PhD proposal: modeling multiple pests in rice crops for agroecological rice protection in Cambodia

CONTEXT

Rice is the most important agricultural production in Cambodia. Farmers grow rice for food and income. Rice crops receive enormous amounts of pesticides, up to 13 pesticide treatments per cropping season in certain regions (Matsukawa, 2016). Farmers often mix several pesticide products and spray preventive treatments. Recently, several rice exportations to Europe have been refused due to excessive content in pesticide residues. There is an urgent need for a reduction of pesticide used in rice crops in Cambodia.

Hypotheses and objectives

A better characterization of the main drivers of biotic stresses will permit to limit useless treatments and to adapt cropping practices to production situations, especially to the local biodiversity.

Agroecological Crop Protection (ACP) is mainly based on ecosystemic services provided by biodiversity and soil health (Ratnadass et al. 2012; Barzman et al. 2015; Deguine et al, 2017), and strongly depends on cropping practices. Different projects in Cambodia aim at developing, with farmers, more resilient rice-based cropping systems, including the introduction of biodiversity within fields and in their immediate surroundings. These cropping systems will impact dynamics of animal pests, diseases and weeds and will therefore permit a reduction in pesticide use. Major steps towards a reduction of pesticides are i) the analysis of the relationship between injuries caused by animal pests, diseases and weeds with the risk of yield and/or quality loss; ii) the identification of means to limit pest development.

The aim of the PhD will be the design of a dynamic model to evaluate the risk of yield and quality loss in a specific situation of biotic constraints, as a function of the cropping system. In order to do so, it will combine models of rice development like DSSAT (Jones et al., 2003), which simulates the effect of environment on crop growth, and multipest models like WheatPest (Willocquet et al., 2008), implemented with the modeling platform Xpest (xpest.inra.fr; Aubertot et al, 2015).

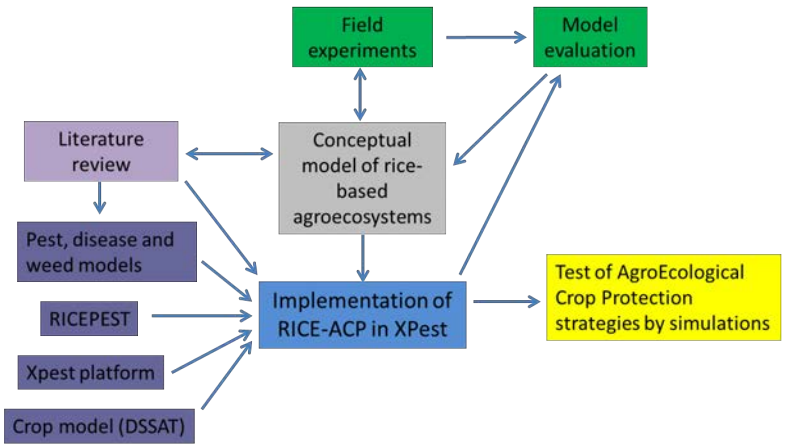
The PhD study will focus on the design of a unique model that will represent the effects of the cropping system and the production situation on yield production, injury profile and the associated damages.

Research questions and Methods

The main research questions are:

1. What are the effects of cropping systems on biotic constraints in rice crops in Cambodia? How do they interact with planned biodiversity?
2. What are the damages associated with a given injury profile?
3. How to create a dynamic model representing abiotic and biotic stresses under the influence of cropping practices?
4. Using simulations, how to determine the best combinations of cropping for ACP in rice (Aubertot et Robin, 2013)?

Multi-year experimental trials will be set-up in Cambodia, especially on the experimental farm of the University of Battambang, and in interaction with a team of local researchers from the Institute of Technology of Cambodia, the Royal University of Agriculture and University of Battambang. In addition to field experiments in Cambodia, the PhD student will spend some time in France, at INRAE Occitanie-Toulouse to perform literature review, and modeling work.



The work will be conducted according to four axes

- Bibliography on i) crop growth models and data sets useful for rice growth without biotic stresses ii) epidemiological or demographic models of major rice biotic constraints iii) models of injury profile of biotic constraints found in Cambodia.
- Measure and analyze in experimental trials of the impact of cropping systems (conventional, or including rotation with cover crops or rotation with reduced tillage) on rice growth, yield, and susceptibility to animal pests, diseases, and weeds.
- Integrate the results in a complete model predicting the impact of biotic constraints on yield in different cropping systems
- Use simulations to identify ACP strategies and reduce the use of pesticides in rice fields

A conceptual model will be developed at the beginning of the PhD study and adapted as a function of the knowledge gained.

References

Sester M, Raveloson H, Tharreau D, Becquer T. 2019. Difference in blast development in upland rice grown on an Andosol vs a Ferralsol. Crop Protection, 115, 40–46

Raveloson H, Ratsimiala Ramonta I, Tharreau D, Sester M. 2018. Long-term survival of blast pathogen in infected rice residues as major source of primary inoculum in high altitude upland ecology. Plant Pathology 67: 610-618

Dusserre J, Raveloson H, Michellon R, Gozé E, Auzoux S, Sester M. 2017. Conservation agriculture cropping systems reduce blast disease in upland rice by affecting plant nitrogen nutrition. Field Crop Research 204, 208-221

Aubertot JN et al. 2015. D1.4. A report on the modelling of multiple pests. Deliverable 1.4. Pesticide Use-and-risk Reduction in European farming systems with Integrated Pest Management. Seventh framework programme.

Deguine JP, Gloanec C, Laurent P, Ratnadass A, Aubertot JN. 2017. Agroecological Crop Protection. Springer Science+Business Media B.V., Dordrecht, 280 p.

Willocquet L, Aubertot JN, Lebard S, Robert C, Lannou C, Savary S. 2008. Simulating multiple pest damage in varying winter wheat production situations. Field Crops Research 107:12-28.

Candidate

For this interdisciplinary project, we look for an enthusiastic person with an appropriate MSc degree in agronomy, with strong analytical skills and interest in participatory research with farmers and other stakeholders. Experience with experimental work and/or modeling is an advantage. An interest in research for development and living in an Asian country is necessary.

Good communication skills and proficiency in English (both oral and written) are a prerequisite.

General information

The PhD will be affiliated to the SEVAB doctoral school.
The student will be funded by CIRAD and INRAE for 3 years, with the support of different research-development projects for field studies.
More than the half of the PhD will be spent in Cambodia, based in Phnom Penh, at ITC (Institute of Technology of Cambodia).

To apply, send a CV and a motivation letter before September 1st, 2020 to:

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