French Agricultural Research Centre for International Development (CIRAD)
PhD proposal

About our organization

CIRAD is the French agricultural research and cooperation organization working for the sustainable development of tropical and Mediterranean regions. CIRAD works with its partners to build knowledge and solutions and invent resilient farming systems for a more sustainable, inclusive world. It mobilizes science, innovation and training in order to achieve the Sustainable Development Goals. Its expertise supports the entire range of stakeholders, from producers to public policymakers, to foster biodiversity protection, agroecological transitions, food system sustainability, health (of plants, animals and ecosystems), sustainable development of rural territories, and their resilience to climate change. CIRAD works in some fifty countries on every continent, thanks to the expertise of its 1650 staff members, including 1140 scientists, backed by a global network of some 200 partners.

The position

CIRAD is seeking for a dynamic and motivated Vietnamese candidate to register and follow a PhD program, pertaining to the topic described below.

The PhD student will register under Montpellier University and will receive a French PhD degree in agronomy upon completion of the PhD program.

The PhD student will be hired by CIRAD and seconded to ICRAF-Vietnam office during his/her time in Vietnam.

The schedule

The PhD program will last 3 years, starting in September 2023. It is expected that the student spend at least his/her first year in Vietnam (study of local ecological knowledge and of Nitrogen leakage), as well as 6 months more in Vietnam in year 3 (knowledge integration). The rest of the time, the student can be either based in Vietnam (ICRAF office) or in his/her university.

When in Vietnam, the student will be based in ICRAF office in Hanoi, and will conduct fieldwork in Gia Lai, Dak Lak and Dak Nong Provinces.

Scholarship / terms of offer

The PhD student will receive a scholarship equivalent to approximately 1400 € /month after taxes, with an insurance included. Half of this scholarship will come from CIRAD, the other half will come from the French embassy in Vietnam after and only after the successful competitive exam hold by the French embassy in Vietnam in the first half of 2023 (see attachement). **The PhD student will only be allowed to register to the PhD program if he/she receives the required funding from the French embassy in Vietnam[1].**

During his/her time in France, the scholarship will be paid by Campus France directly to the student. During his/her time in France, the scholarship will be paid by CIRAD to the student.

Qualifications and requirements

The student shall hold a master degree in agronomy or a related field by August 2023. Previous experiences with surveys, focus group discussions and participatory methods are highly recommended. Alternatively, the student shall hold a master degree in anthropology with a required experience in the field of agronomy. Related work experience is an asset.

The student shall be proficient in English (speaking, reading, writing). His/her capacity to read and write in academic English will be emphasized. Results of of TOEFL, IELTS or an equivalent test are required. French proficiency (speaking, reading, writing) is not a requirement but will be favorably taken into account.

The student must show excellent grades in his/her previous academic courses (a requirement for the French embassy scholarship). In addition, co-authorship in previous scientific articles will be favorably taken into account.

The student must be ready to alternate periods of time in university and in Hanoi, and to conduct regular fieldwork sessions in the Central Highlands.

[1] https://vn.ambafrance.org/Appel-a-candidatures-2023-Programme-de-Bourses-France-Excellence

How to apply

Applications for the position must include:

- A cover letter illustrating your suitability for the position
- A detailed curriculum vitae
- The transcripted of your grades in bachelor and master
- The names and addresses of two referees, including telephone, and email address

All correspondence should be addressed to the World Agroforestry Centre (ICRAF) Office Hanoi, at the 13th floor, HCMCC building, 249A Thuy Khue street, Tay Ho district, Hanoi, Vietnam OR via email: clement.rigal@cirad.fr Applicants should indicate **"Application – PhD on local knowledge and fertility"** on their application letters and email submissions.

Applications will be considered **until the 21st of December 2022.** Please note that only short-listed applicants will be contacted.

PHD TOPIC: Integrating local ecological knowledge and academic knowledge on soil fertility management to design sustainable coffee and pepper farming systems.

Scientific context

Farmers continuously design new farming systems in order to adapt to a changing environment (climate change, environmental constraints, adaptation to price fluctuations…) (Deffontaines et al., 2020). Acquiring knowledge about farming practices and their potential to solve problems is a key part in this continuous design process (Toffolini et al., 2020). Researchers usually derive this knowledge from trials and models. However more recently, researchers have increasingly recognized farmers' local ecological knowledge as a relevant source of knowledge as well (Salembier et al., 2018).

