systems, where strategies are being tested to decrease C footprints associated with rice production while maintaining profitability. In addition, the student will contribute to a new capacity building project focused on implementing the Sustainable Rice Platform (SRP) to Latin America. The SRP is a global multi-stakeholder alliance that developed the world's first framework for evaluating and promoting sustainable rice production practices across 12 Performance Indicators. The project in Latin America is designed to evaluate the benefits and challenges of implementing SRP in this region based on stakeholder engagement and feedback.

The selected student will gain technical skills in the field and lab combined with leadership and project management experience. Continual support will be provided from the host supervisor and collaborators to engage diverse stakeholders and evaluate the potential of GHG reduction programs in a set of countries with growing rice demand. Results from this program will translate into actionable knowledge on GHG mitigation in rice systems as well as peer-reviewed publications.

Desired technical skills and/or experience:

- Experience with rice systems and GHG measurement
- Fluent Spanish to coordinate with project partners and organizations in Latin America
- Independent and creative thinker with demonstrated leadership experience
- Data analysis and writing skills necessary to serve as lead author of scientific publications

Host institution and location:

University of California, Davis, USA

Start and end month of research stay: April – September 2021

39. Mitigating greenhouse gas emissions from coffee production systems through shade management

Keywords: Soil, coffee,

Brief research stay outline:

Coffee arabica cultivation has played a significant role to mitigate deforestation in the tropics because it requires dense canopy cover for growth. However, farmers have shifted recently into less-shaded coffee production in order to boost yield. It is well documented that shade-level influences total nutrient uptake and the microclimate such as soil temperature and moisture. There is however a scarcity of information on whether coffee shade-level influences greenhouse gas (GHG) emissions.

The aim of this project is therefore to quantify N2O and CH4 emissions from coffee production systems for different shade intensity gradients and input levels. The student will conduct a field experiment to test the hypothesis that shade intensity influences GHG emissions from coffee production system via manipulating the microclimate and nutrient uptake. The experiment will be carried out in already established permanent plots, in collaboration with Jimma University (Ethiopia).

These plots vary in shade intensity and input levels. Chambers will be then installed under coffee shrubs and emissions will be quantified using gas chromatography. The gas samples will be collected across different seasons (i.e. wet and dry seasons). Microclimate data will be collected daily using data loggers. Denitrifying and nitrifying microbial communities will be studied along shade intensity and input levels. At the end of this experiment, the outcome will be to determine a threshold shade-level where farmers are able to mitigate GHG emissions without compromising coffee yield. The findings of this project are crucial to ensure climate-smart coffee cultivation and to sustain millions of livelihoods in the tropics.

Desired technical skills and/or experience:

- Basic knowledge in soil science or environmental sciences
- Practical experience in using gas chromatography or INNOVA
- Good communication and teamwork
- Ability to work in intercultural environments
- Fluent in written and spoken English

Host institution and location: Jimma University, Jimma, Ethiopia

Start and end month of research stay: May 2021 – October 2021

40. Mitigation of GHG emissions from agriculture through the use of alternative fertilizers

Keywords: fertilizers, maize, nitrogen

Brief project outline:

Nitrous oxide (N2O) is the main GHG emitted from soil by the agricultural sector. It has a global warming potential (GWP) 298 times greater than CO2 and a half-life in the atmosphere of 121 years, resulting in a contribution of approximately 6% to the effect of global warming.

The growing world population generates a strong and sustained demand for food, and Argentina is one of the countries that can contribute to meeting that demand. This generates an increment of the use of fertilizers in agriculture in Argentina which subsequently will increase the N2O emissions.

The use of nitrification inhibitors for fertilizers allows greater absorption of N by the crop and lower N losses because of a slower rate of N release. In other countries, several studies have concluded that the use of nitrification inhibitors decreased the N2O emission between 30 and 50%. However, its impact on agricultural systems in our region has not yet been evaluated.

