'OUTILLAGE' -Tools to help farmers innovate on their farms

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Summary

The agroecological transition of farms requires an in-depth change in advisory approaches, placing the farmer at the centre of a co-innovation and adaptive management approach. In this context, the main objective of the OUTILLAGE project was to close the gap in operational resources to support these new approaches, by developing tools to support farmers in their system change. Led by Terres Inovia, the project brought together 22 partners for 4 years. It relied on three farmer networks (Berry network, VIVESCIAgrosol club, AGRO D'OC group) to produce three types of tools: (i) dashboards applied to obtaining a robust rapeseed and to the success of sunflower in conservation agriculture, (ii) a decision tree applied to the transition to conservation agriculture, (iii) observation methods to feed these different tools. In this article we also describe the diversity of approaches to advising/supporting farmers and therefore the diversity of expectations in terms of tools and their uses, highlighted during the project. Finally, we propose a framework to help with the construction and use of customised tools, to contribute to scale up these new approaches of innovation support.

Key words: Co-innovation, dashboard, agroecological transition, observation methods, step-by-step design, cropping systems.

Résumé

La transition agroécologique des exploitations agricoles nécessite de faire évoluer en profondeur les approches de conseil, en plaçant l'agriculteur au centre d'une démarche de co-innovation et de gestion adaptative. Dans ce contexte, l'objectif principal du projet OUTILLAGE était de combler le manque de ressources opérationnelles pour soutenir ces nouvelles approches, en mettant au point des outils d'accompagnement des agriculteurs dans leur changement de système. Piloté par Terres Inovia, le projet a réuni 22 partenaires pendant 4 ans. Il s'est appuyé sur trois réseaux d'agriculteurs (réseau Berry, club VIVESCIAgrosol, groupe AGRO D'OC) pour produire trois types d'outils : (i) des tableaux de bord appliqués à l'obtention d'un colza robuste et à la réussite du tournesol en agriculture de conservation, (ii) un arbre de décision appliqué à la transition vers l'agriculture de conservation, (iii) des méthodes d'observation pour alimenter ces différents outils. Dans cet article, nous décrivons également la diversité des approches de conseil/accompagnement aux agriculteurs et donc la diversité d'attentes en termes d'outils et de leurs usages, mis en évidence au cours du projet. Enfin, nous proposons un cadre pour aider à la construction et l'usage d'outils personnalisés, afin de contribuer au déploiement de ces nouvelles approches d'accompagnement à l'innovation.

Mots-clés : Co-innovation, tableau de bord, transition agroécologique, méthodes d'observation, conception pas à pas, systèmes de culture.

Introduction

Most cropping systems currently applied in France have their limitations: technical issues, sensitivity to climatic and market hazards, dependence on inputs whose use is increasingly restricted and costly, lack of profitability, negative environmental impacts, etc. At the same time, agricultural production is subject to multiple and sometimes contradictory demands, which encourage farmers to aim for multi-performance and a greater contribution to sustainable development. The agroecological transition of farms, which consists of an in-depth modification of agricultural production methods to promote and enhance biological processes as the basis of production, appears to be the best way forward. This should lead to robust production systems that reconcile profitability, productivity and environmental performance. However, the uncertainty and high variability of the impact of agroecological strategies depending on the situation, the systemic dimension of the changes to be made, and the diversity of farmers' constraints and objectives mean that it is difficult and not very relevant to design generic solutions that can be applied everywhere (Duru *et al.*, 2015). Supporting farmers in the design of innovations is more likely to lead to solutions that are adapted to each situation, and therefore to promote agroecological transitions, than conventional approaches of designing and disseminating innovations (Le Gal *et al.* 2011; Duru *et al.*, 2015; Prost *et al.* 2018). However, these approaches come up against a lack of skills and tools, which limits their large-scale deployment (Duru *et al.* 2015). This observation, which emerges from the literature, was supported before the project began by observations made in networks of innovative farmers, such as the Berry network, the VIVESCIAgrosol club, and the AGRO D'OC groups. The innovative way in which these groups operated was based more on testing, experience sharing and field evaluation than on traditional top-down advice, and they led to real system transitions based on the principles of agroecology. However, these successes depended on the expertise of the advisors, and the approach used was not formalized, so could not be deployed.

It was against this backdrop that the OUTILLAGE project was set up, with the aim of formalising and deploying approaches and tools to support innovation on farms. The operational objectives of the project were:

- **To develop tools to support on-farm innovation** (dashboards, decision trees and observation methods), enabling farmers and their advisors to imagine, test, evaluate and continuously improve innovations so that they meet their expectations;
- **To support farmers** in implementing the tools in order to study their use in working situations and thus learn from the approaches used to support farmers and contribute to their progress and deployment;
- **Deploying the tools and approaches and promoting the lessons learned from the project** to contribute to the agroecological transition of farms on a national scale.

The OUTILLAGE project ran from January 2018 to February 2022, in a co-innovation approach that involved 22 partners: Terres Inovia, ISARA, INRAE, AGRO D'OC, VIVESCIA, Chambres départementales d'Agriculture de l'Ariège, de l'Indre et de la Marne ; Chambres régionales d'Agriculture de Normandie et d'Occitanie, CETA de Romilly, Cérèsia, Etablissements Villemont, UCATA, EPLEFPA de Toulouse-Auzeville, Arvalis, ITB, FDGEDA du Cher, CETA d'Issoudun, GRCETA de l'Aube, AXEREAL, EPLEFPA de l'Eure, RMT Systèmes de culture innovants.

1. Approach

1.1 Support at the heart of the project

The OUTILLAGE project focused on approaches to supporting farmers in innovation. The term "support" is often used and sometimes refers to very different approaches. In the OUTILLAGE project, we considered the support approach as defined by Le Gal *et al* (2011), summarised in Figure 1. This approach is based on cooperation between Research & Development, advisors and farmers to co-innovate. It places the farmer at the centre of an adaptive management process (Klerkx *et al*., 2010) that involves imagining, testing, evaluating and continuously improving innovations so that they meet his or her expectations and context. Some refer to this process as generative experimentation (Ansell and Bartenberger 2016). It differs from the vertical, top-down approach in which Research & Development designs innovations, through factorial experimentation in comparative trial plots for example, advisors disseminate them, and farmers apply them.

