



## Concept Note

### International summer school on methodological approaches to system experiments

#### Context and background

The idea for this summer school (SS) emerged within the European project PURE (Lescourret, 2017) which aimed at reducing the reliance of major cropping systems on pesticides. PURE relied, in particular, on system experiments carried out across Europe to design and evaluate Integrated Pest Management (IPM) strategies. We observed the difficulty for the participants to process the data obtained from these experiments, alone or in collaboration (networking) for a given category (wheat-based cropping systems or apple orchards for example), and to value the detailed information collected on the functioning of the agroecosystems studied. In addition, it should be noted that the methodological questions raised during the project are widely shared by different groups, notably the European Research Group ENDURE, the INRA Exyst network, or the DEPHY EXPE network of the French National Action Plan ECOPHYTO. We found that difficulties in analyzing the data collected were partly due to the status of system experiments, which were intermediate -- to varying degrees depending on the cases -- between classical factorial experiments and observation of commercial fields (i.e. regional agronomic diagnoses in agricultural plots frequently practiced in agronomy; Doré et al, 2008).

These findings highlighted the need for a training course, such as a SS, to share these difficulties and ways to overcome them. The scope of the SS is obviously broader than the aforementioned example of PURE. The importance of system experiments for the scientific programs in general, and the rise of and interest in such systems at European and international levels, constitute an ideal context for organizing a SS.

Without confining ourselves to data analysis, it is also necessary to reflect on the two preliminary phases to the analysis: the explicitation of a hypothetical scheme or a conceptual model, and the experimental design. It is thus essential to treat during the SS these three phases, which are linked to the specific approach of system experiments, as in any experimental or observation procedure.

The idea of this SS, therefore, is to deepen the methodological approaches of system experiments as described above. A number of methodological dimensions of system experiments, which are also very important, will be kept outside the scope of this SS for feasibility reasons and consistency of the content. These include, for example, the choice of data to be collected -- a broad description of the decision-making framework, indicators of the practices, physico-chemical and biological structures and functions of the agroecosystems studied at the relevant scales and the rater/observer effect. Even if the type of data to be collected is not treated as such, its consequences for the design of a



hypothetical scheme, of an experimental design or a data analysis strategy will be taken into account. This applies in particular to decision rules. Likewise, multicriteria assessment methods, for which there are dedicated platforms (Means platform: <https://www6.inra.fr/means/>) or structures (RMT Erytage : <http://www.plage-evaluation.fr/webplage/>), will be outside the scope of this SS.

## Content highlights

In the first phase, we will clarify the types of system experiments, mention their characteristics including the description of decision rules, and then work according to this classification on the underlying hypothetical schemes (Part I). This work will ensure a smooth transition to the following parts: How to design an experimental layout and collect data to materialize these patterns (Part II)? And how to process data to test these patterns (Part III)?

In the second phase, we will present and discuss experimental designs for system experiments. Based on the objectives previously established, system experiments can be classified in two categories. The first category consists of **system experiments by prototyping**. These approaches are carried out by experimentation in the strict sense, with control of the studied factors. The second category consists of **step-by-step system experiments**. The approaches are intermediate between the former approach, and the observation of farming situations, which corresponds to what is commonly practiced in ecology. In such cases, we can speak of 'supervised observatories'.

How to design experimental designs for these two categories, with the framework of constraints and specific objectives of the system experiments, and with which sampling strategy?

In the third phase, we will present data processing methods for system experiments. The aim is to make participants aware of the possible methods, the choice of which depends on the type of experimental design, and also on the fact whether the experiment is monosite, in an 'homogeneous' network (with identical protocols shared across the different network sites), or in an 'heterogeneous' network (with various protocols across experimental sites). Which approach to adopt? When is it appropriate to use methods aiming at statistical inference (e.g. analysis of variance and its variants), and how? How to explore datasets to test hypothetical schemes and to understand the functioning of the agroecosystem studied (graphical methods, multivariate analyses, Partial Least Squares regression, decision trees and other methods of data mining)? What are the possible links to modeling? All this keeping in mind that most models are nothing more than a mathematical (and/or computational) formalization of the hypothetical scheme worked in the first part.



### Target audience

Researchers (permanent and non-permanent), engineers, PhD students involved in the design, monitoring and exploitation of systems experiments, without restriction of domain (plants, animals). Both French and international audience (Europe and beyond) are targeted. The ENDURE network will be of support to encourage, in particular, European practitioners interested in system experiments as demonstrated by a recent collective publication (Lechenet et al., 2017). A maximum of thirty participants will be accepted to ensure effective work.

Although the targeted domain of the SS is that of research institutes and universities, ingeneers of R&D organizations can participate in the SS.

### Steering committee

It is constituted by representatives of the following institutions: INRA Divisions (EA, MIA, SPE); ENDURE; INRA/CIRAD IPM network; INRA EXYST mission; Dephy Expe Ecophyto; RMT Systèmes de cultures innovants; RMT modélisation et analyse de données; GIS PicLég; FormaSciences.

### Form, date and venue

The form will be that of alternation between lectures and group works with concrete examples and datasets, and a field trip.

Date: June 23-28, 2019

Venue: Scuola Internazionale di Alta Formazione (SIAF) in Volterra, Italy.

### References

Doré, T., Clermont-Dauphin, C., Crozat, Y., David, C., Jeuffroy, M.H., Loyce, C., Makowski, D., Malézieux, E., Meynard, J.M., Valantin-Morison M. 2008. Methodological progress in on-farm regional agronomic diagnosis. A review. *Agronomy for Sustainable Development* 28 151-161

Lechenet, M., Deytieux, V., Antichi, C., Aubertot, J.-N., Bàrberi, P., Bertrand, M, et al., 2017. Diversity of methodologies to experiment Integrated Pest Management in arable cropping systems: analysis and reflections based on a European network. *Eur. J. Agron.* 83, 86-99.

Lescourret, F., 2017. Toward a reduced use of pesticides in European farming systems: An introduction to the PURE project. *Crop Prot.* 97, 7-9.