The hypothesis of this project is that fertilizer use with nitrification inhibitors delays the release of nitrates, increasing the synchronization between their availability, the N requirements of the commercial crop and decreasing the N2O emissions.

The project is linked to the GRA Croplands Research Group (CRG) and the student will conduct an experiment that aims to evaluate this hypothesis in a maize crop production with different commercial fertilizers. This project will provide new knowledge on the effectiveness of the nitrification inhibitors. This proposal includes both laboratory and field work.

Desired technical skills and/or experience:

- Field work experience, mostly in crop production.
- Independent thinking and ability to resolve problems.
- Organized and meticulous.
- Effective teamwork and interpersonal skills.

Host institution and location:

Instituto Nacional de Tecnología Agropecuaria, INTA Castelar, Buenos Aires, Argentina.

Start and end month of research stay: June 2021 to December 2021.

41. Mitigation of Nitrous oxide and Methane Emissions from Livestock Congregating around Stock Ponds.

Keywords: Livestock, soil, N2O, CH4, manure management

Brief research stay outline:

Congregations of grazing livestock produce manure and urine, ammonium and nitrate which contain coliform bacteria. Riparian damage resulting from congregating livestock during grazing alters watershed hydrology, and leads to soil compaction and erosion, resulting in concentrated areas of nitrous oxide and methane emissions. These changes lead to issues of water quality and contamination. Most studies have previously concentrated on pastures or open ranges and have not considered “hot spots” of congregating animals under trees or around water sources.

This study evaluates the effects of livestock grazing in proximity to water stock ponds on changes in soil properties, soil water availability, nutrient cycling, nitrous oxide and methane emissions and water quality.

Geostatistical sampling will be conducted around stock ponds to document the congregation patterns of livestock and their environmental effects. Soil, vegetation, and water samples will be collected to evaluate the effects on plant productivity, nutrient distribution, microbial diversity, nitrous oxide and methane emissions and water quality using standard methods. This project contributes to the USDA-ARS Long-term Agricultural Research Network.

Desired technical skills and/or experience:

- Course work in soils, chemistry or biochemistry
- Knowledge of geostatistical sampling and GPS systems but not required
- Knowledge of Gas Chromatography analysis of greenhouse gases
- Critical thinking skills to resolve problems
- Effective teamwork and interpersonal skills

Host institution and location: USDA Grassland Soil and Water Research Laboratory,Temple, TX.

Start and end month of research stay: Flexible between July 2020 through December 2021.

42. Mitigation strategies to decrease methane emissions of Argentina pastoral livestock systems

Keywords: Livestock, enteric CH4, measurement, SF6, mitigation

Brief project outline:

Animal production represents a significant source of methane (CH4) emission, mainly due to ruminant enteric fermentation. There are a large number of available technologies that to reduce CH4 emissions in livestock systems. Mitigation strategies differ due to their feasibility and cost. Some mitigation strategies can be applied easily in intensive production systems, but not in grazing conditions.

In this project, we propose the use sulphur hexafluoride (SF6) tracer technique to quantify methane emissions from livestock systems. Data obtained in this project will contribute to the national inventory of livestock greenhouse gases (GHG) and to develop local information on the potential to reduce GHG emissions by diet management. The student will participate in experimental work on nutritional mitigation of enteric CH4 emissions from lactating cows using SF6 tracer technique. In addition, rumen microbial population will be studied.

We will provide training to the CLIFF-GRADS student in:

1) Measurement of enteric methane emissions using the SF6 tracer technique.

- Assembly and calibration of SF6 permeation tubes, sampler collection systems and flow restrictors;
- Calibration and measurement of CH4 and SF6 in air samples by gas chromatography.

2) In vivo assays:

- Evaluation of productive performance, enteric methane production using different diets, and ruminal samples (perform molecular techniques for the study of the dynamics of the ruminal microbiota and techniques to determine the fermentative parameters).

The PhD Student will participate in several assays in different regions of Argentina.

