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Deltakende modellering for agroøkologisk overgang Studie av akse 4 i TRAVERSéES-prosjektet i Barrois-regionen

Participatory modelling for agroecological transition Study of axis 4 of the TRAVERSéES project in the Barrois region

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Résumé: Le plan Ecophyto II+ propose la mobilisation d'acteurs comme un des nouveaux leviers d'action, pour atteindre son objectif de réduction de l'utilisation de produits phytosanitaires de 50 % d'ici 2025. Le projet TRAVERSéES s'inscrit dans ce second programme Ecophyto dans le but de développer et paramétrer un modèle numérique à l'aide d'une modélisation participative. Celui-ci a pour objectif de simuler et identifier des scénarios de changement de pratiques phytosanitaires. Pour cette seconde étape de paramétrage, le comité de recherche a mis en place une série de deux ateliers participatifs regroupant des acteurs locaux du territoire du Barrois. Se pose alors la question de la forme participative du processus. Quelles sont les qualités et limites des deux ateliers de modélisation participative mis en place ?

Pour y répondre, une démarche en trois temps a été réalisée. Tout d'abord, une analyse exploratoire des formes de participation a été menée, avant de participer à l'organisation et à la réalisation des deux ateliers participatifs. Enfin, 13 entretiens semi-directifs ont été réalisés auprès des acteurs présents aux ateliers afin de caractériser les qualités et limites perçues des ateliers. Les critères d'évaluation se sont appuyés sur des indicateurs de concertation, permettant finalement d'évaluer la forme participative des ateliers. Les limites perçues des ateliers ont permis d'identifier deux pistes d'améliorations sous forme de projet de recherche. L'un propose une co-construction des composantes secondaires du modèle numérique avec des acteurs d'un nouveau territoire. L'autre propose la co-écriture du projet avec un groupe d'acteurs définit dans un objectif global de transition agroécologique.

Abstract: *Ecophyto II+* promotes the mobilisation of stakeholders as one of the new action levers, to achieve its goal of reducing the use of phytosanitary products by 50% by 2025. The *TRAVERSéES* project is part of this second *Ecophyto* program with the aim of developing and configuring a numeric model using participatory modelling. Its objective is to simulate and identify scenarios for changing phytosanitary practices. For this second configuration step, the research committee organised a series of two participatory workshops involving local stakeholders from the Barrois region. The question then arises about the participatory form of the process. What are the qualities and limits of the two participatory modelling workshops that have been implemented?

To answer this question, a three-step approach was undertaken. First, an exploratory analysis of forms of participation was conducted before participating in the organisation and implementation of the two participatory workshops. Finally, 13 semi-structured interviews were conducted with the stakeholders present at the workshops to characterise the perceived qualities and limits of the workshops. The evaluation criteria were based on concertation indicators, ultimately allowing for an assessment of the participatory nature of the workshops. The perceived limits of the workshops identified two improvement paths in the form of research projects. One proposes the co-construction of secondary components of the numeric model with stakeholders from a new territory. The other suggests co-writing the project with a group of stakeholders defined with an overall goal of agroecological transition.

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List of abbreviations and acronyms

APO: Agricultural Professional Organism

ARDI: Stakeholders-Resources-Dynamics-Interactions

CHA: CHamber of Agriculture

CA: Conventional Agriculture

Certiphyto: Individual certificate for phytosanitary products

CIRAD: Centre de coopération Internationale en Recherche Agronomique pour le Développement ; Center for International Cooperation in Agricultural Research for Development

COPS: COoperative and Participative Society

CUAE: Cooperative for the Use of Agricultural Equipment

EEIG: Economic and Environmental Interest Group

DFFU: Departmental Federation of Farmers' Unions

GOF: Group of Organic Farmers

HEV: High Environmental Value

ICEV: Intermediate Crops with Environmental Value

INRAE: Institut National de Recherche pour l'Agronomie, l'Alimentation et l'Environnement ; French National Research Institute for Agronomy, Food and the Environment

NM: Numeric model

OA: Organic Agriculture

PP: Phytosanitary Product

RC: Research committee

RPG: Role Playing Game

SCA: Soil Conservation Agriculture

TRAVERSéES: Trajectoires de transition Vertueuses pour la Réduction des usages des pesticides aSsociant les leviers Ecologiques, Economiques, Sociaux et institutionnels à l'échelle du territoire ; Vertuous transition trajectories for reducing pesticide use, combining ecological, economic, social and institutional levers at regional level

UAA: Useful Agricultural Area

Measures

ha: hectare

h: hour

mn: minute

q: quintal / qs : quintals

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1 Introduction and literature review