The integration of local ecological knowledge and academic knowledge is gaining recognition as a relevant method to model and act upon complex environmental issues. Indeed, the complementarity between these two types of knowledge enhances our understanding of complex farming systems. Academic knowledge is known for its robust methods, its capacity to generate new knowledge to fill gaps, and its quantitative description of complex systems. On the other hand, it shows its limitations when it comes to tailoring general models to local contexts, to communicating results and to engaging with local stakeholders (Harrison et al., 2018). Local knowledge is increasingly recognized as detailed, adapted to local contexts and issues, and key in understanding current practices. On the other hand, it often shows its limitations when it comes to understanding and modelling complex processes, and to anticipating changes due a changing environment (Ruddle and Davis, 2013). The complementarity of these two types of knowledge therefore puts forwards the need for methods to integrate them and base the sustainable transition on a hybrid –type of knowledge (Uprety et al., 2012).

More and more scientific studies focus on local ecological knowledge to identify local issues, key practices (Hermans et al., 2021), or the role of associated biodiversity (Rigal et al., 2022). Nonetheless, integrating this knowledge with academic knowledge remains difficult. It too often consists of a description and a comparison of the different types of knowledge (Barbero-Sierra et al., 2018), even sometimes in the validation of local knowledge based on academic standards (Mistry and Berardi, 2016). Methods for integrating both types of knowledge are still missing (Oudwater and Martin, 2003). In the field of agronomy, Hermans et al. (2020) suggest to conduct this integration around on-farm trials, used as a tool to foster dialogue with and participation of farmers. Additional socio-economic data can be collected to complement the biophysical data (De Roo et al., 2019). In this context, local knowledge could open up new areas of research and suggest new hypotheses for academic scientists who would test them in the on-farm trials (Raymond et al., 2010). Furthermore, it would allow a better dissemination of biophysical results to local stakeholders, with specific implications in terms of farming practices and possibilities of simulations to explore future scenarios (Lacombe et al., 2018).

Operational context

Coffee (*Coffea canephora*) and pepper (*Piper nigrum*) are key crops in Vietnam, which is the first pepper production (~100,000 ha) and the second coffee producer (~600,000 ha) in the world (FAO, 2022). Interviews conducted in 2020 showed that coffee and pepper farmers display intensive farming practices. This is in particular the case with mineral fertilizer inputs, equivalent to 350 kg.N/ha/yr (Byrareddy et al., 2019). In this context, mineral fertilizers are the main expense related to these farming systems, estimated between 15 and 25% of the net coffee and pepper income (Thuy et al., 2019). On top of the high cost, high mineral fertilizer inputs also lead to soil degradation and acidification, as well as the main source of greenhouse gases in these farming systems. Interviews hint that the decision-making process about fertilizer inputs is mostly based on economic reasons (price of coffee and pepper, price of fertilizer, price of labor). Nonetheless, the identification of leverage axes toward more sustainable farming practices and better management of fertility requires a detailed understanding of the biophysical farming systems and of farmers' understanding of these systems (Rushemuka et al., 2014).

Several clues for improving the management of fertility are already under study in the V-Scope project: i) enhancing fertilizer use efficiency through a reduction in inputs and the use of lime, ii) replacing part of the fertilizer inputs by compost and biochar made from coffee husks, iii) designing new farming systems based on agroforestry with fruit trees. These research fields have resulted in establishing a network of on-farm trials to measure the agronomic performances of different farming practices over three years. These trials are monitored on a regular basis, starting in mid-2022, to record the farming practices and agronomic performances, as well as nutrient leakage on a sub-sample of trials. Indeed, nutrient leakage is thought to be the most important reason for low fertilizer use efficiency in coffee and pepper farms under intensive management practices. The network of on-farm trials will provide valuable biophysical data, but the experiments do not take into account the local ecological knowledge of farmers. The present PhD topic would complement the biophysical study through a focus on local ecological knowledge and its integration with academic knowledge derived from these on-farm trials.

SCIENTIFIC OBJECTIVE, HYPOTHESES, METHODOLOGY AND EXPECTED RESULTS

Objective

The present PhD topic aims at designing a methodology to integrate local ecological knowledge with academic knowledge, using an existing network of on-farm trials as a tool for dialogue (Hermans et al. 2020). It will focus on soil fertility management in farming systems based on coffee (Coffea canephora) and/or pepper (Piper nigrum) in the Central Highlands in Vietnam.