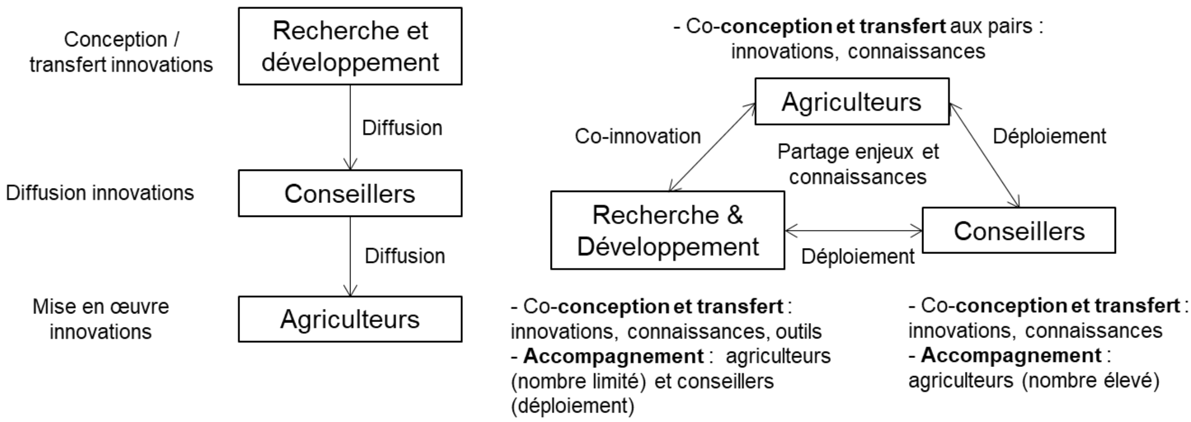

Figure 1: Schematic representation of two types of approach to innovation in agriculture: on the left, the linear, diffusionist approach of top-down innovation advice; on the right, the interactive, participatory approach of innovation support (adapted from Le Gal *et al,* 2011).

These two approaches correspond to different visions and expectations of research, advice, and farmers. For reasons of motivation, priority and/or availability, some farmers expect turnkey solutions and are more inclined to adopt a top-down advisory approach. Other farmers are looking for decision-making autonomy or wish to explore new solutions and are more inclined to adopt a support approach. This simplified representation conceals a continuum which means that, depending on the individual or the issue under consideration, the most appropriate approach is either top-down advice or support.

The tools used in the OUTILLAGE project were developed primarily with a support approach in mind. What they have in common is that they take account of farmers' specific expectations and encourage exploration and learning, based largely on observations in cultivated plots and on the formalisation of operational knowledge. The OUTILLAGE project has confirmed the continuum of approaches between top-down advice and support, and the expected diversity of uses for the resulting tools. Thus tools (e.g. decision trees) or uses of tools (e.g. use of dashboards to assess agronomic variables during the growing season in relation to a state considered optimal), corresponding more to the top-down approach to advice, have also been worked on in order to meet the expectations of advisors and farmers in the three networks.

1.2 Three networks to develop and test tools

The OUTILLAGE project tools (dashboards, decision tree and observation methods) were co-designed with farmers, advisors, and project partners. Three networks of farmers, federated through the Syppre inter-institute action[1], were used to develop the tools (Figure 2).

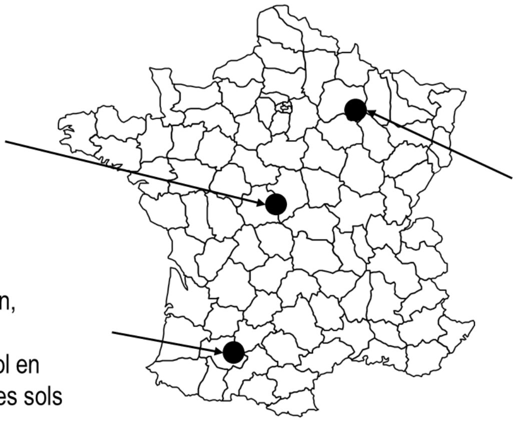

Figure 2: Map of the three networks of farmers who developed and tested the support tools

The choice of these three networks was based on a shared approach to support (based on testing and observation, desire to formalise tools, use of agroecology principles, etc.) and on specific features (soil and climate diversity, diversity of support structure, specific themes) enabling tools to be developed and tested under a variety of conditions.

- The **VIVESCIAgrosol Club** is supported by VIVESCIA, an agricultural and agri-food cooperative group specialising in the production and processing of cereals. The VIVESCIAgrosol club was set up in 2005 and brings together around 350 farmers with a wide range of backgrounds, soil and climate conditions, intensity of tillage and crop rotation. They are organised into 18 groups based on themes and geographical proximity. The club's common theme is the successful transition to conservation agriculture (CA).
- The **Berry network** is managed by Terres Inovia, the French technical institute for oilseed, protein crops and hemp. It includes around fifteen farmers in the Indre and Cher departments. The approach was initiated in 2005 at the request of farmers to improve the performance of winter oilseed rape in a complicated soil and climate context, with short rotations (oilseed rape-wheat-barley), irregular and sometimes mediocre economic performance and crop yields. The common theme of the network is to obtain a robust oilseed rape crop, i.e. one that is not sensitive to climatic hazards nor to insect damage, while at the same time not being very dependent on inputs, by relying on successful establishment, fertile soil and a diversified rotation.
- A **group of farmers** supported by **AGRO D'OC**, an agricultural cooperative providing advice on arable farming and organised as a CETA, made up of around ten farmers from the Gers, Tarn and Haute-Garonne. The local context is characterised by clayey and dry hillsides, sometimes very steep, where the "wheat - sunflower" rotation is dominant, with several major problems including soil erosion. The group's common theme is the implementation of the principles of conservation agriculture to limit the risk of erosion, and the success of sunflowers, which are considered essential in cropping systems but difficult to achieve without tillage.

[1] https://syppre.fr/les-reseaux-dagriculteurs/

In each of these three networks, the tools were developed thanks to a back-and-forth process involving workshops with farmers, advisors and project partners, 'expert' workshops with project partners, and the implementation of the tools with farmers.

Finally, a reflective analysis was carried out to establish the link between the tools produced and their use in the various working situations, to understand the diversity of the tools obtained and the diversity of the uses made of them, and then to draw lessons for future development of support tools and advisory activities. This analysis was based on the approach proposed as part of the CASDAR Changer project (Omon *et al,* 2019), distinguishing five areas: (i) the influence of the history of each network in the design and testing of tools, (ii) the articulation of working situations for the design and testing of tools, (iii) the analysis of a particular working situation in each of the networks, (iv) the observation of the modification of tools through use, (v) the analysis of farmers' reflexivity about this support approach mobilising new tools in order to draw lessons for the activities of advisory and development organisations.