Desired technical skills and/or experience:

- Familiarity with animal handling procedures.
- Familiarity with general laboratory techniques.
- Independent and reflective thinking.
- Basic Spanish skills are desirable but not essential.

Host institute and location:

National Technological University, Buenos Aires Regional Faculty (UTN), Bs As, Argentina.

National Institute of Agricultural Technology (INTA), Hurlingham, Bs As, Argentina.

Start and end month of research stay: Flexible after July 2020.

43. Modelling and predicting SOC sequestration potentials of SLMP watersheds in Ethiopia

Keywords: Carbon, land management practices, NDC

Brief research stay outline:

Soil organic carbon (SOC) is the largest pool of carbon in terrestrial ecosystems. Increasing the total amount of carbon stored in soils is widely considered a means to alleviate the anthropogenic increase in CO2 in the atmosphere.

Many international initiatives exist to increase SOC, e.g. the 4 per 1000 initiative on Soil for Food Security and Climate launched by the French Ministry of Agriculture at the United Nations Framework Convention for Climate Change Conference of the Parties (UNFCCC COP 21) and the Land Degradation Neutrality programme run by the United Nations Convention to Combat Desertification (UNCCD). As a part of those international commitment, nations have committed to reduce emissions in their Nationally Determined Contribution (NDC) and to achieve their Land Degradation Neutrality (LDN) target, respectively.

Therefore, Ethiopia invested more than US$ 1.2 billion per year over the past 10 years for various Sustainable Land Management Program (SLMP) in four regions of the country. Reversing degradation has the potential to contribute to carbon sequestration – aboveground and in the soil – and hence to mitigate climate change. However, the lack of proper guidance on estimating and monitoring as well as where to implement what technologies is the main challenge to achieve the NDCs. This project focuses on (1) modelling and mapping SOC sequestration potential of SLMP watersheds in Ethiopia, and (2) Identify the types and placement of optimal land management practices to enhance SOC in the highland of Ethiopia.

This proposal involves both field work and modelling.

Desired technical skills and/or experience:

- Ability to work independently and in team
- Good scientific writing skill for high impact journals
- Modelling experience using large spatial dataset
- R (or python) programming

Host institution and location: Alliance Bioversity-CIAT, Ethiopia Office, Addis Ababa

Start and end month of research stay: Flexible between Sep 2020 to May 2021.

44. Modelling adaptation co-benefits of mitigation in regional farming systems

Keywords: modelling, AgMPI, soil

Modelling, crops, livestock, farming systems, mitigation, adaptation, co-benefits

Brief research stay outline:

The GRA Integrative Research Group (IRG), in collaboration with GRA partner AgMIP, is conducting a series of activities to develop a modeling framework for determining adaptation co-benefits of mitigation. Synergies could include enhancement of soil moisture arising from soil carbon sequestration and better soil nutrient status from improved manure management practices that reduce GHG emissions. Such potential interactions exist in multiple crop, livestock, and mixed farming systems.

This research stay is linked a new activity of the IRG on the interactions of mitigation and adaptation. It involves developing a modeling framework that combines various types of models in order to determine environmental and socio-economic co-benefits and trade-offs. This modeling framework will enable the assessment of outcomes so that the adaptation co-benefits that arise from mitigation across cropland and livestock systems can be evaluated.

The research will involve evaluating how current mitigation and adaptation models can be effectively combined. For crops and soils, models such as CENTURY and DNDC are used for mitigation, and dynamic process crop models such as APSIM and DSSAT for adaptation. Locations for testing the model framework are Senegal, Ghana, and Zimbabwe, leveraged to take advantage of the AgMIP CLARE A-Teams project.

The researcher will be based with the AgMIP Coordination Unit in New York City, but will interact with GRA and CCAFS modeling research groups for mitigation and adaptation, as well as potential travel to sites in Africa.