1.1 The modern agriculture and the controversy of phytosanitary products

Over the past centuries, agriculture in France has undergone significant transformations such as the rise of the chemical industry in the 19th century, promoted as essential to national prosperity. This movement, led by chemists like Louis Grandeau, favored laboratory-based approaches and marginalised farmers, depicting them as incompetent for the national economy (Jas, 2005). A century later, the Green Revolution strengthened this trend, promoting mechanisation, monoculture, and the use of Phytosanitary Products (PP), but resulting in issues such as pollution, resource depletion, and dependence on chemical inputs (Guichard et al., 2017; Poulot, 2010; Regnault et al., 2012). The use of PP, despite its advantages for agricultural yields, has sparked debates and controversies due to its environmental and health impacts, exacerbated by a lack of interaction among stakeholders in the agricultural system (Batsch, 2011; Leenhardt et al., 2023; Mendez, 2016). According to Jean-Marc Meynard, research director at *INRAE* (National Institute for Agricultural Research, Food, and the Environment), agriculture has been stuck in a 'sociotechnical impasse' since its reliance on PP (Guichard et al., 2017).

At the European and national levels, the use of PP has been subject to various regulations during the last decades (European Directive 2009/128 on "Sustainable Use of Pesticides, French legislation on the ban of neonicotinoids in 2018, "*De la ferme à la table*" French strategy in 2020, *Ecophyto* plans). While the national plan *Ecophyto II+* had planned to phase out glyphosate for all its uses by 2022, the European Commission proposes in 2023 to extend its authorisation for more than 10 years. These differences reveal underlying issues related to changes in phytosanitary practices. Chateauraynaud (2018) identifies among the causes of this socio-technical controversy the diversity of stakeholders defending their own interests, such as the chemical industry, farmers, researchers, consumers, and public policymakers.

1.2 Agroecology and participatory approach of the research

Agroecology, as a science, social movement, and agricultural practices, addresses modern agricultural challenges by integrating ecological principles. Also, it seeks to involve key stakeholders and their knowledge (farmers, NGOs, activists, consumers, researchers, political representatives) and to promote the practical implementation of the ideals of the agroecological movement (food sovereignty, social justice, biodiversity conservation, equitable access to resources, etc.).

Mendez (2016) emphasises the need for agroecology to consider not just ecological but also social, cultural, and political aspects of the system for a holistic understanding of its complexity. In the case of phytosanitary practices within an agroecological system, it is essential to understand that these practices cannot change without a comprehensive shift in agricultural practices. These agricultural practices are influenced by various ecological, economic, social, and political factors (local soil and

climate conditions, market conditions, public policies, professional networks, local and empirical knowledge, psychological individualities, etc.). Therefore, agroecology must provide a framework for research-action that integrates transdisciplinary, and participatory approaches, as well as the socio-political and economic issues affecting agri-food systems (Mendez, 2016)

The participatory approach to agroecology has gained increasing interest in recent decades. This approach values the diversity of stakeholders by involving them as active participants in a cyclical and iterative process that integrates research, reflection, and action (Mendez, 2016). It seeks to include or amplify the voices of those who have traditionally been excluded from the research process and yet are directly affected by the outcomes. Concertation[1] with researchers and other stakeholders, as the first step in a participatory approach, should begin early enough in the construction of a research project to align the needs, capabilities, and methods of the stakeholders. Even if the project starts without this concertation, the key is that the iterative process between research, reflection, and action leads to a shift towards more inclusive dialogue and a more balanced power relationship, ultimately resulting in improvements that participants can take ownership of. Indeed, it is important for the participatory approach to translate into actions for the concerned stakeholders, rather than merely remaining at the stage of information exchange. However, this knowledge transfer is also crucial for valuing (and even preventing the loss of) the empirical knowledge accumulated by local stakeholders, which may not be documented in the literature (Mendez, 2016; Wezel et al., 2009). According to Mendez (2016), organisers should maintain an empathetic and modest posture, focusing on observation and avoiding interpretations, assumptions, and judgments to gain a deep understanding of system complexity. The horizontal approach thus helps organisers to gain extensive and deep sensory experience and to participate in the observation and overall understanding of the complexity of the system (Mendez, 2016).

In this thesis, we refer to phytosanitary practices in relation to the use of PP. Furthermore, it is important to note that the mentioned agroecological transition includes the goal of reducing the use of PP but is not limited to it. Indeed, agroecological transition concerns a complex socio-agrosystem, composed of interconnected elements such as biophysical factors, agricultural practices, stakeholders, and policies, which must be analysed as a whole.