Research questions

We hypothesize that integrating local ecological knowledge with academic knowledge will lead to a detailed understanding of coffee and pepper farming systems, tailored to the local context of the Central Highlands in Vietnam, and shared between local stakeholders and scientists. Integrating the two types of knowledge will thus support the design of innovative farming systems adapted to the main current and future challenges of agriculture. In particular, this PhD will answer two research questions, a methodological one and a cognitive one:

- Q1: how can we integrate local knowledge with academic knowledge?
- Q2: how can we improve the management of soil fertility in coffee and/or pepper farming systems?

PhD activities

This PhD is divided into 3 activities, the 3rd one based on: 1) local ecological knowledge; 2) academic knowledge; 3) integration of knowledge for farming system design.

Activity #1: identification of local ecological knowledge

The first activity aims at **characterizing local coffee and pepper farmers' local ecological knowledge, with a specific focus on fertilizer inputs, on associated crop diversity and on farming practices to improve soil health**. It will also aim at identifying indicators used by farmers to manage fertility Brinkmann et al., 2018; Huynh et al., 2021). Based on 30 years of experience in growing coffee first and then pepper in the Central Highlands, we believe that local farmers have acquired a detailed understanding of coffee and pepper crop needs when these are grown in monoculture systems. Similarly, we believe that farmers have a detailed understanding of

conventional techniques for soil remediation, such as compost and lime inputs. On the other hand, agroforestry practices being recent practices, and the use of coffee husk biochar being limited, farmers might have a less detailed understanding of the interactions between coffee, pepper and fruit trees under agroforestry systems, and of the impact of biochar application. Divers methods can be used for a qualitative or quantitative study of local ecological knowledge, such as "fuzzy cognitive mapping" (Özesmi and Özesmi, 2004) and the AKT tool (Cerdán et al., 2012) to build conceptual causal models of complex systems. Other methods can be used to specifically identify indicators used by farmers to characterize their farming systems and manage fertility (Toffolini et al., 2015; Barbero-Sierra et al., 2018), such as the protocole defined by LICCI2. The student will have to identify, select and apply the most relevant methods.

- Methods: interviews, focus groups and workshops
- Expected results: one or several conceptual models of fertility management, comprising both the local indicators used by farmers and the farming practices impacting soil fertility.

Activity #2: analysis of the nitrogen cycle in coffee and pepper farming systems based on on-farm trials

The second activity aims at **analyzing the nitrogen cycle in instrumented on-farm trials and to create new academic knowledge on soil fertility**. This activity will revolve around a nework of on-farm trials setup in 2022 under the V-Scope project, and in particular on 4 trials instrumented with sensors to monitor nutrient leakage (1 trial in a monoculture coffee system, 1 trial in a coffee-avocado system, 1 trial in a monoculture pepper system, 1 trial in a pepper-macadamia system) divided into blocs with or without coffee husk biochar application (5 t/ha). Considering the difference in nutrient inputs by fertilizers and nutrient export through harvest, we believe that a large share of mineral fertilizers is lost through leakage. We also believe that leakage is reduced in agroforestry systems, thanks to a deeper root systems from fruit trees, and in systems with biochar application. The network of trials is already setup and running by WASI staff. The PhD student will join the data collection and analysis, and might complement the trials with additional measurements to estimate the leakage of other nutrients, characterize indicators of soil fertility identified through the study of local knowledge, or test new hypotheses formulated by farmers.

- Methods: analysis of experimental on-farm trials setup in the summer 2022; additional physico-chemical analyses to characterize soil fertility indicators.
- Expected results: a quantified model of the main compartments of the Nitrogen cycle, including the impact of practices (biochar application) and farming system design (monoculture versus agroforestry). Characterization of indicators used by farmers to manage soil fertility.

Activity #3: Integrating local ecological knowledge and academic knowledge

The third activity will aim at **defining a methodology to confront and integrate local ecological knowledge (activity #1) and academic knowledge (activity #2) on soil fertility and its management**. It will support the identification of innovative and realistic solutions to better manage fertility in the Central Highlands. This research activity is innovative by essence, since there is no existing methodological framework to integrate local and academic agronomic knowledge (Oudwater and Martin, 2003; Failing et al., 2007). The student will create a shared representation of the farming systems taking into account mineral fertilizers and farming practices, as a tool to foster dialogue (Hermans et al., 2021) between farmers and scientists. This tool will be used as the foundation for designing innovative practices for soil fertility management and discussing their feasibility and the required conditions for their implementation. This tool could also be used through simulations, and in particular economic simulations, to identify potential economic leverages towards more sustainable farming systems. This activity will require an iterative approach to build a shared representation of the farming system. In case of disagreements between local ecological knowledge and academic knowledge, the student will have to create space for dialogue to support the formulation of new hypotheses (Raymond et al., 2010), potentially leading to new on-farm measurements and to an additional loop in the pursuit of knowledge integration.