2. Results

2.1 Different tools for different uses

At the outset, the OUTILLAGE project planned to work mainly on the 'dashboard' tool as a strategic aid to the design and analysis of the results of agronomic projects with a view to progressing towards a result expected by the farmer. The limited scope of the tool in relation to the diversity of working situations faced by farmers and the advisors who support them quickly led to difficulties in understanding the value of the tool and how it should be designed. The first step was therefore to clarify the role and complementarity of a variety of support tools, based on the conceptual framework of the types of activities of farmers and advisors defined during the CASDAR Changer (Omon *et al,* 2019; Kockmann *et al,* 2019). These types of activities are of three kinds: (i) **creative** to imagine the agronomic strategies to be implemented, (ii) **operative** to implement the imagined strategies in the farm plots, (iii) **reflexive** to analyse the results and draw lessons from the implementation of the strategies with a view to progressing towards the expected results (Figure 3).

During these different phases, the farmer will explore, design his system, carry out the cultivation operations, observe his plots to decide whether to intervene or evaluate the success of his operations, and then analyse his results with a view to adjusting his practices for the following season. The advisor can support farmers in all these activities, and not just in making tactical decisions during the season. These different activities explain the diversity of the tools needed to support farmers: tools to help them making decisions (Decision Support Tools, decision trees), observation methods to support decision-making or evaluation, tools to evaluate and analyse results (agronomic diagnosis tools, performance calculation tools, dashboards), and finally tools to explore new ways of producing (dashboards, design workshops, etc.). This clarification has made it possible to specify the scope and complementarity of the tools being worked on, and to avoid trying to do everything with a single tool.

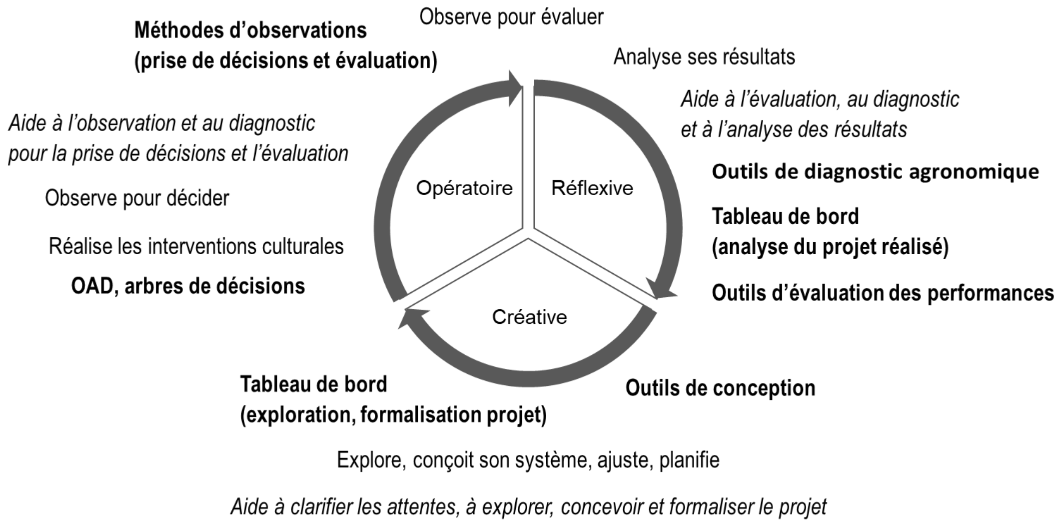

Figure 3. Positioning of observation tools and methods (in bold), the activities of farmers who design their systems step by step (classic font) and the advisors who support them (in italics) in relation to the three types of activity.

In addition, it was the discussions held during the project on the specific workings and activities of the advisors in the three networks that led to the identification and then proposal of tools adapted to their advisory/coaching activity, which was in the process of being built up, rather than "forcing" the use of the dashboard on everyone. There is an equivalence in reasoning between placing the farmer at the centre of a specific design of his cropping system and placing the advisor at the centre of the design of his support activity.

Three tools were developed as part of OUTILLAGE: dashboards, decision trees and observation methods.

2.2 Dashboards

2.2.1 General description of the tool

The dashboard was initially proposed to build, present, and evaluate a territorial project (Girardin *et al,* 2005). It has subsequently been used as a tool for adaptive management and generative experimentation (Sausse *et al*, 2011; Paravano *et al*, 2016; Reau *et al*, 2017; Prost *et al*, 2018). It can be defined as a strategic tool for step-by-step innovation design, making it possible to imagine and analyse the success of an agronomic project with a view to identifying paths of progress towards an expected result. It focuses on a **result expected** by farmers, alone or in groups, and not on cultivation practices. It sheds light on the ways of achieving the expected result by highlighting the **key states of** the cultivated field, rather than detailing all the mechanisms involved, and by describing the **cause-and-effect relationships** that link cultivation practices to the expected result via the key states. It contains indicators and thresholds that make it possible to specify expectations and objectify the evaluation (Figure 4).

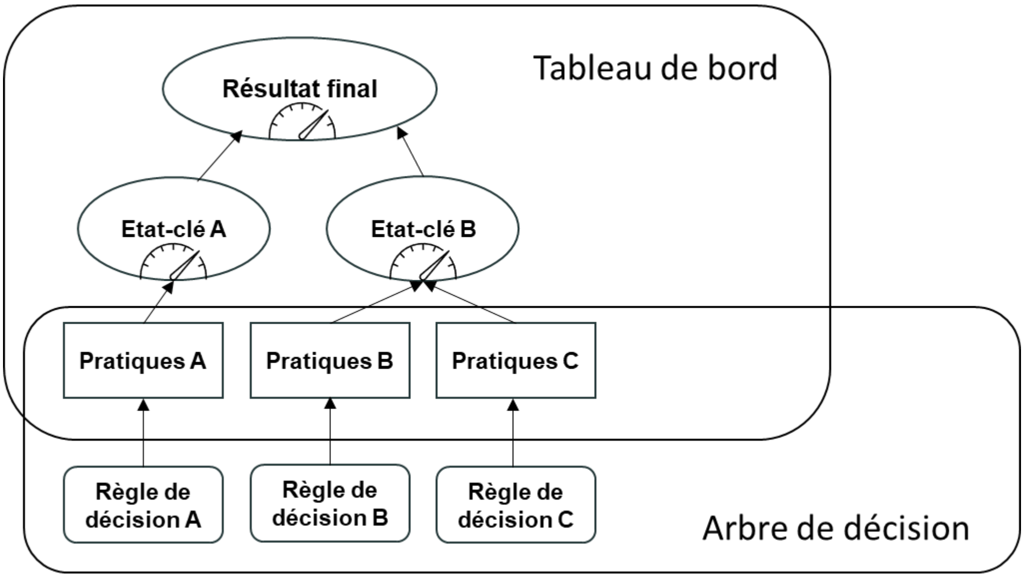

Figure 4: Simplified diagram of a dashboard and decision tree

Three dashboards were developed as part of the OUTILLAGE project: a robust winter oilseed rape dashboard and two successful sunflower dashboards for conservation agriculture.