1.3 Political decisions related to the issues of phytosanitary products: the successive *Ecophyto* plans

The agroecological transition is increasingly recognised socially, scientifically, and politically, leading to political incentives in Europe and France aimed at reducing the use of PP. Despite various

[1] Concertation seeks to find a compromise between the objectives of the different stakeholders in order to build a project that best satisfies all stakeholders.

initiatives, the first national *Ecophyto* plan (2008) did not achieve its objective to reduce the use of PP by 50% within 10 years (ministère de l'Agriculture et de l'Alimentation, 2021). In 2014, a parliamentary mission revealed shortcomings in the approach, including a lack of control over important levers and inadequate consideration of various stakeholders in the supply chain (such as collection, marketing, and processing)(Guichard et al., 2017; Potier, 2014). Following these observations, *Ecophyto II* plan (2015) offered to consider agricultural practices systemically and not independently of each other (ministère de l'Agriculture, de l'Agroalimentaire et de la forêt, 2015). Nevertheless, its objectives were not met, leading to the *Ecophyto II+* plan (2020) which strengthens previous actions by promoting territorial concertation and the implementation of the plan at the local level (sensibilisation, training programs, farm diagnostics, reduction plans, technical support, etc.) (ministère de la Transition écologique, 2018). It is within this framework that the TRAVERSéES project was proposed, in which my internship is integrated.

1.4 The *TRAVERSéES* project: participatory modelling of a numeric model for the agroecological transition of the Barrois region

1.4.1 Context and objectives of *TRAVERSéES*

The *Ecophyto II+* plan is divided into six axes, with the second axis aiming to 'improve knowledge and tools for the future and promote research and innovation.' Among the preferred approaches to achieve this objective, the focus is on the territorial dimension, multidisciplinarity, and cooperation among the stakeholders involved in the process of change. This has led to the establishment of a call for projects funded by the Ministry of Agriculture and Agroecological Transition, within which the *TRAVERSéES* project (Robert, 2020) is situated. This project, coordinated by Corinne Robert (researcher at *INRAE ECOSYS*, Saclay), brings together a group of researchers from different disciplines, including *INRAE*, *CIRAD*, and the University of Paris-Sud. In addition to this multidisciplinary consortium of researchers, the project includes four partners: Lisode (a private partner) and three Economic and Environmental Interest Groups (EEIG[2]): Apab, Sol Union, and AgroEco.

The main objective of the project is to identify and simulate agroecological transition pathways associated with a combination of territorial actions, leading to a significant reduction in the use of Phytosanitary Products (PP). The idea is to consider territorial actions of various types: ecological, economic, social, or institutional. To achieve this, the project proposes an iterative process involving the study and understanding of a reference agricultural territory (the Barrois region) and the development and simulation of a more generic numerical model (NM). This model simulates

[2] Group of farmers (and potentially other partners) working together in a multi-year project to modify or consolidate their practices with economic, environmental, and social objectives, aiming to contribute to agroecological transition.

trajectories of practice change under the influence of different territorial actions. The project is organised into four axes, as represented in Figure 1 (next page), over a total duration of four years (2019-2023). Activities carried out for these axes involve various types of work, including fieldwork. In addition to online surveys (Honoré, 2020), interviews with farmers and other stakeholders in the agricultural territory (Grohens, 2021), as well as several participatory workshops, were conducted throughout the project to engage multiple stakeholders.

Some workshops brought together farmers, while others involved researchers or Agricultural Professional Organisations (APO). The consulting firm Lisode, specialised in participatory methods, was tasked with facilitating dialogue between local stakeholders and the group of researchers (*INRAE*) in a collaborative approach to reflect and work together on the use of PP, particularly during participatory workshops.

