THE UNIVERSITY of EDINBURGH

Job Description

Internship Title: NERC Research Experience Placement - Employ.ed on Campus - Livestock and global climate change: what should cows eat?

Department / School	Global Academy of Agriculture and Food Security, University of Edinburgh
Reports To	Prof Dominic Moran, Global Academy of Agriculture and Food Security, University of Edinburgh, dominic.moran@ed.ac.uk

Job Purpose

The student will engage with highly topical research to understand and account for the greenhouse gas emissions arising from livestock production systems. Our model will consider the greenhouse gas emissions attributable to livestock systems and feeding decisions in particular. The objective is to locate modified feeds within the range of alternative cost-effective strategies for reducing livestock emissions.

Main responsibilities

The activities and experiences involved in the studentship:

- Brief literature review on context of agriculture and climate change and strategies to reduce methane production in beef systems
- Introduction to and training on modelling methods to be used including linear optimisation, carbon foot-printing, farm profit modelling and animal nutrition
- Introduction to key data sources and required adjustments to be model compliant
- Training in and undertaking model simulations using Python
- Model results interpretation and communication#
- Periodic reporting and group meetings
- Advice on developing interdisciplinary environmental research projects
- Insights into the application for/ role and development of a PhD studentship
- Briefing a research report/publication targeting different audiences
- Insights into publication strategy – journal types and submission processes
- Insights into other research communications

Knowledge Skills and Experience

Person specification
Essential:

- A student from a STEM discipline e.g. mathematics, physical sciences or engineering
- Some familiarity with programming in R or Python
- Familiarity with the concept of linear programming

Desirable:

- Familiarity with challenge of global climate change
- Interest in food systems and environmental impacts
- Interest in interdisciplinary modelling of environmental problems.

Key contacts

- Prof Dominic Moran (Line Manager), Global Academy of Agriculture and Food Security,
- Dr Rafael De Oliveira Silva (Project Supervisor), Global Academy of Agriculture and Food Security,
- Dr Stephen Mackenzie

The project will be led jointly by Dr Rafael Silva (Chancellors Fellow) and Dr Stephen Mackenzie It will also be overseen by João Gabriel Marques - final year PhD student

The GAAFS team of supervisors have significant experience in mathematical modelling of environmental impacts from livestock systems, linear optimisation of and identifying cost effective strategies to reduce these impacts.

Dr Rafael De Oliveira Silva is a University of Edinburgh Chancellor's Fellow at the Global Academy of Agriculture and Food Security. He is an applied mathematician with a PhD in Optimization and Operations Research. His research focuses on the development of mathematical models for agriculture, food security and biodiversity conservation. He is a supervisor for the PhD of Joao Gabriel Marques and oversaw the development of the models intended for use in this proposal.

Dr Stephen Mackenzie is a Research Fellow at the Global Academy of Agriculture and Food Security. He is an is an interdisciplinary scientist (formal training in Animal Science, Chemical Engineering and Chemistry) with 8 years of experience quantifying environmental impacts of livestock systems. He has specific expertise in both Life Cycle Assessment and Animal Nutrition and has published several papers on the potential of novel ingredients to reduce the environmental impact of livestock systems. He has successfully co-supervised two PhD students through to completion as well as multiple MSc student projects.

Joao Gabriel Oliveira Marques is a final year PhD student at the Global Academy of Agriculture and Food Security. He is reading for a PhD in Mathematical optimisation models for sustainable agriculture. As part of this work he was the primary developer of the life cycle assessment and diet formulation models in python that are to be utilised in this student project.

Dimensions

This is a 7-week placement with preferred start date: 14th June 2021 (or soonest date after).

Closing date: 19 May 2021
Interview date: to be determined by the supervisor
Start date: preferred start date 14 June 2021
Hours per week and preferred pattern/restrictions (if applicable): 35 hours per week (part-time option available)

Length of internship: 7 weeks

Additional Information

Host and Project outline

Project environment

This project will be hosted by a research team at the Global Academy of Agriculture and Food Security (GAAFS). We can offer the student a stimulating environment to conduct interdisciplinary research at the interface of agri environmental science and policy, food security/nutrition, economics and mathematical modelling. We focus on diverse policy relevant questions related to global food systems and their effects on our environment. The student will be exposed to a variety of qualitative and quantitative research methods useful in any future career in food systems and environmental management more generally.