Desired technical skills and/or experience:

- Modelling experience in either crops, livestock, or economics
- Knowledge of smallholder systems in Africa
- Basic knowledge of crop and livestock mitigation and adaptation processes
- Independent thinking and ability to solve problems
- Effective teamwork and interpersonal skills

Host institution and location: Columbia University, New York, NY with potential visits to Senegal, Ghana, and Zimbabwe

Start and end month of research stay: Sep 2020-Feb 2021

45. Modelling Greenhouse Gas Emissions from dairy production in Cameroon

Keywords: Livestock, dairy cattle, N2O, CH4, modelling

Brief research stay outline:

In Cameroon, milk demand is 297,000 tons per annum, which is approximately three times greater than milk production of 125,000 tons per annum. This drives government plansto inseminate 270,000 cows by 2027 to boost dairy sector production ("Business in Cameroon," 2016).

Consequently, manure management and enteric fermentation emissions will increase as a result of increasing absolute production. Insufficient data is available to give a clear picture of dairy system emissions in Cameroon, which is crucial given the increasing trend in environmental temperature in Cameroon (Molua, 2006), coupled with the increasing demand for animal proteins (meat and milk). Cattle exposed to lower temperatures produce more milk than cattle exposed to higher environmental temperatures (Broucek et al., 2007).

It is therefore necessary to investigate dairy system emissions in Cameroon, and develop predictive models that will assist decision makers in developing mitigation strategies to reduce the burden of emission regulation on dairy farmers and create resilience in dairy farming communities.

The student will:

- Analyse contributing effects of different daily dairy farm operations to CH4 and N2O emissions
- Analyse the impact of environmental temperature stress on quantity (in Kg) and quality of milk.

The project has two expected outputs:

1. Decision tool: simple predictive models to support decision makers and use this to recommend strategies to optimize dairy farm production.
2. Develop a model prototype of a low-cost dairy farm with minimal inputs for effectively monitoring and controling CH4 and N2O emissions from farms.

Desired technical skills and/or experience:

- Hands on experience with animals, particularly dairy cattle
- Familiarity with gas separation techniques like chromatography
- Diligent and open-minded
- Effective teamwork and interpersonal skills
- Language skills: English (native) and French (fluent: written & spoken)

Host institution and location: Institute of Agricultural Research for Development (IRAD) P.O box 2123, Nkolbisson, Yaounde, Cameroon

Start and end month of research stay: October 2020 to March 2020

46. Modelling of greenhouse gas emissions according to cattle manure management practices on small farms in Upper Casamance, Senegal

Keywords: livestock, manure management, nitrogen, carbon sequestration, modelling

Brief research stay outline:

Mitigation of GHGs from livestock production is one of the major challenges of this century. As a result, research is increasingly focusing on the carbon (C) sequestration associated with the frequent use of animal manure on small farms and on the GHG emissions caused by poor management of this manure. In Senegal, family farms have different manure management methods, from the stable or paddock to the agricultural production plots. This will have consequences on manure quality and gaseous emissions.

Manure management will:

- reduce the emission of greenhouse gases (CH4, NO2, etc.),
- improve carbon sequestration in the soil,
- have a favourable impact on agricultural production and
- mitigate the effects of climate change on family farms.

Thus, this project aims to contribute to the knowledge of manure management methods and to estimate nitrogen losses in family farms in Upper Casamance. This is part of a dynamic of limiting greenhouse gas emissions and improving soil fertility through quality manure. These activities will include a field phase (surveys) and a laboratory phase (establishment of models).

Desired technical skills and/or experience:

- knowledge of manure management practices
- Capacity building in estimating GHGs based on manure management practices,
- Teamwork.

Host institution and location:

Senegalese agricultural research institute/Agricultural Research Centre of Djibelor, BP 34 Ziguinchor, Senegal

Start and end month of research stay: July 2020 to december 2020.