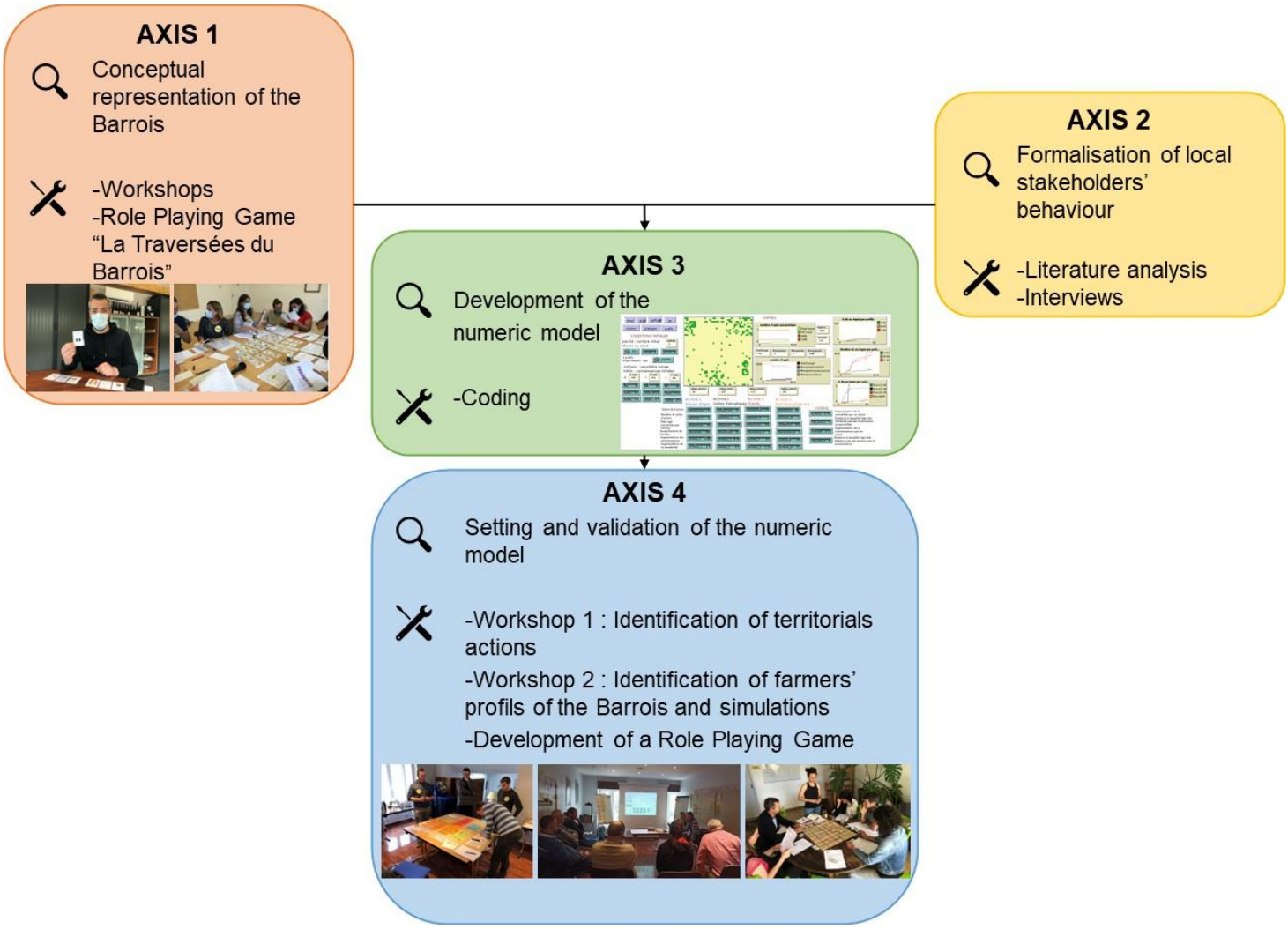


Figure 1 : The four axes of the *TRAVERSéES* project
Source : Robert, 2020, Photo Credit : Lisode

1.4.2 The partner Lisode, and concertation

Lisode is a Cooperative and Participatory Company (SCOP), established in 2008 and based in Montpellier (south of France), specialising in concertation engineering. It is involved in the design, facilitation, and evaluation of participatory processes on a wide range of issues, many of which are related to the management of shared natural resources involving various stakeholders (Lisode, 2023).

Arnstein defines participation on a scale of decision-making power granted to citizens (Appendix 1). According to her, citizen participation in a project ranges from citizen education (or even manipulation) to full control of the project by citizens. Lisode adapts Arnstein's scale of citizen participation, expanding it to encompass all stakeholders involved in a project and simplifying it into four levels (Figure 2): information, consultation, concertation, and co-decision (Lisode, 2023).