2.2.2 Robust oilseed rape dashboard

The 'obtaining a robust oilseed rape' dashboard was developed with farmers from the Berry network, to help farmers develop strategies for obtaining a robust oilseed rape, adapted to each situation, hence its generic nature. The context is one of climatic ups and downs and difficulties in controlling autumn insect damage, which makes it difficult to grow a successful crop and justifies the search for an oilseed rape that can be described as "robust", i.e. not very sensitive to these hazards, not very dependent on the use of inputs and more capable of expressing its yield potential. The strategies for obtaining robust oilseed rape, which draw on the principles of agroecology, vary greatly from one situation to another and are part of a systemic vision. The 'obtain robust oilseed rape' dashboard is therefore a tool to help develop solutions tailored to each situation.

Discussions with farmers and monitoring in the field have made it possible to identify key states and thresholds that characterise robust oilseed rape, and to clarify the cause-and-effect relationships between possible practices, key states and the result which is robust oilseed rape (**Figure 5**).

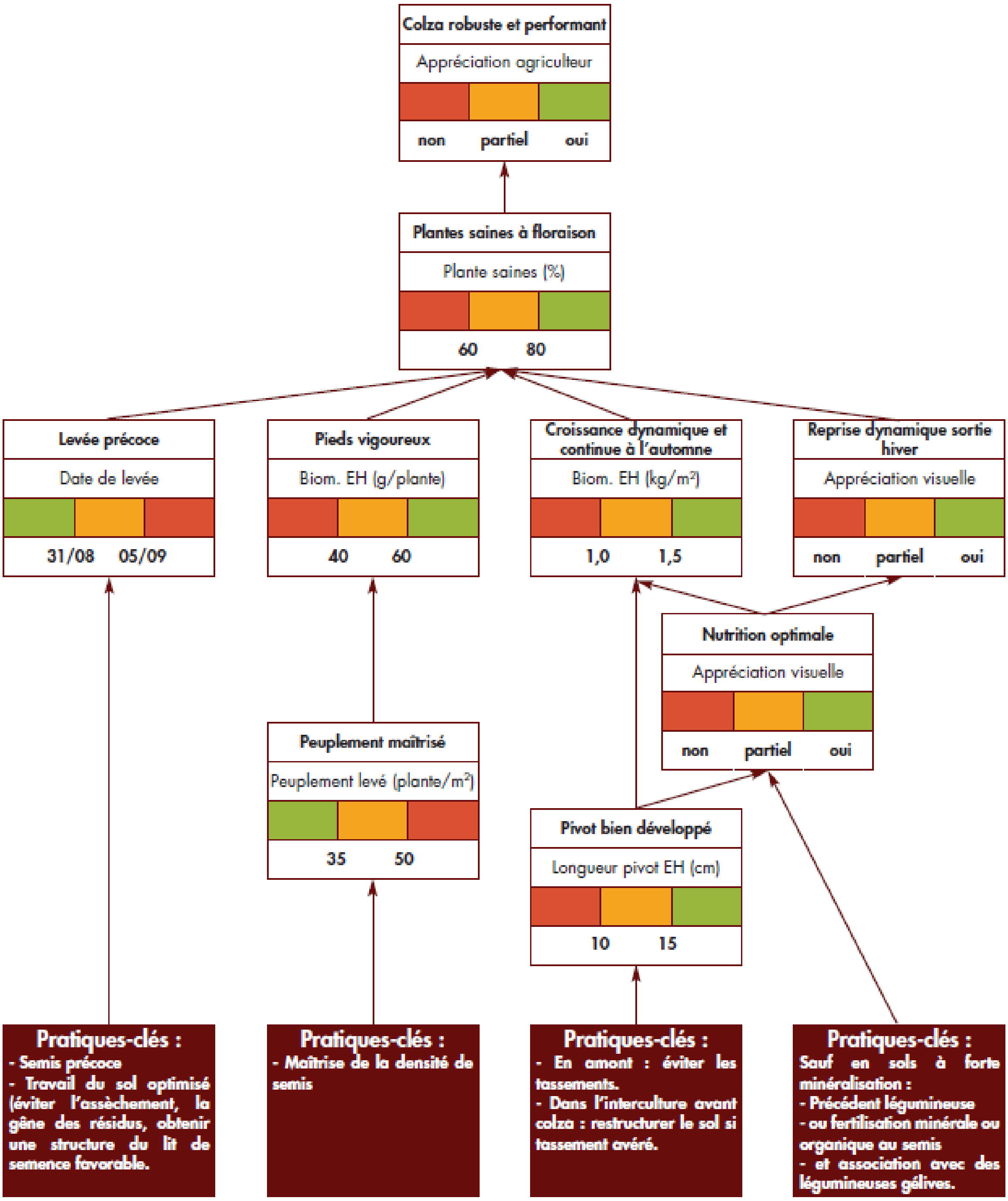

Figure 5: 'Obtaining a robust oilseed rape' dashboard

2.2.3 Successful sunflower dashboards in CA

Farmers and advisors from AGRO D'OC, in partnership with Terres Inovia and ISARA, have developed two dashboards on the success of sunflowers in CA. In the context of the clay hillsides of the South-West, erosion problems are leading farmers to turn to conservation techniques (reduction or even elimination of tillage and soil cover in particular). Sunflower, the mainstay of many systems in the region, is difficult to grow successfully without deep tillage, and therefore in CA. The aim of the 'successful sunflower in CA' dashboard is therefore to help farmers find solutions to reconcile successful sunflower growing with low levels of erosion in the plots.

