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Design of cropping systems at territorial scale: methodological lessons from case studies

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1 Introduction

Water quality in France is highly degraded, and must be improved according to the European Water Framework Directive. As agriculture has been recognized liable for diffuse water pollution, measures have to be taken in water catchment areas, often including a redesign of cropping systems to efficiently limit nitrate and pesticides transfer to water while keeping an economically powerful agriculture. Such a redesign at a territorial scale raises methodological issues: who should be involved on the design process and how, to allow a sustainable and long-term change of local practices? Which knowledge should be used, in order to take into account the characteristics of the local situations? As the change is thought to last several years, which process should we start to favor actors' learning? From two methods developed and implemented in six case studies, we analyzed the main characteristics and specificities of a process of design at territorial scale in order to be efficient.

2 Presentation of the two methods of design at territorial scale

Two methods aiming at collectively designing cropping systems at territorial scale were developed: Co-click'eau, based on the adaptation to a water catchment area of the method proposed by Jacquet *et al.* (2011) and Brienon, named after the place the approach was built (Burgundy, France) (partly described in Ravier *et al.*, 2015).

The Co-click'eau method includes 6 steps (Gislard *et al.*, 2014): (1) the choice of indicators for the assessment of cropping systems and territory scenarios, (2) a synthetically characterization of the present situation of the area (water quality issues and current cropping practices), (3) the building of a grid describing crop*soil*current and alternative practices combinations, with their main performance (yield, pesticide and N fertilizer use or gaseous losses emissions, work load, gross or direct margin, ...), (4) the collective identification of the main territory objectives and constraints (e.g. maximum profitability, minimizing pesticide use, a maximum area in organic agriculture), (5) the design of scenarios with a mathematical programming model satisfying the aims, and the assessment of the various scenarios (described as percentages of the cultivated area corresponding to each combination of the grid), and (6) a discussion on the results to build the action plan (if the results were not satisfactory, a new loop with steps 4+5+6 began). Steps 1, 4, 5 and 6 were realized by a steering committee, involving diverse stakeholders, including consumers, while steps 2 and 3 were implemented by a technical committee (farmers, advisors knowing the area).

The Brienon method includes 8 steps: (1) the analysis of the requirements built from interviews with the various stakeholders in the catchment area, (2) a collective identification of the targeted aim for the water quality, with the steering committee, (3) a diagnosis on the cropping systems in the area, (4) the design of new cropping systems, realized by local farmers (5) the assessment of the new cropping systems regarding the targeted aims, with adapted tools, (6) the building of an action plan, after a discussion of the possible cropping systems to be implemented with the local farmers, (7) the proposal and discussion of the action plan with the steering committee, (8) proposal for the monitoring of the action plan.

3 Results and Discussion

Since 2011-2012, these two methods have been tested in several water catchment areas located in the Northern part of France, each measuring between 17 and 47 km², and used predominantly for field crop production, winter wheat and rapeseed in particular (see Chantre *et al.*, 2014). Action plans were validated in each of these areas, sometimes following the actions plans built from our methods, sometimes not. Where the action plans were in line with the one built thanks to one of the two methods, change of practices has begun to be implemented. In Brienon for instance, the dynamics is very promising and the monitoring shows that the actions and results are in line with what was expected.

From these different experiences, their successes and their failures, we propose to discuss five characteristics of both methods that seem important to design cropping systems at territorial scale.

First, both methods involve the various actors concerned by the agriculture in the territory, including citizens, with their specific aims and values. Rather than building a common aim to reach, we propose various means to explore and take into account the diversity of the actors' targets, agree on their assessment criteria, and identify the agricultural solutions which respect as much as possible the diverse aims (Ravier *et al.*, 2015). Keeping the objectives of each stakeholder helps to alleviate tensions between differing opinions, thus facilitating the dialogue between them, particularly between farmers, the suppliers and water consumers, asking for a service. Considering together water quality and economic, social and environmental performance of agricultural practices in the targets helps at involving the various stakeholders in the approach.

Second, both methods show that describing and characterizing the current cropping systems, and their estimated impact on water quality, is a crucial step before designing new cropping systems and territory scenarios. This step allows the actors to build a shared vision of this territory and issues, by identifying and sharing the main practices that prevent to reach the targeted aims, justifying the need to design new cropping systems and territory scenario.

Third, both methods show that a step in sharing scientific and expert knowledge among actors about local agricultural conditions, and about innovative practices, together with their performance, is powerful. It also appears important that the results of the *ex ante* assessment of the innovative cropping systems and/ or scenarios, designed for the territory, be collectively discussed in order that every participant learns from the links between these results and the characteristics of the combinations practice*soil type in the area.

Fourth, exploring possible solutions, even if obstacles to their implementation exist (lack of market opportunities, economic performance...) and assessing their impacts at the territorial scale helps at defining the final scenarios in the action plan. Creativity can be enhanced by the exploration of breakthrough scenarios. This step is more powerful when assessment or optimization tools are used.

Fifth, choosing together the timescale of the action plan (what is possible to do and when), and the intermediary indicators that monitor the actions implemented and results obtained, contributes to the motivation of the participants. The monitoring of the implemented process allows the participants to assess the efficiency of the solutions proposed or to collectively imagine other solutions if the results are not as good as expected.

4 Conclusions

Finally, it appeared, from these case studies, that the implication of the actors all along the process, together with regular discussions on the intermediate results of implemented innovative practices, is required for a full and continuous implication of stakeholders. Sharing the information, diagnosis, knowledge, objectives at each step of the approach allows a learning loop for the participants, about the challenge, the methods, the organization, innovative technical practices, but also about the diversity of points of view in the catchment area (Chantre *et al.*, 2014). Several tools are needed for this approach that should be adapted to the activity and learning of the stakeholders: tool for representing the diversity of practices, tool for identifying optimal scenarios, tool for assessing solutions at the territorial scale, tool for monitoring the action ...

The success of the process greatly depends on the management of the stakeholders' positions and motivations: taking into account the diversity of the opinions, working with an open mind in order to find innovative solutions, accepting that the first solutions proposed do not allow to reach the targets and motivate the farmers to be more innovative.

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