Rationale & objective

The student will engage with highly topical research to understand and account for the greenhouse gas emissions arising from livestock production systems. This is a research area of global relevance as governments seek to reduce emissions from agriculture and food supply chains. The project will likely to appeal to a student with a quantitative background. Specifically, during this project the student will identify the economic break-even levels for the inclusion of ingredients capable of reducing enteric methane production within traditional profit driven models of feedlot beef farming. The project will offer the student training and experience in the development and use of bio-economic models combining environmental, economic and production system elements. Our model will consider the greenhouse gas emissions attributable to livestock systems and feeding decisions in particular. The objective is to locate modified feeds within the range of alternative cost-effective strategies for reducing livestock emissions.

Project background & outline

The production of animal feeds is the source of around 20% of all food related GHG emissions when accounting for land use change 1. For feed lot cattle (i.e. animals that are finished for a significant amount of time in a confined lot), feed production contributes 36% of total GHG emissions the majority being enteric methane production, which constitutes the majority of GHGs from these systems 2. Feed inputs have a significant influence on enteric emissions as well as levels of nutrient excretion in manure. A variety of nutritional solutions to reduce methane yield in ruminant production have been proposed recently, including novel ingredients such as seaweed 3, garlic and citrus extract 4, supplemental 3-nitrooxypropanol 5 and various other secondary plant metabolites 6. However, their uptake by farmers will be dependent on sufficient market incentives. In other words, they have to be cheap as well as being a low cost relative to other emissions reduction interventions. Feed prices are of the most important barriers to changing the environmental impact of some livestock systems over time 7.

We will structure a feasible and engaging work plan for the student to learn about, explore and improve an existing basic model of feed intake and GHG emissions. The student will be given training to use an existing bio-economic model developed to optimise feedlot beef diets for cost- effective environmental impact reductions 8. They will identify the financial and economic break- even levels for the inclusion of novel ingredients in cattle diets. Financial break-even points focus on the (private) farm financial performance/incentive; the economic break-even seeks to include all external costs associated with GHG values and other

pollutants. The student will therefore be exposed to conceptual terms relevant to the general (and model-specific) evaluation of GHG mitigation strategies (i.e. embedding environmental sustainability into economic models – as per NERC objectives, see below).

The student will then be guided to explore a series of modelling experiments, testing a matrix of price scenarios for novel and currently underutilised ingredients in the diets of beef lot cattle that have demonstrated significant technical potential to reduce methane yield. The student will undertake research on the current market price and availability of such ingredients and run model simulations to test break-even points where these ingredients would be included at sufficient levels in beef lot diets formulated to maximise farm profit. The project results will help determine the necessary relative price of these ingredients to be included in beef feedlot diets at sufficient levels to produce the methane reductions demonstrated in pilot studies. The results will provide guidance for future policies on economic incentives, plus required production efficiencies for these ingredients. The student will learn how these results fit into policy frameworks and will be guided to draft a communique/project brief relevant to both policy makers and industry stakeholders.

References

1. Ritchie, H. Food production is responsible for one-quarter of the world's greenhouse gas emissions. Our World In Data (2019). Available at: https://ourworldindata.org/food-ghg-emissions. (Accessed: 11th November 2020)

2. Gerber, P. J. et al. Tackling climate change through livestock - a global assessment of emissions and mitigation opportunities. (2013).

3. Roque, B. M. et al. Red seaweed (Asparagopsis taxiformis) supplementation reduces enteric methane by over 80 percent in beef steers. PLoS One 16, e0247820 (2021).

4. Roque, B. M., Van Lingen, H. J., Vrancken, H. & Kebreab, E. Effect of Mootral-a garlic- and citrus-extract-based feed additive-on enteric methane emissions in feedlot cattle. Transl. Anim. Sci. 3, 1383–1388 (2019).

5. Van Wesemael, D. et al. Reducing enteric methane emissions from dairy cattle: Two ways to supplement 3-nitrooxypropanol. J. Dairy Sci. 102, 1780–1787 (2019).

