

PhD proposal offer

ULg - GxABT / Yncréa HdF

Project context:

In January 2018, the Charles Viollette Institute and the Terra research unit of ULg-Gembloux Agro-Bio Tech decided to launch a cross-border research dynamic and create a Joint Cross-border Research Unit (UMRt). This UMRt is divided into 3 research poles and 4 structuring axes.

Among the research poles, the first is dedicated to agricultural research. It is subdivided into 3 teams. The first team is studying the plant and its functioning, the second team is studying interactions within the soil-plant-atmosphere continuum and the third, which will oversee the thesis project described below, is interested in the design of innovative crop systems.

Within the UMRt, the third team include researchers from ULg (Gembloux AgroBioTech campus and Arlon Environnement campus), ISA-Lille/Yncréa Hauts de France and INRA of Laon.

The research questions of this team are structured around two main axes:

1. **The management of cropping systems** and the optimization of cropping techniques within these systems;
2. **The design of innovative cropping systems**, through the production of agronomic, and a fortiori economic, and environmental performance indicators.

To answer these questions, the team will focus on:

- **Studied object:** The new knowledge acquired on the ecophysiology of the individual plant (team 1) will be considered to improve the understanding of its functioning in the population;
- **Scale:** The working scales will range from the plant (team 1 and 2) to the territory, and from the growing season to the rotation, thus covering large spatial and temporal scales;
- **Tools:** The tools mobilized will be made up of databases (acquired over time and space), proxy- and remote-sensing, as well as soil-plant-atmosphere modelling.

In order to initiate the work of Team 3, ULg-GxABT and ISA-Lille / Yncréa HdF, with the technical and scientific support of INRA AgrolImpact Laon, decided to co-finance a thesis. The PhD project will be described here after and should start by the end of 2019.

Keywords :

Agronomy, cropping systems, modelling, precision agriculture, Decision Support Tools

Description of the PhD thesis project:

Title

Evaluation of the potential of precision agriculture in Wallonia and the Hauts-de-France and development of tools dedicated to the optimization of the nitrogen fertilization strategy on a winter wheat crop.

PhD thesis context and specific objectives

Nitrogen (N) is one of the most abundant elements on Earth. However, it remains a limiting factor for the growth of most plants. In order to meet the food needs of the world's rapidly growing population, global use of nitrogen fertilizers has increased considerably since the 1950s (Vance, 2001) with current average annual growth of 1.5% (FAO, 2017). This has led to many environmental problems such as groundwater pollution by nitrates, increased production of greenhouse gases N_2O , increased NO_x emissions and acidification of soil and fresh water (Bibi *et al.*, 2016).

In order to deal with this problem, a European Directive was established (European Nitrate Directive 91/676/EEC (EC-Council Directive, 1991)) to optimize the management of nitrogen (N). It has become a necessity to secure crop production and farmer's financial safety while reducing the environmental pressure linked to excessive N applications.

Nevertheless, uniform agronomic management remains inefficient where there is spatial variability (Pierce and Nowak, 1999). A recent study (Basso *et al.*, 2019) looking at the potential of precision agriculture across the US Midwest has demonstrated how inefficient uniform N management could be in some low or unstable yielding area and how technology based approach of N management could help to save fertilizer and money, to lower GHG emissions and to reduce environmental and energy losses.

As proposed by the precision agriculture concept, site-specific management strategies aim at answering these issues (Basso *et al.*, 2012). In particular, by offering the opportunity to take several factors into account, such as soil characteristics, management practices and climatic variables, a promising approach for optimising N fertiliser lies in the use of dynamical crop growth models.

One of the major challenges of current agricultural activity is therefore to reconcile the needs of a productive, competitive and quality agriculture with the maintenance and improvement of the surrounding environment.

In this general framework, the main scientific objectives of this study are to:

- **Obj.1:** Evaluate the potential of precision agriculture approaches deployed at the territorial scale of Wallonia (Be) and Hauts-de-France (Fr). In particular, through the concepts of yield stability and management zone, the nitrogen use efficiency of wheat will be evaluated at the sub-field scale, to evaluate the potential of improvement.
- **Obj.2:** Evaluate the potential of using soil-crop model to accurately simulate the dynamic of crop growth and yield elaboration under variable N management strategies.
- **Obj.3:** Study the evolution of the C and N cycles in the agro-ecosystem under variable N management, in order to further evaluate environmental losses associated to those elements (CO_2/N_2O emissions and N leaching) ;
- **Obj.4:** Develop a multi-criteria approach (agronomic (Obj.2) and environmental (Obj.3) objectives) to optimize N management at the territorial scale, through the use of soil-crop modelling (Obj.2) within sub-zone of the field (Obj.1).

Additional information

Requirements

The candidate must possess a Master's degree in agricultural sciences, bioengineering, environmental sciences or equivalent.

Having more specific knowledge in agronomy, plant (eco)physiology, crop sciences, or the functioning of the plant-soil-atmosphere continuum is warmly welcomed. General knowledge about the agricultural sector is a plus.

The selected candidate needs to have some skills in computer sciences (coding, etc.). Knowledge or prior experience with crop modelling will be strongly appreciated.

He/she should have skills to work within a team, while showing a high level of autonomy. He/she will be able to demonstrate analytical or synthesis skills, as well as oral and written English expression. He/she needs to have basics of French language.

Selection process

Applications will be evaluated by both supervisors.

Applicants are required to send their *curriculum vitae*, a copy of their diploma and a motivation letter. Any recommendation letter is welcome.

The applications have to be send by October the 18th, 2019, to Bertrand Vandoorne (bertrand.vandoorne@yncrea.fr) and Benjamin Dumont (benjamin.dumont@uliege.be).

Interviews will be organized by the end of October/early November.

Work locations

The successful candidate will be based 1.5 years in ISA Lille and 1.5 years in Gembloux Agro-Bio Tech. He/she will have the opportunity to regularly visit the other institute during the 3years of the project.

Questions ?

If you have any questions, please do not hesitate to contact us: bertrand.vandoorne@yncrea.fr and benjamin.dumont@uliege.be