At the start of the project, the difficulty of identifying the key states and the indicators that inform them, as well as the difficulty of extracting oneself from the advice during the season, led to the development of an initial 'agronomic path' dashboard, focusing solely on the success of the sunflower. This version consists of a chronological list of all the desirable states of the cultivated field (in this case, focused on sunflower cultivation) so that the gap between the results obtained and the ideal growth path for the plant can be assessed during the season. This dashboard is a tool that sets benchmarks and milestones, which are particularly useful for farmers and advisors making their first experiences of growing sunflowers in CA. At each point in the crop cycle, it can be used to identify conditions that are not at optimum levels, but it is more difficult to analyse the root causes of these deviations and thus identify ways of improving. For this reason, the purpose of this dashboard differs from that described in part 2.2.1. Secondly, by taking a step back, it was possible to identify the key conditions both for the success of sunflowers in CA and for controlling erosion. A second 'analysis' dashboard, corresponding to the definition given in part 2.2.1, was then gradually developed (Figure 6). This dashboard makes it easier to identify areas for progress in reconciling sunflower success and erosion control, leaving more room for observation in the field and "reflective" re-reading *a posteriori,* based on the causal links defined. The way in which the tool is read is therefore important, and reversed in relation to the order in which it is filled in: we start with the final key states (in this case, erosion control and sunflower yield) and work our way up to the cultivation practices, passing through the intermediate states (from left to right).

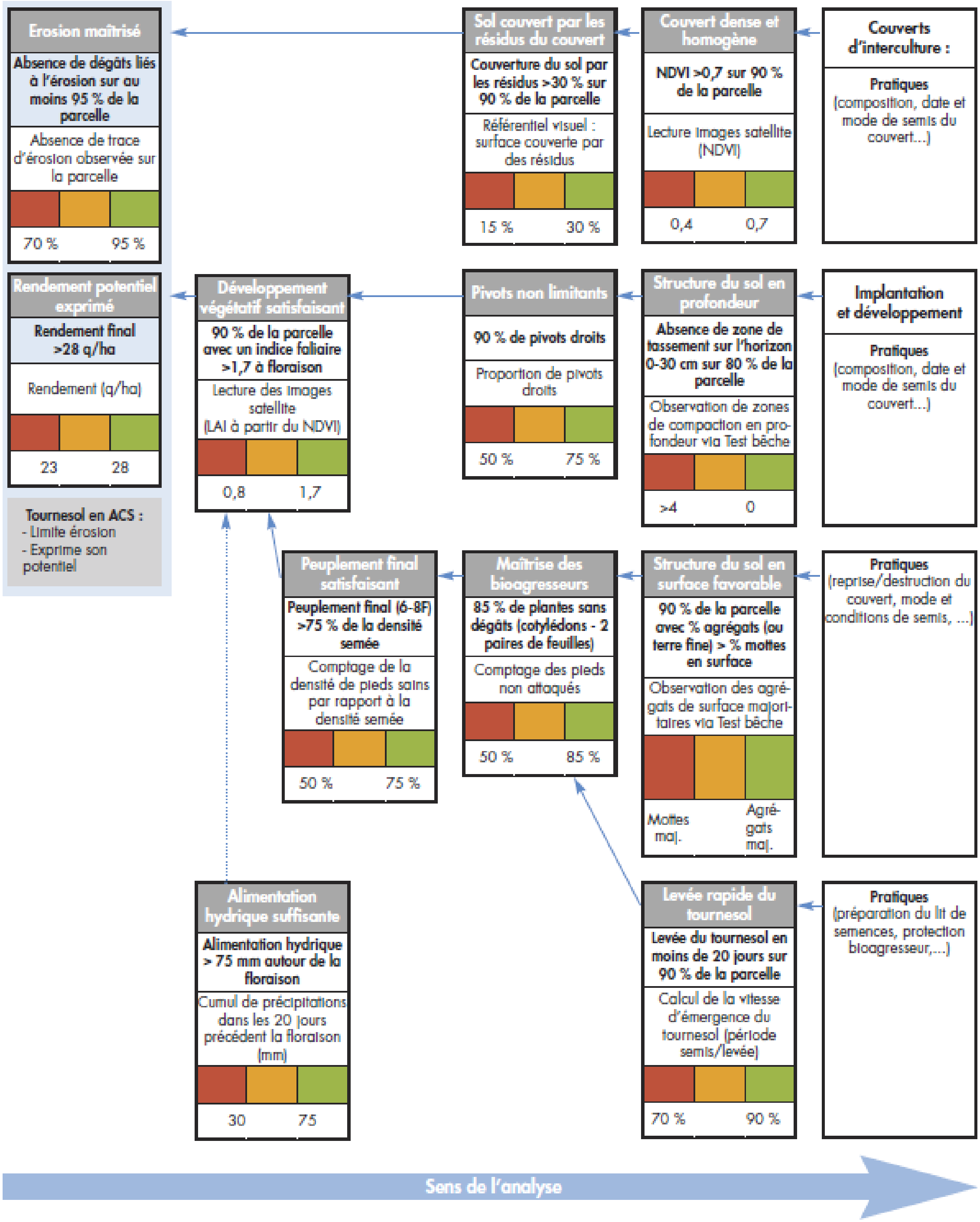

Figure 6. "Analysis" dashboard for successful sunflower in CA

2.2.4 Building and using customised dashboard

The OUTILLAGE project has produced three operational dashboards on two themes. The characteristic of the dashboard tool is that it focuses on a result expected from a (group of) farmer(s) and can therefore be applied to a variety of services. The lessons learned from the OUTILLAGE project, as well as from previous dashboard construction experiments (Sausse *et al*, 2011; Paravano *et al*, 2016; Reau *et al*, 2017; Prost *et al*, 2018), have made it possible to propose a generic framework for the construction and use of customised dashboards.

The first observation to be drawn from these various experiments is that the ease with which a dashboard as described in part 2.2.1 can be constructed depends on how familiar you are with generative experimentation and your level of knowledge of the mechanisms involved in achieving the expected result. If one of these elements is lacking, a preliminary step consisting of listing all that is known about the mechanisms involved (knowledge trees) or the chronological succession of optimum states of the cultivated field ('agronomic pathway') may prove useful. The dashboard itself can then be constructed by progressively identifying the key states, the indicators for evaluating them, and the cause-effect links to clarify the hypothesis scheme.

The second observation drawn from the OUTILLAGE experience is that the diversity of approaches to advice and the expectations of advisors and farmers lead to a diversity of purposes and therefore possible uses for dashboards:

- Step-by-step system re-design: this is the initial aim described in section 2.2.1, based on *a posteriori* analysis of the results and identification of areas for improvement.
- Results assessment in relation to a benchmark, without seeking to redesign the systems: this is the aim of the 'agronomic pathway' version, described in section 2.2.3.