47. N2O mitigation from agriculturally managed organic soils

Keywords: N2O, livestock production, organic soil, mitigation, peatland

Brief research stay outline:

Peatlands are increasingly drained for agriculture in all climate zones of the world, particularly in the tropics. Drainage induces subsidence and converts a former carbon sink to a carbon source. Further, drainage for agriculture induces a strong N2O release. Globally, almost two Pg CO2-eq. are emitted from disturbed peatland soils per year. Because these soils often provide high production potential, mitigation measures beyond rehabilitation towards the natural state are sought after. To counteract subsidence, farmers start to cover their organic soil with layers of mineral material. The changes in biogeochemical conditions induced thereby may affect the GHG exchange of CO2, N2O, and CH4.

In the project, which is already underway on a field site in Switzerland, the successful student shall apply measurements to quantify N2O (and CH4) exchange on a field with mineral soil coverage and compare it to a reference site without coverage. The site is managed as intensive grassland for cattle breeding. A newly developed automated chamber system that is able to provide continuous flux data will be used and handling of that system is one of the major goals of the training.

The project is embedded in the GRA Croplands Research Group (CRG) Peatland Management Network, to which the research host contributes actively. The student will work in a dynamic environment in an international research group of nearly 20 individuals. The work includes nearly 70 % experimental work (mostly field) and 30 % data evaluation, and will include contribution to a publication.

Desired technical skills and/or experience:

- Familiarity with processes of GHG formation in agricultural systems, particularly soil
- Experience in field work
- Experience in chamber-based gas sampling and advanced GHG measurement techniques desirable
- Data management and evaluation skills, basic statistics
- Good social skills, willingness to become an active member of the research group

Host institution and location:

Climate and Agriculture Group, Agroscope, Zurich, Switzer-land. Agroscope is the Swiss Federal Research Institution for Agriculture.

Start and end month of research stay: Ideally April 2021 – September 2021 (main vegetation period)

48. Nitrogen management to mitigate nitrous oxide emissions (N2O) in sugarcane.

Keywords: Fertilization; Plant-growth-promoting rhizobacteria

Brief research stay outline:

Sugarcane is an important crop in tropical and subtropical regions. Through its' high biomass production and due to its use in bioethanol production, it has a recognized role in reducing greenhouse gas (GHG) emissions. However, sugarcane is traditionally fertilized with high amount of synthetic nitrogen (N) that can offset the positive effect on GHG emissions through the emission of high amount of nitrous oxide (N2O). N2O is the main GHG emitted by agricultural systems and has a high warming potential (298 times higher than CO2). The objective of this project is to establish N management strategies to mitigate N2O emissions from the soil-sugarcane system. In turn, this study would advise adaptation of the Argentine sugar and ethanol industry to a low C production system.

The student will conduct an experiment that aims to evaluate the effects of different synthetic N rates combined with plant growth prompting rhizobacteria (PGPR). This project will generate new knowledge related to new management practices to mitigate N2O emissions in sugarcane. The final outcome of the project will be a research publication.

The National Institute of Agricultural Technology (INTA) has an ongoing project to develop strategies to mitigate GHG emissions from crop systems. INTA welcomes a CLIFF GRAD PhD student competent in agricultural sciences and environment management to apply for this research stay to work with the eco-physiology group of the EEA Salta, Argentina. The CLIFF GRAD project proposed here will contribute to the Integrative (IRG) and Croplands (CRG) Research Groups of the GRA.

Desired technical skills and/or experience:

- Good skills on field and laboratory experiments.
- Familiarity with GHG measurements (static chamber method) and statistical approaches.
- Effective teamwork and interpersonal skills.
- Independent and reflective thinking.
- Skills in science writing.
- Basic Spanish skills are desirable but not essential.

Host institution and location: Salta Experimental Station, National Institute of Agricultural Technology (EEA Salta INTA). Cerrillos, Salta, Argentina.

Start and end month of research stay: January to June 2021.