- Methods: interviews, prospective workshops, simulation.
- Expected results: a model shared by farmers and scientist ; the identification of leverages and required conditions to foster the transition towards a more sustainable management of soil fertility.

[2] https://licci.eu/research-tools/

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TITLE OF PROPOSED INTERN RESEARCH PROJECT:

Environmental Life Cycle Assessment of Coffee production in Vietnam

PERIOD & DURATION:

4 to 6 months

THE ORGANISATION:

CIRAD (French Agricultural Research Centre for International Development) is the French agricultural research and cooperation organization working for the sustainable development of tropical and Mediterranean regions.

More information: https://www.cirad.fr/en

LOCALISATION:

The intern will be based in the Central Highlands.

Fieldwork will be conducted in one or several of the following provinces: Gia Lai, Dak Lak, Dak Nong, Lam Dong.

PROJECT DESCRIPTION:

Life Cycle Assessment (LCA) is a tool allowing the identification of environmental hotspots and mitigation options across a product value chain: from the producer to the consumer. LCA is the international reference method to quantify environmental performances. This approach is based on a comprehensive inventory of activities, including farm practices, which are then translated into global impacts (e.g. climate change) and regional impacts (e.g. water deprivation, acidification). This product-oriented approach is relevant in an international and global market context, by looking at both the international drivers and the regional impacts.

LCA will be applied to coffee farms within the framework of the BOLERO project (European project). The main objectives will be the assessment of environmental impacts and the potential of innovative practices, including grafting techniques, to mitigate the environmental impacts.

The intern will support the team in the application of LCA to coffee production system in Vietnam. This will involve one or several of the following tasks: preparation of survey/questionnaire for data collection, data collection on coffee farms, data analysis in Excel, life cycle modelling with a LCA software (Simapro), impact scores analysis and interpretation. A large share of the internship will be spent in the Central Highlands for data collection.

The intern will be trained and supported by CIRAD researchers and LCA experts based in France and in Australia.

The intern will have to provide the team with a report at the end of the study. The intern can later on be associated in the writing of research articles based on their work.

SKILLS:

- Bac +4
- Computer skills: advanced experience with Excel,
- A solid background in Agronomy and Environmental impact assessment,
- Basic knowledge on Life Cycle Assessment would be appreciated,

- Good oral, reading and writing English capacities are required.

FINANCE

The student will receive the equivalent of 250 USD / month plus travel expenses when conducting field work.

CONTACT

All correspondence should be addressed to the World Agroforestry Centre (ICRAF) Office Hanoi, at the 13th floor, HCMCC building, 249A Thuy Khue street, Tay Ho district, Hanoi, Vietnam OR via email: clement.rigal@cirad.fr Applicants should indicate **"Application – Master Internship in Center Highland"** on their application letters and email submissions.

Proposal of Internship for a Master Student

Context

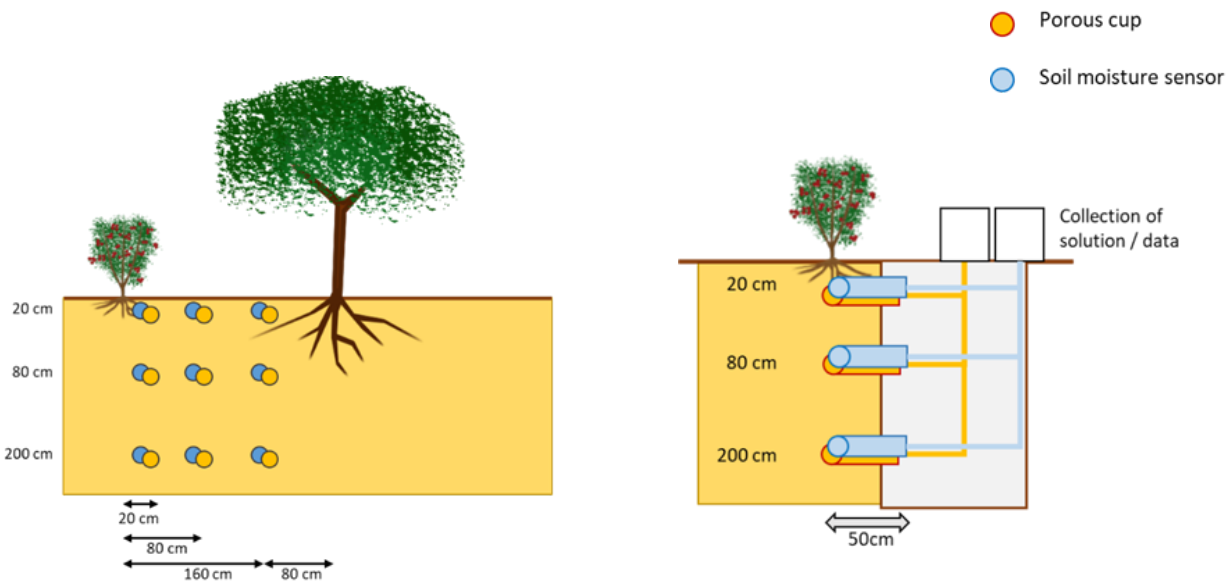
The V-SCOPE project (Vietnam towards Sustainable Coffee and Pepper) is a research project coordinated by ICRAF (World Agroforestry Center) and funded by the ACIAR (Australian Centre for International Agricultural Research). It aims at increasing the sustainability, productivity and economic value of coffee and black pepper farming systems and value chains in the Central Highland region. One key aspect of the research project focuses on improving farming practices through improved fertilizer inputs and recommendations on agroforestry practices.