Whatever the use, there are three ways of constructing the dashboard, depending on the hypothesis to be explained and the objectives and uses envisaged:

- **Generic expert construction**: this involves formalising the expertise of agronomists on an expected result that is widely shared. This generic version can then be customised to meet specific expectations. This approach may prove useful for tackling a subject about which farmers are still unfamiliar.
- **Construction specific to a farmer**: this involves formalising the reasoning of a farmer to achieve his expected result. This specific version can then be generalised, particularly when it converges with that of other farmers. This approach may be appropriate when farmers have a high level of expertise in the subject being worked on.
- **Hybrid construction**: this involves co-constructing the dashboard with advisors and farmers who share their expertise. This approach can be useful when you want to achieve a shared vision of the subject being worked on.

Whichever approach you use, there are five steps to building a dashboard:

1. **Bringing out the result expected** by (the group of) farmers: this is a crucial stage which is not easy to achieve, because paradoxically it is not usual to define an expected result precisely. Its formulation defines the scope of the subject being worked on. It must be an ambitious target that is *a priori* achievable (Prost *et al,* 2018). It is often preferable to limit yourself to a single expected result to have an operational dashboard. It is possible to define two when seeking to identify key states and practices that make it possible to reconcile two priority objectives (e.g. sunflower dashboard in CA that seeks to reconcile sunflower success and erosion control). Whatever the construction approach, it seems necessary to have the target defined by the farmer(s) and not by the advisors. Experience shows that advisors often have a biased or incomplete view of farmers' expectations. Finally, it is necessary to specify the criterion and its target value which will be used by the farmer(s) to judge whether the expected result has been achieved at the end of the campaign.
2. **Bring out the key states** (or intermediate results), i.e. the succession of environmental states which are decisive in achieving the final or intermediate result, and on which the farmer exerts an influence through his practices. The challenge here is to find the right balance between defining enough key states to account for the major processes involved, but not too many to avoid either

ending up with a structure that is too complex, making it difficult to identify the links between cause and effect, or giving too much weight to processes that have only a slight influence on the expected result. If it is difficult to bring out the key states, particularly when the hypothesis scheme is unclear, it may be necessary to go through an intermediate stage. This involves making an exhaustive and possibly chronological list of all the states that may be involved in obtaining the result. The diagram must then be progressively simplified, retaining only the most decisive states.

3. **Identify the key practices** known to have an influence on the key states. Initially, it may be useful to consider a variety of key practices to open up the field of possibilities for the solutions to be tested.
4. Assemble the elements of the dashboard by linking the expected result, the key states and the key practices with **causal links**. This stage generally begins at the same time as the previous three stages, so that the cause-effect relationship of each key state and each proposed key practice is explained, and results in a clear and coherent set of hypotheses.
5. For each result and key state, define an evaluation **indicator that provides** an objective view of the result achieved and **thresholds** (generally two) that indicate the level of satisfaction with the result obtained (satisfied, moderately satisfied, not satisfied). These indicators must be based on **observation methods that are** clearly defined beforehand, so that the value taken can be given in an objective and reproducible way. Indicators, and especially thresholds, can be difficult to define in advance. They can be refined gradually as the dashboard is implemented, by capitalising on, compiling and analysing the results of observations.

All these stages can be carried out in the form of co-design workshops (Figure 7).

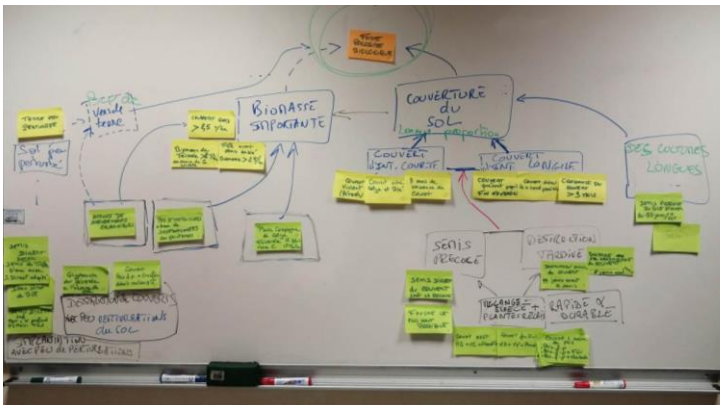

Figure 7. Draft dashboard for 'achieving high biological soil porosity' produced during a workshop between experts.

Once built and shared, the dashboard must be implemented in the plots to help farmers gradually achieve the expected result. There are also five stages to implementation, with some variations depending on the purpose of use:

1. Define with the farmer(s) the **practices to be tested to** achieve the expected result. At this stage, the dashboard acts as a tool for imagining solutions, thanks to its hypothesis diagram, which is intended to be enlightening. Some advisors may use this tool to provide top-down advice, but they rely more on benchmarks for the state of the environment to be achieved than on "good practices".
2. If necessary, it may be necessary **to support the farmer in implementing the practices to be tested**. This stage involves other types of tools, such as the decision tree (see part 2.3). The "agronomic pathway" version of the dashboard can also be used at this stage to identify any unsatisfactory environmental conditions that may require a change of practice during the season.

3. **Observe/measure** the dashboard **indicators** in each plot during the season, using clearly defined observation methods.
4. **Enter** the observed/measured values for each result and key status **in the dashboard** and give a visual indication of the level achieved (generally green if the status is satisfactory, yellow if it is moderately satisfactory and red if it is unsatisfactory).
5. **Analyse the results at the end of the campaign**. Depending on the purpose, this stage can take several forms:
    - **Analyse the reasons for the level of achievement of the result and identify avenues for progress** if the result is not achieved, with the aim of designing step-by-step strategies that meet farmers' expectations (Figure 8). This is the initial purpose of the dashboard, as described in section 2.2.1.
    - **Analyse the anomalies** identified to generate new knowledge about the cause-effect links between practices, key states and the result and/or to identify innovations. For example, satisfactory key states that lead to an unsatisfactory result may reveal the absence of a key state or a poor understanding of the links between cause and effect. The opposite can reveal key states that are not as decisive as originally thought. In the same way, identifying that practices which were not initially planned enable satisfactory key states to be achieved is a way of spotting innovations (innovation tracking).
    - **To assess the results** of the strategies implemented, and to situate oneself in relation to a known agronomic optimum without seeking to redesign the system. Instead, it is used as an expert appraisal aid and an agronomic diagnostic tool. This is a new purpose identified during the OUTILLAGE project, which has led to the development of an 'agronomic pathway' type dashboard.