49. Plant secondary metabolites to inhibit rumen methanogenic archaea

Keywords: CH4, culturing, archaea, rumen, plant extracts

Brief research stay outline:

Ruminants rely on the microbes inhabiting the rumen to uptake energy from feedstuffs. Methanogenesis is essential in the rumen microbial food web, as it removes hydrogen and allows reduced cofactors to be recycled. However, from a sustainable perspective, methane (CH4) is a potent greenhouse gas, and it represents a loss of energy for the animal. Accordingly, methanogens represent an attractive target for any strategy to improve the efficiency of feed utilisation and reduce the environmental footprint of livestock. In this perspective, direct and specific inhibition of methanogens should allow redirecting hydrogen towards alternative pathways. To date, only chemical compounds (2-bromoethane sulfonate, chloroform, 3-Nitrooxypropanol) are known to inhibit specifically methanogens. Plant secondary metabolites are not only a useful array of natural products but also, food additives readily acceptable by farmers and consumers.

In previous work, we selected, among wild flora around pastures, a set of 6 plants species that reduced methane production in vitro with no adverse effects on fermentations. We hypothesise that secondary metabolites in these plants may directly affect methanogens' activity. In this context, we propose to study the effect of these hydroalcoholic extracts on pure cultures of hydrogenotrophic and methylotrophic rumen methanogens, but also in in vitro batch experiments with complex rumen microbial community. Plant extracts will be analysed by HPLC-DAD. Pure and batch cultures will be realised in anaerobic conditions. Methane and volatile fatty acids production will be followed by GC. Effects on individual microbes and microbial communities will be monitored using molecular biology tools. Experiments should allow identifying the mechanisms of methane reduction; this is essential for i) a better understanding of the functioning of the rumen microbial ecosystem and ii) the design of novel strategies for reducing livestock's environmental footprint.

Desired technical skills and/or experience:

- Microbiology & Molecular biology
- Highly motivated for an interdisciplinary work
- Proficiency in French would be an advantage
- Excellent communication skills

Host institution and location:

UMR1213 Herbivores, INRAE Auvergne-Rhône Alpes, 63122 Saint Genès Champanelle, FRANCE

Start and end month of research stay: Flexible from October 2020

50. Quantification of enteric methane emissions and carbon footprint of silvopastoral systems in the Peruvian Amazon Region.

Keywords: livestock, SF6, LCA, silvopastoral systems, carbon footprint, tropics

Brief research stay outline:

Studies suggest silvopastoral systems contribute to minimize emissions from land use practices and enhance productivity of smallholder dairy farms in a sustainable way. However, current evidence about the environmental benefits of such systems under the conditions of the Peruvian Amazon is limited.

We welcome a PhD student to take part in a research project on measuring enteric methane emissions using the SF6 tracer technique and calculating carbon footprints in silvopastoral systems of the Peruvian Amazon. This research will improve our understanding of livestock methane emissions in the tropics. This project is part of a larger programme funded by the Peruvian National Council for Science and Technology (CONCYTEC), which includes national and international partners (U. Wisconsin and U. Hohenheim) that contribute towards evaluating strategies for mitigation and adaptation of livestock production against climate change in the Andean and the Amazon region. The CLIFF GRAD project proposed here will contribute to the GRA's enteric fermentation research agenda.

The PhD student will learn about livestock production systems in the tropics, enteric methane measurements using the SF6 tracer technique and the calculation of carbon foot prints of silvopastoral systems. This proposal includes both laboratory and field work.

Desired technical skills and/or experience:

- Intermediate understanding of methodologies for quantifying enteric methane emissions in cattle
- Familiarity with IPCC and LCA methodologies and approaches
- Independent and reflective thinking
- Basic Spanish skills are desirable but not essential

Host institution and location:

Universidad Nacional Agraria La Molina Lima (30 %) and San Martín in the Amazon region (70 %)

Start and end month of research stay: From January to June 2021

51. Quantifying methane conversion rate (Ym) from Finnish lactating dairy cows

Keywords: dairy cattle, CH4, modelling, inventory

Brief project outline:

Agriculture is the third largest source of GHG in Finland with major contributions from enteric fermentation (i.e. 32% of total GHG emissions in the agriculture sector; Statistics Finland). Therefore, livestock, especially dairy cattle play an important role in Finland's national GHG emissions.

