# Supporting the design process of agricultural systems in a watershed: Lessons from a case study

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## 1 – Introduction

In many studies, the research agronomists have been the designers of target systems, notably by using simulation models or prototyping methods. However, this role is being called into question as the farmers are more and more recognized as the actual designers of their agricultural systems. How, then, can agronomy support the farmer's design capabilities and progressive transition towards innovative systems? What inputs (knowledge, methods, tools) should we, agronomists, bring or build to do that? To answer these questions, we analyse a case study, supported by research agronomists over several years, in which a collective of farmers had to redesign their agricultural systems to restore the quality of water in a catchment area (Prost et al., 2018).

## 2 – Materials and methods

In France, more than 1000 priority catchments for drinkable water have been identified. In these areas, local authorities are required to develop an "action plan" defining effective changes in agricultural practices. Our case study is located in one of these catchment areas, in north-eastern France. Annual crops in short rotation predominate on the 1700 ha of the agricultural land. 25 out of 58 present farms account for 80% of the agricultural land. The water quality is characterized by high nitrate concentration. The local Agricultural Chamber (CA89) was chosen in 2010 to build and implement the action plan. It began a collaboration with INRA agronomists who had a high interest on design studies. This collaboration, which has been active for 9 years, is based on the involvement of researchers in local dynamics: participation in collective activities with farmers and the steering committee of the area, participatory observations and interviews. Data about agricultural practices, crop growth, nitrogen uptake and mineral soil nitrogen content have been annually collected and recorded in a local database.

## 3 – Results – Discussion

**Different steps in the design process (2010-2018)**

The researchers and facilitator from the local Chamber firstly supported the design of the action plan (2010-2012): they proposed an agronomic diagnosis characterizing the impact of the cropping systems of the area on the water quality and they helped the steering committee to define a water quality to achieve. They worked with a group of voluntary farmers to design various target cropping systems during a four-day design workshop which combined knowledge sharing, definition of a design goal (less than 60 $kg.ha^{-1}$ soil inorganic nitrogen in mid-autumn), design of disruptive cropping systems that would allow to reach this goal and selection ofpractices to be recommended to the whole farmers. These commitments were validated by all farmers at a special meeting. The researchers formalized these commitments in a dashboard (Girardin et al., 2005), which presented the reasoning behind the design solution and provided a way of monitoring the design process each year (Fig.1).

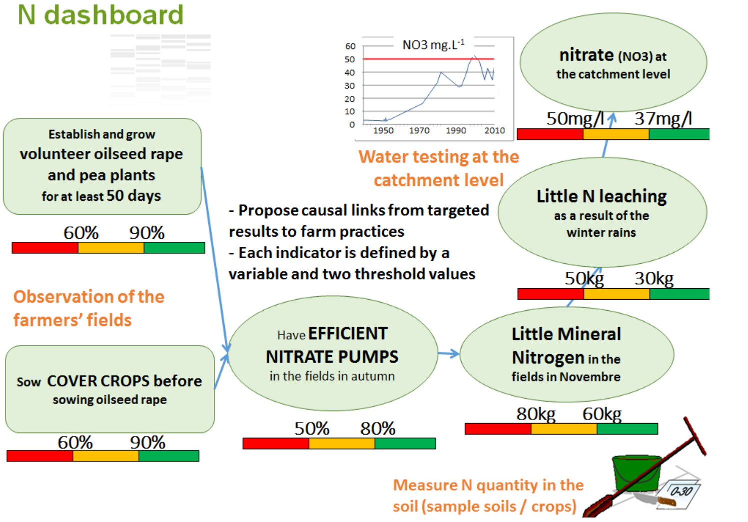


Figure 1 : the dashboard. We follow the causal chain from farmers' actions to water quality. Each link is assessed with a specific indicator (% area for the left and middle links, kg.ha-1 for soil N water content and N leaching on average over the area, mg.L-1 NO3 in water for water quality). Two thresholds are defined for each indicator to define 3 color classes for each link. e.g.with regard to the efficient pumps, if less than 50% of the relevant area is covered with efficient pumps, the link is red; if more than 80% of the relevant area is covered, the link is green; for anything between the two, the link is orange.

The action plan was launched with the 2012-2013 dashboard presentation in 2013. Since then, the dashboard has been used to monitor the design process in the area (Fig. 2). It has become a tool for the farmers' and the steering committee's strategical decisions about the design process. It is a key element in the facilitation of farmers' activities: collection of data about crops and soils status, *in itinere* field visits and exchanges about the states of the fields, *ex post* individual and collective analyses of the results obtained.

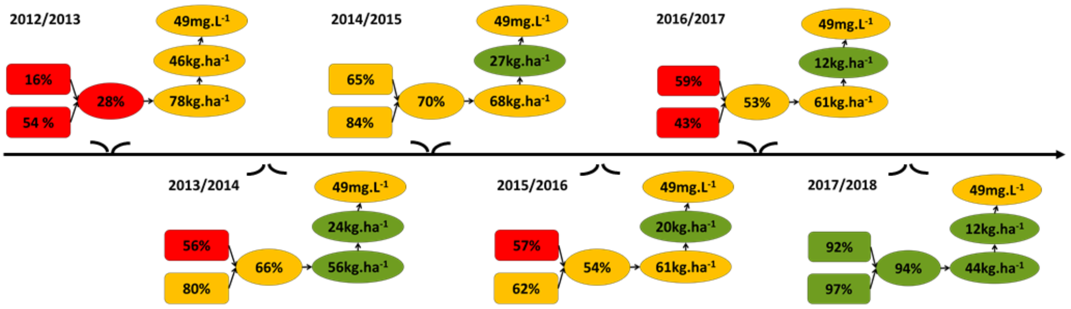


Figure 2: The results shown by the dashboard over the years. The colors of the links fit the thresholds defined in Fig. 1. In each link, there is the value of the indicator reached each year

### Combining project management and adaptative management

The results illustrate that invention part of a design process is only just the beginning of this process. Beyond the first design workshops and through the implementation of the first solutions, the design continues, in a "step by step" design process (Meynard et al., 2012). We point out that the design of agricultural systems is a process of both project and adaptive management. Project management since it requires the formulation of a design intention (or goal) as a constant reference throughout the process to build solutions. Adaptive management since solutions and design intention must be constantly assessed and adjusted to the actual situation and results obtained. For instance, the analysis of the first years' results at farm level showed a high diversity of N efficient cropping systems, some of them being very distant from the 2011 target systems.

**Research contributions to the design process**

Our contributions supported different design activities: sharing of knowledge, promoting creativity and design reasoning, reinterpreting this reasoning and design strategy throughout the process. Several tools were useful: 1) The diagnoses of the actual cropping systems and their possible impact on nitrate leaching (Reau et al., 2017) and knowledge exchanges about N leaching mechanisms promoted design creativity; 2) we used indicators to assess the nitrate leaching from practices or from the soil N measures; 3) the dashboard was a key tool to articulate a design intention to the actual situation; 4) some new tools have emerged like the characterization of the available N in autumn of the fields to question the farmers' solutions.

## 4 – Conclusions

We showed how research agronomists combined knowledge, indicators and models with several objectives: allowing the farmers to keep in mind a design intention; raising the causal relationships between actions and targeted results; and allowing the stakeholders to regularly reconsidering the targets and the actions when necessary. To do so, they mobilized agronomic tools that support monitoring and adaptation with regard to a design intention. Beyond the current decision making tools, there is a need for design making tools to support adaptive management of the territory projects.

## References

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