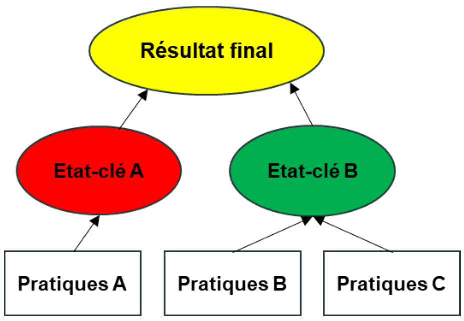

Figure 8. Simplified schematic representation of the implementation of a dashboard. In this example, key condition A is not satisfactory and explains the partial achievement of the result. The way forward for the next campaign is to find a more suitable practice than practice A.

2.3 Decision tree 'Making the transition to CA'.

The decision tree tool is made up of a series of decision rules that help to choose cultivation practices that are suited to the conditions encountered. It thus complements the dashboard tool, which links the practices finally chosen with their effects on the key states and the expected result (Figure 4).

The decision tree 'making the transition to CA' was developed with the farmers in the VIVESCIAgrosol club, to help advisors and farmers making decisions at each stage in the implementation of the cropping system. The 'decision tree' tool was chosen because farmers felt it was a priority to formalise all the decision rules developed over many years of advice and practices, and to make it easier to understand the overall coherence.

This decision tree is organised around several key sequences in the transition to CA: management of short and long intercrops, management of winter oilseed rape and management of semi-permanent cover crops. Each stage leads to proposals for suitable cropping practices (e.g. choice of cover crop, planting method, crop protection, etc.), depending on what is observed in the field (Figure 9).

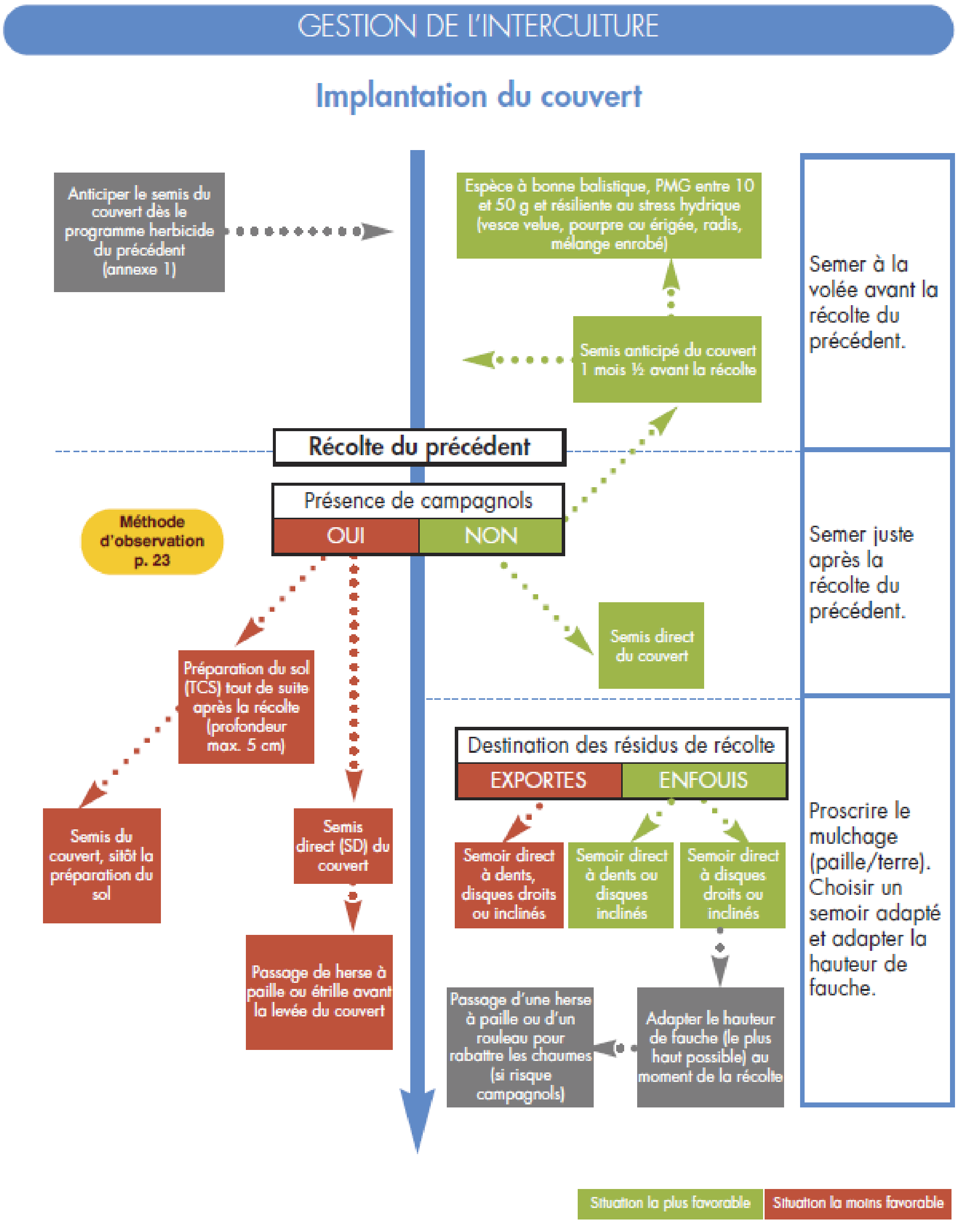

Figure 9. Sequence of the decision tree 'making the transition to CA', relating to the management of cover crops.

Complementary to the decision tree in terms of its ability to bring out new ideas for favourable practices, a 'succeeding in the transition to CA' dashboard was sketched out at the end of the project but not finalised. This draft nevertheless served as a proof of concept that it is possible to propose a dashboard with a simple structure, applied to a complex and resolutely systemic theme.

2.4 Observation methods

The project has confirmed that observation of the state of the environment is a key element in the support process (Figure 10). It has three key functions:

- Tactical decision-making during a campaign by helping to adapt the decision to the actual situation. Observation can then be used to feed decision-tree tools;
- Evaluation and analysis of the results of strategy implementation at the end of the campaign. Observation can then feed dashboard tools;
- And more generally, to encourage learning, by helping people to understand and see for themselves the effect of practices, as Toffolini *et al.* (2015) have already shown.