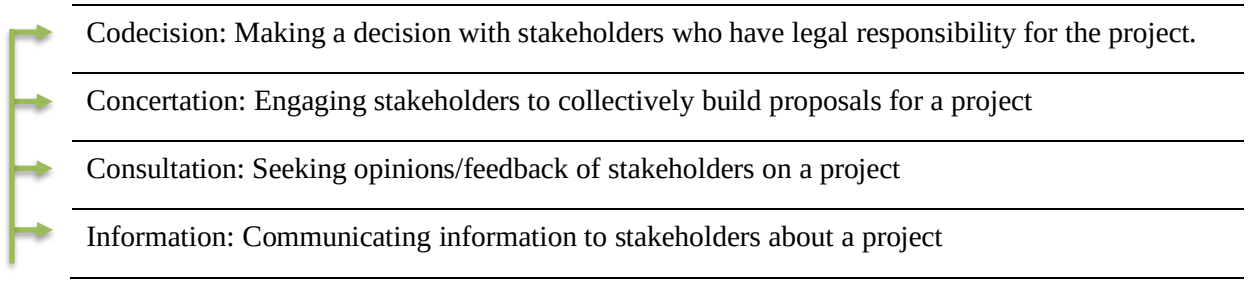


Figure 2 : Simplified scale of participation in a decision-making process

Source : Adapted from Lisode, 2023

Concertation seeks to find a compromise between the objectives of the sponsor and those of the participants in order to build a project that best satisfies all stakeholders. Unlike consultation (Figure 2), it involves the confrontation of different viewpoints, the definition of shared objectives, the generation of new ideas, etc. It does not directly lead to a decision, as co-decision does, because the ultimate decision is made by the stakeholders who have the legal responsibility to do so. However, these stakeholders are required to inform the participants of the elements that were accepted or rejected, as well as the underlying reasons for their choices (Lisode, 2017). In order to facilitate a concertation process, Lisode employs various forms of support and tools: participatory modelling, stakeholder analysis, Role-Playing Games (RPGs), including accompanying modelling through games (ComMod), group facilitation, process evaluation, multi-agent modelling.

As partner of the *TRAVERSéES* project, Lisode is responsible for designing and implementing the participatory dimension of the project. In axis 4 of the project, Lisode is tasked with organising and facilitating participatory modelling through two participatory workshops and designing the second JDR. These two workshops serve as the material for my study.

1.4.3 Participatory modelling, a tool of concertation

Participatory modelling is a tool that can be used in the initial phase of the concertation process,

known as the diagnostic phase. During such workshops, participants are encouraged to establish a common knowledge base that they can later use to support their discussions. To achieve this, participants must describe the domain they want to discuss using a pre-established ontology, which is a system of representing knowledge. Lisode (2017) emphasises the importance of ensuring that the selected ontology aligns with how participants perceive their environment. There are various ways to represent these models and facilitate their construction. Lisode suggests approaches like Stakeholder-Resource-Dynamics-Interactions (ARDI) diagrams. This type of tool allows for the creation of a neutral collective mental model based exclusively on factual elements shared and discussed among participants.

In the case of the *TRAVERSéES* project, researchers from *INRAE* wanted to explore the possibility of using a research NM[3] as a participatory modelling tool. This research NM abstractly represents components of a system and their interactions (Robert, 2020). The goal was to work with a systemic view of the territory, focusing on various levers for reducing the use of PP. To achieve this, *INRAE* researchers 1) created an initial version of the NM, 2) improved the NM through individual interviews with farmers in the Barrois region, and 3) organised participatory workshops to collaboratively set up up the NM with local stakeholders and assess the consistency of its results. Additionally, the sharing of information by local stakeholders allows researchers to refine and contextualise the actions to be simulated. Beyond its instrumental objective, the NM serves as a support for discussion between local stakeholders and researchers, fostering a process of co-learning through interaction during the NM's development. As a discussion intermediary, the NM also enables the exploration of sensitive topics, such as PP use, without getting caught in opinion-based conflicts. This approach encourages stakeholders to detach from their realities and imagine and envision future goals and solutions.

1.4.4 The studied area: the Barrois region

The project focuses on the Barrois territory (Figure 3 next page), chosen due to the presence of the three EEIG associated with the *TRAVERSéES* project, and the challenges encountered by agricultural practices in this region, including climatic ones. The Barrois, a Small Agricultural Region[4] covering approximately 700,000 ha of farmland from Aube to Haute-Marne, plays a central role in agriculture with a substantial area dedicated to farming (51% of Utilised Agricultural Areas (UAA) in Haute-Marne and 64% in Aube (Agreste, 2020)).

[3] A research NM is a simplified representation of reality created using computer software and algorithms. It is used to study, simulate, or analyse various phenomena, processes, or systems within the context of scientific research.