So far methane emission from Finnish dairy cows is estimated using IPCC guidelines. To our knowledge, there is no direct estimation of methane emissions from empirical data which would more accurately reflect country-specific production systems under Nordic conditions. Finnish dairy cattle production systems are characterized by feeding grass silage based diets supplemented with moderate amount of feed concentrates. Since 2009, Luke has conducted several national or EU projects, and experiments, with the main focus of studying nutritional strategies to reduce methane emissions from dairy cattle. Data collected under different experimental conditions and production levels, using both respiration chamber and SF6 tracer techniques, will be compiled and analyzed to quantify the methane conversion rate (Ym), which will be used to improve the accuracy of inventory calculations on a national basis.

The CLIFF-GRADS student will participate in the data collation process as well as modelling of methane emissions. Furthermore, the student will have the opportunity to gain experience by participating in ongoing experiments measuring methane on farm in addition to collaborating with our Nordic, European and international partners working on nutritional strategies to reduce methane emissions and modelling methane emissions from livestock which we believe will improve his/her communications/networking within the international scientific community.

Desired technical skills and/or experience:

- Good ability to work with data (Excel and SAS)
- Preliminary skills on modeling
- Good presentation and writing skills
- Strong teamwork attitude

Host institute and location:

Natural Research Institute Finland (Luke), Jokioinen, FI-31600, Finland

Start and end month of research stay: March 2021 – September 2021

52. Technologies and practices to increase C sequestration in integrated crop-livestock system on humid tropical savannah

Keywords: crop-livestock system, mitigation, carbon sequestration

Brief project outline:

Technologies and practices (T&Ps) already exist to offer promising entry points for climate change mitigation. Mixed farming systems have great potential to combine food production with environmental services, including climate change mitigation. This study aims to determine how a crop-livestock (CL) system can increase C sequestration by means of manipulating greenhouse gas (GHG) fluxes and soil organic carbon (SOC) stocks. Within the CL system, a combination of available low-carbon emission T&Ps are tested: zero-tillage, crop rotation and intercropping of common main crops (such as soybean, maize and rice) with the application of green manure and cover crops, forage grasses, as well as biological co-inoculation to promote plant growth. Low-carbon T&Ps can enhance nutrient cycling, reduce dependence on chemical inputs and increase crop yield. The net gas exchange (carbon dioxide and methane) is measured between the CL system and the atmosphere using micrometeorological methods, as well as nitrous oxide fluxes from soil using manual static chambers. Soil organic carbon and nitrogen stocks are quantified to a depth of 1 m.

The CLIFF-GRADS project proposed here will contribute to the Soil Carbon Sequestration Network of the Integrative Research Group (IRG), Soil Carbon Flagship and to the Integrated Crop-Livestock Systems Network of the Croplands Research Group (CRG) of GRA. We welcome a CLIFF-GRADS PhD student who has knowledge in soil science, agronomy and is familiar with geochemistry and agricultural production systems to apply for the research stay at Embrapa Rice and Beans, in Santo Antonio de Goiás, Goiás State, Central-West region of Brazil. The student will learn about the Brazilian low-carbon emission policy and its capacity to reduce GHG emissions, and techniques to measure greenhouse gas fluxes and SOC stock change at plot and system scales.

Host institute and location: Embrapa Rice and Beans, Santo Antônio de Goiás, GO, Brazil

Collaborating institutes: University of Brasília (UnB), Brasília, DF, Brazil; Federal University of Goiás (UFG), Goiânia, GO, Brazil

Start and end month of research stay: March 2021 – August 2021 (Project timeline is July 2019 – June 2023)

53. Using a Tier II Model (CQESTR) to Predict Soil Organic Carbon Storage and CO2 Emissions.

Keywords: Modelling, Carbon Sequestration, CO2

Brief research stay outline:

Several models have been developed for soil organic carbon (SOC) sequestration prediction and CO2 emission. The CQESTR IPCC Tier II Model was developed by our research group and will be used in this project to predict SOC stocks from data collected by student. It is proposed that a PhD student will obtain experience in process-based soil C modelling, using the CQESTR model (https://www.ars.usda.gov/pacific-west-area/pendleton/swcr/docs/cqestr/).