Considering the levels of mineral fertilizer inputs assessed through previous surveys (~400 kg.N/ha/yr), it is believed that nitrogen leakage in deep soil horizons is a major cause of nitrogen loss (after the export of fruits from harvest). Quantifying nitrogen leakage is therefore key to improving nutrient input efficiency. On the other hand, the ongoing transition of monoculture coffee and pepper systems towards agroforestry with fruit trees could reduce nutrient leakage.

As part of the research project, 4 on-farm trials were setup in May 2022 to measure nitrogen leakage:

- 1 trial in a monoculture coffee farm
- 1 trial in a coffee-agroforestry farm
- 1 trial in a monoculture pepper farm
- 1 trial in a pepper-agroforestry farm

Each trial is equipped with porous cups to sample soil solutions every 10 days, and soil moisture sensors to take measurements every 15 minutes.



Front view of a trench

Side view of a trench

Illustration of the experimental design in a coffee-agroforestry plot

Objective

Setting up a model for water displacement in the soil in the 4 on-farm trials.
The model will be used by researchers to estimate nutrient leakage based on the laboratory analysis of NH4+ and NO3- concentrations in soil solution samples in order to:

- assess the nitrogen leakage in coffee and pepper systems;
- assess the role of agroforestry design to mitigate nitrogen leakage;
- assess the role of coffee husk biochar inputs (5t/ha) to mitigate nitrogen leakage.

The student will work on data collected from May 2022 in the 4 trials. In addition, the student will participate in field trips to visit the trials and (optionally) collect additional measurements.

Institutional arrangement

The student will do the internship under ICRAF/CIRAD supervision and the supervision of his/her university professor.
Field costs will be covered by ICRAF.
A stipend will be provided by ICRAF.
Study-period: Jan 2022-Dec 2023

Requirements / Qualifications
Master student familiar with soil hydrology and modelling.
Autonomous, able to conduct fieldwork in the Central Highlands.
Good level in either English or French.
Previous experience in similar work will be considered as an asset.
Previous experience in scientific writing will be considered as an asset.

How to apply
Applications for the position must include:

- A cover letter illustrating your suitability for the position
- A detailed curriculum vitae
- The transcript of your grades in bachelor

All correspondence should be addressed to the World Agroforestry Centre (ICRAF) Office Hanoi, at the 13th floor, HCMCC building, 249A Thuy Khue street, Tay Ho district, Hanoi, Vietnam OR via email: icraf-vietnam@cifor-icraf.org. Applicants should indicate "Application – master internship on nutrition leakage" on their application letters and email submissions.

Applications will be considered as soon as possible or until the vacant is filled. Please note that only short-listed applicants will be contacted.

About our organization

The World Agroforestry Centre (also known as the International Centre for Research in Agroforestry or ICRAF) is an independent research institution which generates science-based knowledge about the complex role which trees play in agricultural landscapes and rural livelihoods. As part of the Centre's work to bring tree-based solutions to bear on poverty and environmental problems, researchers – working in close collaboration with partners – are developing new technologies, tools and policy recommendations for increased food security and ecosystem health.

The Centre's headquarters are located in Nairobi, Kenya, and research is conducted in 34 countries in Africa, Asia and Latin America. We are supported by the Consultative Group on International Agricultural Research (CGIAR) and receive funding from over 50 different donors.

To learn more about our organization, please visit our website: www.worldagroforestry.org

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