Berry network | AGRO D'OC Group | Club VIVESCIAgrosol

Figure 10: Example of a discussion on the observation of agronomic conditions in the three farmer networks during the project.

During the project, we therefore had to identify observation methods to be used in the various support tools produced. Whatever the tool, for each criterion (expected result, key state, or criterion of a decision rule) a variable need to be identified to provide information on the value taken for this criterion. Thresholds then need to be defined to transform this variable into an indicator for positioning on a level of satisfaction with the result, generally obtained with three classes (satisfied, moderately satisfied, not satisfied) (Figure 11). This generic construction means that the same observation method can be used with different tools and therefore for different purposes.

The choice of observation methods and the associated measurement protocol is often the result of a compromise between reliability in reporting an observed state and feasibility of implementation. It therefore depends on the user (advisor and/or farmer), and the level of precision required to interpret the results. The importance of the learning function of the methods also reinforces the interest in moving towards methods that are explicit for users. The choice can therefore range from measurements based on experimental protocols to visual methods based on picture references, for example. This means that the choice must be considered at the design stage of the tool, to ensure that it is feasible in the field and can be used to assess the results obtained as accurately as possible.

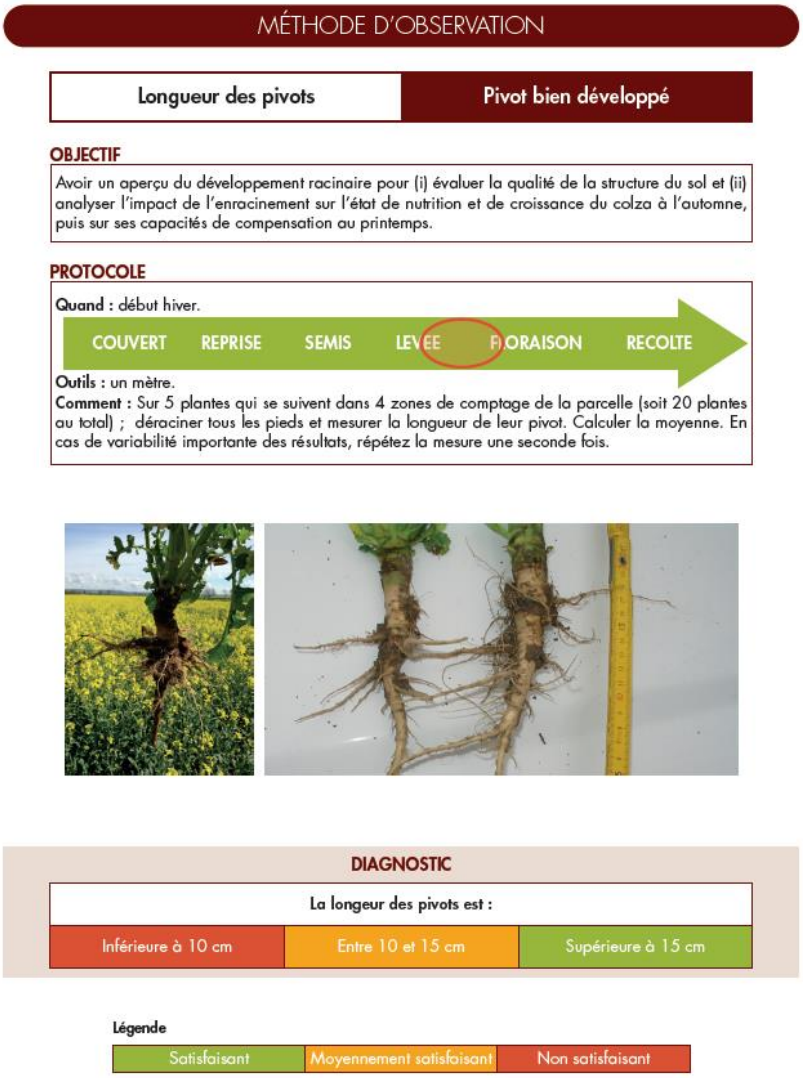

Figure 11. An example of the observation method used to feed the 'obtain robust oilseed rape' dashboard.

As well as being fed directly into the tools, the observations can be capitalised on, by the advisors in particular, to compile data and produce technical references, for example to gradually specify the interpretation thresholds for the variables measured.

As part of the project, we selected existing methods and/or developed new observation methods for each of the tools produced. Each tool is detailed in a guide that describes the structure of the tool, its use and the protocols for measuring and interpreting observations. We have also produced a document that compiles and summarises the various field observation methods identified by the project. It contains 58 method sheets organised around four themes: soil condition, plant cover management, soil fertility assessment and bio-aggressors (diseases, pests and weeds).

Conclusion and outlook

While there is a growing consensus on the need for an agroecological transition of farms, paradoxically few projects focus on changing the approaches involved and, above all, on their operational implementation through new adapted tools. Based on concrete cases, the OUTILLAGE project has developed and formalised several context-specific tools for and with farmers and their advisors. These tools and all the results of the project are freely available on the following website: https://www.terresinovia.fr/web/institutionnel/-/outillage-1. In particular, the project explored the dashboard tool, initially proposed by Girardin *et al* (2005) but still deployed in a very limited number of situations (e.g. Paravano *et al*, 2016), and thus made it possible to specify how it could be applied operationally in different contexts. As highlighted by Prost *et al* (2018), this tool is part of a new approach to supporting change, and facilitates a paradigm shift and systemic vision of cropping practices. For example, the robust oilseed rape dashboard seems to federate many people around a consensus result objective and facilitate the development of agroecological production strategies adapted to each situation (Sauzet and Cadoux, 2019).

OUTILLAGE also revealed the diversity of ways in which farmer networks operate, provide advice and support, implying a diversity of expectations in terms of tools and their uses. In addition, the project has highlighted the continuum between the historical approaches of top-down advice to farmers, and the more recent approaches of support which place the farmer at the centre of a process of co-innovation and adaptive management. We have therefore attempted to shed light on this diversity of expectations and proposed a framework to help build and use customised tools, so that everyone can make an operational commitment to innovation support. Finally, it should be noted that these changes in advisory approach and in the tools required take time and require an appropriation period that should not be underestimated.

OUTILLAGE has therefore produced operational resources to provide farmers and advisors with tools to support innovation. Further work is required to adapt these tools to other themes and scales, as in the case of the Transi'Sols project, for example, which aims to develop dashboards of the services expected from soil fertility, and to continue to learn from and develop the support approaches.

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