PhD Position

Modelling climate change feedback within the global agri-food land use system

CONTEXT

The BIOCaP-LCA[1] project aims to advance consequential Life Cycle Assessment (LCA) methods to evaluate the environmental impacts of bioeconomy deployment scenarios at the scale of France. While LCA is widely used to assess products or compare technologies, it has limitations when applied to large-scale, long-term transitions that involve complex socio-economic and biophysical dynamics. The project focuses on some key challenges specific to the bioeconomy, including accounting for land use and land-use change (LULUC), impacts on climate and biodiversity, and feedback loops between natural systems (the ecosphere) and human systems (the technosphere), which are not well captured in traditional LCA. To address these issues, BIOCaP-LCA proposes an innovative approach that combines LCA with biophysical and socio-economic models in a dynamic and forward-looking framework.
The project is funding three PhD theses that will lead to methodological advances in these research areas, including the PhD thesis described in this offer.

PhD OBJECTIVES

This PhD thesis focuses on the full modelling of the climate change impacts within this advanced consequential approach to capture potential feedback loops. Climate change is already reshaping agriculture around the world. Rising temperatures, shifting weather patterns, and more frequent extreme events are putting pressure on crops and livestock, in different ways across regions according to the Intergovernmental Panel On Climate Change (IPCC). One lesser-known effect is that climate change can actually make agriculture's own environmental footprint bigger. For example, when yields drop, more land is needed to grow the same amount of food — which means more greenhouse gas emissions (GHG). Between 1992 and 2020, this effect led to an extra 21.8 Gt of CO_2 emissions due to cropland expansion[2]. But other effects may be expected, including antagonist ones such as CO_2 fertilisation. The challenges consist in both identifying all potential involved mechanisms and their dynamics, as well as quantifying their extents in space and time and uncertainty based on existing databases and modelling work.

The first objective of the PhD will be to investigate all potential feedback mechanisms for various GHG emissions in the agricultural sector. Based on a literature review, an exhaustive list of potential mechanisms should help to identify their likeliness, the data availability and potential snowball or antagonist effects.
The second objective will be to operationalise a set of feedback factors taken among the most critical ones identified during the first stage. This stage will combine, first, a process-based modelling to investigate potential loops of feedback on the agricultural productions, focusing on key productions and land uses (to be determined based on global agronomy literature). Second, it will be necessary to examine the socio-economic constraints that may limit adaptation or avoidance strategies (e.g., no additional fertiliser or labour available) and to identify the thresholds or tipping points that could halt potential feedback mechanisms.
The third objective will be to produce sets of feedback-aware characterisation factors for added t of CO_2eq to each concerned GHG emissions adapted to the various scenarios explored in prospective LCA, and implement the PhD modelling outputs to case studies explored within the BIOCaP-LCA project.

[1] An ANR-funded PEPR project bringing together INRAE, CEA, IFPEN and CIRAD to advance LCA modeling for the bioeconomy: https://www.pepr-bioproductions.fr/eng/funded-projects/axis-4-cross-cutting-methodologies-and-tools/biocap-lca
[2] https://doi.org/10.1038/s41561-025-01724-1

WHO WE ARE LOOKING FOR

We are seeking a curious and proactive candidate, motivated by research and holding a Master's degree (M2).

Advanced skills in Environmental or Agricultural Sciences are required, along with a strong interest in mechanistic quantitative modelling of environmental impacts.
Relevant additional qualifications can include experience in LCA or programming (Python, R, …).

Candidates must have excellent English writing and communication skills.

WORK ENVIRONMENT

The PhD student will be hosted within the ITAP research unit located on La Gaillarde campus (about a 10-minute bike ride from the city centre and the train station). Within ITAP, you will join the ELSA research team composed of researchers and engineers specialized in advanced LCA modelling.

The student will be co-supervised by Dr. Pierre Jouannais (INRAE) and Dr. Anthony Benoist (CIRAD), both of whom have extensive expertise in LCA, particularly in Consequential and Dynamic LCA, and in biosystem modelling.

The two co-directors are Dr. Eléonore Loiseau (INRAE) and Dr. Cécile Chéron-Bessou (CIRAD).

↘ Terms & conditions

- Location: Montpellier
- Contract: PhD Position
- Duration: 36 months
- Beginning: Autumn 2026
- Salary: 2,300€ gross monthly

↘ How to apply

Send a CV and motivation letter (references are also appreciated) to:

pierre.jouannais@inrae.fr

and

anthony.benoist@cirad.fr

Application deadline: **19 June 2026**