6. Ku-Vera, J. C. et al. Role of Secondary Plant Metabolites on Enteric Methane Mitigation in Ruminants. Frontiers in Veterinary Science 7, 584 (2020).

7. Ottosen, M., Mackenzie, S. G., Filipe, J. A. N., Misiura, M. M. & Kyriazakis, I. Changes in the environmental impacts of pig production systems in Great Britain over the last 18 years. Agric. Syst. 189, 103063 (2021).

8. Marques, J. G. O. et al. An improved algorithm for solving profit-maximizing cattle diet problems. Animal 14, s257–s266 (2020).

Training

As previously described, this studentship has a model focus that will facilitate training in cross- disciplinary modelling methods – combining biology, economics, animal nutrition and the scienceof greenhouse gas emissions. The project will appeal to a student wishing to engage in the field of global environmental change. Training will likely build on a student's existing exposure to modelling in R, Python, Matlab and other relevant software.

Learning/training will be face to face as far as possible and we aim to develop a rounded researcher, giving them a view of the life of further postgraduate research and the stages of developing a thesis by publication. This includes:

- Research funding pathways for finding the right PhD - e.g. the DTP application options
- Advice on general research funding scholarships and studentship
- The broader research funding landscape - e.g. UKRI and H2020
- Insights into the e.g. the JeS submission process

We will seek to provide training in concise communication (papers and online audiences) and oral presentation methods (with or without a poster).

Ultimately, the student will be in a good position to submit a DTP application following the experience.

Location

Pending Covid restrictions this placement will be based at GAAFS in Easter Bush. However, periodic team meetings will take place at or around the Edinburgh Climate Change Institute (central Edinburgh campus) or remotely if necessary.

Covid-19 contingency plan

This placement can be designed to be conducted remotely if the need arises due to current distancing requirements. In the eventuality, we will design a program around daily Teams calls to ensure the placement remains integrated with the GAAFS environment (e.g. team and group meetings and a journal club) and the project work plan.

Student would just need access to a laptop and to download Python (open source).

Programme Information

Research Experience Placement is a summer placement scheme funded by NERC, aimed at undergraduate students to address demographic and diversity-related challenges in the environmental sciences as well as thematic skills gaps (e.g. quantitative skills).

Please see the application instructions and selection process on the REP webpage: Research Experience Placements (REPs) | The University of Edinburgh

Employ.ed on Campus is run by the Careers Service in collaboration with University departments and Schools. It offers exclusive summer internships at the University over the summer for 2nd year to penultimate year undergraduate students studying in an UK Higher Education institution.

As well as great work experience, the Careers Service provides supporting resources, this is combined with a framework to support the development of participants' employability and self-reflection with an Edinburgh Award as part of the internship.

Application Support

For guidance on writing an effective application see our website: CV, Applications and Interview Advice
You can also make an appointment with a Careers Consultant using MyCareerHub.

Eligibility

Students are subject to eligibility criteria to be able to apply for NERC REPs and must:

- Be undertaking their first undergraduate degree studies (or integrated Masters)

- Be applying for a placement in a different department to their undergraduate degree
- Be eligible for subsequent NERC PhD funding, i.e. be either:
    - an UK citizen OR
    - an EU citizen with pre- or settled status under the EU Settlement Scheme OR
    - a non-EU citizen who have obtained the right to remain in the UK - known as 'indefinite leave to remain' (ILR) O
    - an International/EU student already studying in the UK and currently under a Tier 4 or Student Route Visa with validity until at least September 2021

REPs do not meet the requirements for a visa request therefore non-UK students who are not currently living in the UK or who are without a suitable UK visa are not eligible to apply.

Internships are ONLY open to 2nd year to penultimate year undergraduate students studying in an UK Higher Education institution and based in the UK. You cannot take part if you are a visiting student, or you have already taken part in the programme before.

Privacy Statement

In addition to the University's HR data privacy statement, please read the Student and Graduate Privacy Statement: Internships and work experience programmes to understand how and why we will use the information you submit for the Employ.ed Programmes

Health & Safety Requirements for the role

None required

Key Job hazard information specific to the role

N/A

If you require this document in an alternative format please contact Internships and Work Experience Team by email at employ.ed@ed.ac.uk