[4] The Agricultural Regions (RA) and Small Agricultural Regions (PRA) were defined in 1946 to highlight homogeneous agricultural zones. The PRA is formed by the intersection of departments and RA

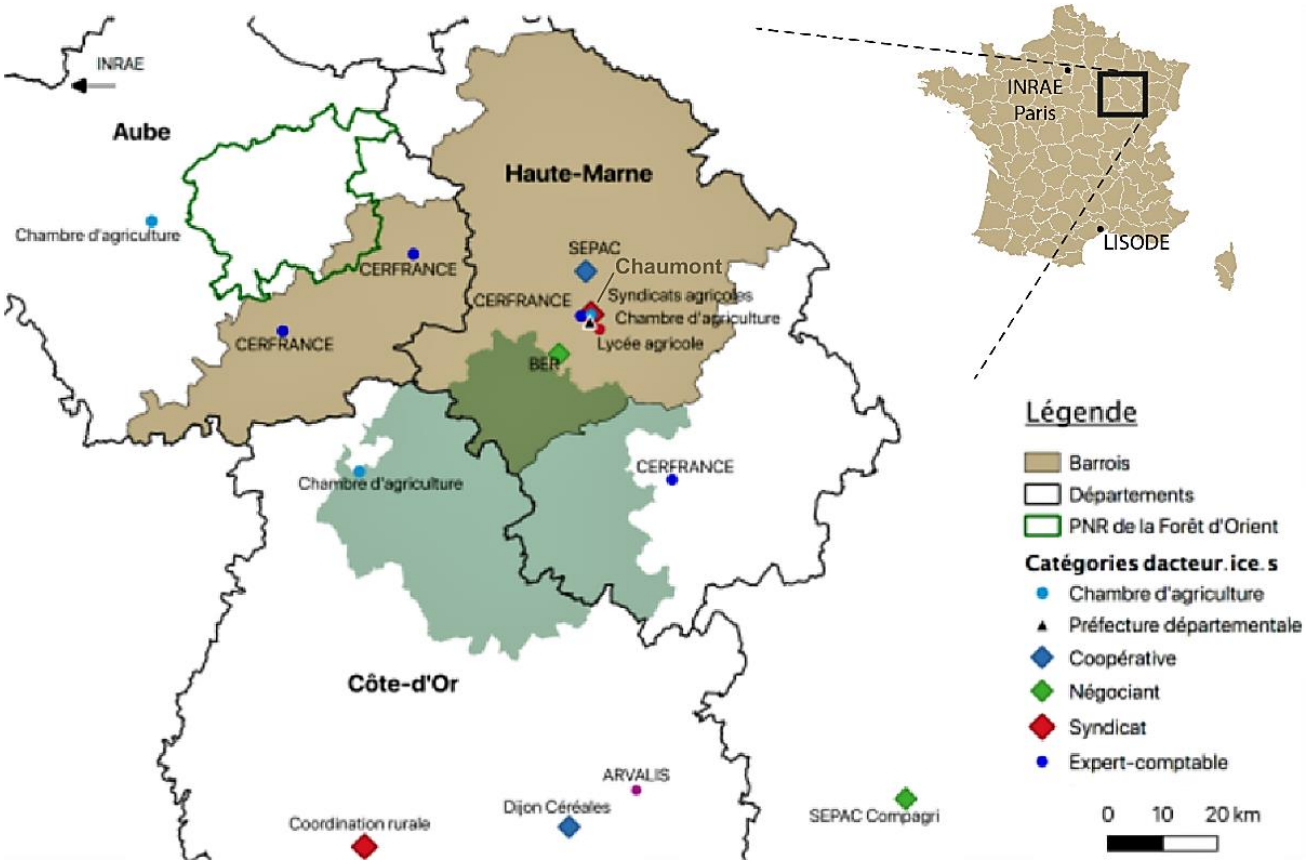


Figure 3 : Map of the Barrois region and its stakeholders
Source : Honoré, 2020

The description of the Barrois that follows is mainly based on the report by L. Grohens (Grohens, 2021), conducted as part of axis 1 of the *TRAVERSéES* project. The agronomic characteristics of the region pose particular challenges, such as the higher farm size than the national average (170 to 180 ha compared to the national average of 63 ha) (INSEE, 2023), challenging soils (50% of the area's surface is composed of shallow, stony, and chalky soils), issues with rapeseed production (resistance of certain pests to PP), and frequent summer droughts (rapid water runoff and lack of storage).

Faced with these challenges, changes in agricultural practices have emerged in recent years thanks to some pioneering farmers and others following the advice of their peers. The use of PP in the region is relatively low compared to other cereal-producing regions in France. The study has revealed diverse production dynamics, including possible oppositions between Soil Conservation Agriculture (SCA) and Organic Agriculture (OA) among cereal farmers and mixed crop-livestock farmers. The evolution of livestock in the region, the issue of abandoned lands, the encouraged installation of methaniser, and the implementations of ICEV (Intermediate Crops with Environmental Value) crops also raise questions about the future of agriculture.

Regarding support for farmers, there are numerous structures (CHamber of Agriculture (CHA), agricultural cooperatives, CERFRANCE, Departemental Federation of Farmers' Union (DFFU)) but

their coordination and communication may be inadequate, making more challenging for farmers to access clear advice. Some farmers turn to the internet and social media to obtain information, particularly about alternative practices. Finally, changes already implemented by farmers have been examined, including organising into groups, the importance of ongoing training programs, and the influence of farmers' social networks. However, obstacles such as land access, social pressure regarding PP use, and the economic health of farms have also been identified.