Specifically, the PhD student will:

(1) learn how to prepare CQESTR input files;
(2) utilize existing experimental data to run CQESTR model simulations (data from our long-term experiments and published literature, or long-term soil C data collected by the PhD student at his/her institution);
(3) predict best management practices for C storage and reduced CO2 emissions under particular soil and climatic conditions;
(4) run climate change simulation scenarios under IPCC projected RCP scenarios; and
(5) synthesize and integrate the information to select the best management practices for future climatic conditions.

The PhD student is expected to learn how to analyze soil C, run the models and estimate carbon storage/loss under different land management scenarios while in the United States. Prior to departure the fellow will give an exit seminar. Upon returning to his/her home country, the student should be able to design experiments to improve SOC and the potential to sequester C, transfer knowledge gained to their colleagues, and continue research collaboration with U.S. scientists and the GRA Croplands Research Group (CRG).

Desired technical skills and/or experience:

The PhD student should be competent in soil science with a good understanding of factors influencing soil organic C sequestration and CO2 emissions, and have some experience in database development, modeling and statistical analysis.

Host institute and location:

USDA- Agricultural Research Service - Soil and Water Conservation Research Unit, Pendleton OR 97801, USA.

Start and end month of research stay: April - September 2021.

54. What is the contribution of microbial necromass to soil carbon storage?

Keywords: Carbon sequestration, Soil organic matter, Carbon dynamics, Priming

Brief research stay outline:

Enhancing soil carbon (C) storage represents a major goal in the global drive to promote sustainable agricultural production and food security in our efforts to reduce greenhouse gas emissions. To achieve this, a good understanding of how C is stored in soil is required. The microbial biomass represents a major store of C in soil. Further, it is being established that (i) the turnover of dead microbial biomass (necromass), and that (ii) the waste products excreted by microorganisms while alive may be key regulators of long term C storage (i.e. these C products are more likely to become physically and chemically protected in soil).

Our understanding of the factors which regulate microbial necromass turnover, however, remain poorly understood. For example, it is still unclear whether this process is mainly driven by biotic forces (e.g. predatory viruses, protists, mesofauna) or abiotic forces (e.g. extremes in temperature or moisture) and how this is influenced by plant roots (i.e. rhizosphere priming). Using highly sensitive 14C-labelled tracers, however, it is possible to experimentally investigate and disentangle the influence of these factors by manipulating the soil biome and the soil environment.

This project will use 14C isotope tracers to label different components of the microbial biomass to enable us to measure the rate of turnover of the active biomass and necromass in soil. This can be done in both the laboratory and in the field at our experimental field station or on soils from around the world (e.g. those being used by the applicant in other parts of their PhD). We will use simple first order kinetic equations to model the soil C turnover (i.e. to calculate microbial carbon use efficiency, mean residence time etc).

The CLIFF-GRADS student will receive training in all aspects of the work as well as interacting with the Bangor University PhD community working on related issues (e.g. greenhouse gas emissions, carbon cycling). The aim will be to use the information collected in this experimental project to write a journal article targeted at the journal Soil Biology & Biochemistry.

Desired technical skills and/or experience:

- Practical field and lab work experience of soils is desirable.
- Basic statistical analysis skills.
- Independent thinking and ability to resolve problems.
- Organized and meticulous.
- Effective teamwork and interpersonal skills.

Host institution and location:

Soils and Ecosystems Research Group, Environment Centre Wales, Bangor University, UK. The Experimental Station is located 5 km from our department.

Start and end month of research stay: June 2021 to Nov 2021.