1.4.5 Internship and study framework: axis 4 of the *TRAVERSéES* project "Setting up and validation of the numeric model"

As shown in Figure 1, the objective of the fourth axis of the *TRAVERSéES* project is to collaborate with stakeholders in the Barrois region to configure the NM in order to explore the impact of territorial actions on potential changes in PP practices within the region. Initially, axis 4 planned a series of three participatory workshops with Barrois stakeholders (Figure 4 on the following page). The first two workshops aimed to engage local stakeholders from the Barrois region to configure the NM, ground it in the reality of Barrois, conduct simulations with participants, and discuss the outcomes. The third workshop aimed to test a ComMod[5] RPG with Barrois stakeholders, allowing them to assume the role of a farmer, test actions (training, participation in research projects, thematic visits, agroecological practices, etc.), and evaluate the consequences, particularly in terms of PP use. From a methodological perspective, the idea was to compare the two modelling tools: the NM and the RPG.

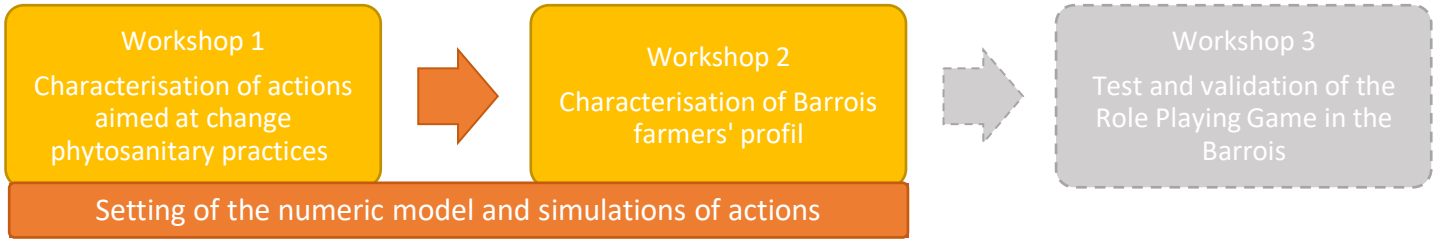


Figure 4 : Succession of the three initially planned participatory workshops from axis 4 of the *TRAVERSéES* project

My internship falls within this framework. Its main mission was to construct and test the RPG based on the NM, the participatory workshops, and the knowledge acquired about the region (results from axes 1 and 2 of the project). The internship was organised into two main phases (Appendix 2): participation in the development and implementation of the two participatory workshops, followed by the design of the RPG. The internship mission resulted in a prototype version of the RPG tested

[5] The Companion Modelling (ComMod) is an approach that combines modelling and concertation with the aim of improving knowledge and/or aiding decision-making. It offers a well-defined stance: www.commod.org/qui-sommes-nous/posture

internally. Various internal and external factors during the internship did not allow for the testing and validation of the RPG with stakeholders from the Barrois region. Nevertheless, the obtained version of the RPG was presented as a poster (Appendix 3) at the 54th ISAGA[6] conference held in La Rochelle (north-west France) from July 4th to 7th, 2023. My study's focus ultimately shifted to the participatory process of the two workshops in axis 4 in which I participated.

1.5 Problematic

The *TRAVERSéES* project is part of the *Ecophyto* II+ plan. Its objective is to develop a NM as a tool for representing an agricultural system, simulating the evolution of phytosanitary practices, under the impact of various territorial actions. Once the NM was developed, the goal was to collectively set upt the NM with stakeholders from the Barrois territory and identify consistent territorial actions to simulate. To achieve this, the project mobilised local stakeholders through two participatory workshops. At the end of each workshop, a post-workshop questionnaire (Appendix 11; Appendix 15) was distributed to participants to evaluate the quality of the workshop, especially its participation process. However, some questions about the participatory process of the workshop were not asked. Furthermore, the evaluation of the induced effects of the workshop on participants was limited to a single question out of 10 on the questionnaire. Thus, a longer-term evaluation of 1) the participatory process of the workshops and 2) the effects of participation on participants would help identify the limits of the participatory form of the workshops and suggest areas for improvement. This study aims to answer the following question:

In what way do the two participatory workshops in axis 4 of the *TRAVERSéES* project represent a process of concertation?

It focuses on the specific case of the two participatory workshops in axis 4 of the *TRAVERSéES* project. To do so, two main sub-questions will be addressed: 1) What are the qualities and limits of the participatory modelling process? 2) What are the effects of the participatory process on participants? To answer these questions, this study will rely on an exploratory analysis of participation and the *TRAVERSéES* project, as well as on the conduct of the workshops before conducting semi-structured interviews with the stakeholders present at the workshops.

[6] International Simulation and Gaming Association: https://lienss.univ-larochelle.fr/ISAGA-2023-conference

2 Materials and methods

2.1 General methodology and data's collection

To address the issue, a three-step approach was implemented (Figure 5 next page). The first step involved conducting an exploratory analysis of the levels and methods of stakeholder participation in a decision-making process, as well as the *TRAVERSéES* project, particularly its fourth axis. The initial objective was to identify various levels of stakeholder participation in a decision-making process and understand their goals, tools, and stakes. Subsequently, it aimed to characterise the process of constructing the *TRAVERSéES* project, its objectives, and its stakes. Both participatory workshops of the fourth axis were studied in the same manner. To achieve this, bibliographic research was conducted in parallel with open interviews with key stakeholders.

The second step involved participating in the organisation, execution, and observation of the two participatory workshops of the fourth axis of the *TRAVERSéES* project. The goal was to immerse in a participatory process to analyse its progression based on the intended objectives. Note-taking was prioritised and supplemented with open discussions with the research committee (RC) and other key stakeholders.

The third step entailed a comprehensive evaluation of the participatory process and its induced effects on the participants. Preliminary research on methods for evaluating participatory processes was conducted. Subsequently, 13 semi-structured interviews were conducted to collect information on 1) the qualities and limits of the participatory process and 2) the effects of the participatory process on the participants.

2.2 Exploratory analysis of the concept of participatory processes and the participatory approach of the *TRAVERSéES* project

Literature research was initially conducted to delve into the levels of stakeholder participation in a decision-making process, as well as their objectives, tools, and challenges. Additionally, research was carried out on the *TRAVERSéES* project, its construction process, and some of its outcomes. Two types of bibliographic resources were explored: internal documents of Lisode and external bibliographic resources.

To accomplish this, readings of *TRAVERSéES* project reports and books on concertation within Lisode were conducted. Furthermore, search engines such as Google, Google Scholar, and Scholar Vox were explored using keywords in both French and English, such as "concertation", "*TRAVERSéES*", "participatory approach", "companion modelling", "participatory modelling" using search operators AND and OR. In addition to these bibliographic searches, discussions with Lisodians and the RC were able to provide insights into understanding the *TRAVERSéES* project and the concertation issues.

Figure 5 : Methodological plan for the study

2.3 Organisation of the two participatory workshops of axis 4

2.3.1 Objectives and general organisation of the workshops

The two participatory workshops were co-organised between *INRAE* and Lisode and facilitated by Lisode. The overall goal of *INRAE* researchers was to engage Barrois stakeholders in collectively configuring their numeric model (NM) to enable consistent simulations within their region. Additionally, the NM was used as a basis for discussing the issue of reducing Phytosanitary Products (PP). The aim was to induce co-learning between researchers and participants through these discussions. Therefore, this participatory modelling had both an instrumental and social objective.

Each workshop took place in Chaumont (north-east France) and was conducted twice, with a one-day interval: one session with farmers and another with Agricultural Professional Organisations (APO) from the Barrois region. This separation of stakeholders was chosen to minimise potential power imbalances between farmers and APO. Farmers perceived advisors as "experts." Thus, separating these stakeholder types ensured a certain spontaneity and transparency in discussions.

For each session of each workshop, the date was chosen several weeks in advance, following three steps to ensure maximum participant attendance. Firstly, potential participants were selected from a contact list (established at the beginning of *TRAVERSéES* and updated throughout the project through meetings), which included farmers and APO from Barrois. Twenty farmers and APO were selected, prioritising those who had already participated in the *TRAVERSéES* project (either in previous axes or workshops of axis 4). Next, the identified stakeholders were contacted by phone to inform them of the workshop date and topic. This helped identify around fifteen interested and potentially available individuals. Finally, an email was sent to these individuals to complete a survey to choose the final workshop date. Based on the results, the date with the most participants who had already been involved in the *TRAVERSéES* project was selected. The composition of session groups was substantially similar from one workshop to another (Table 1).

Table 1 : Composition of the group sessions of the workshops 1 and 2

		Workshop 1	Workshop 2
Session 1	Farmers	5	5
	Student	1	1
Session 2	APO	5	4
	Total	11	10

The description of participant profiles and an assessment of their involvement in the *TRAVERSéES* project can be found in Appendix 4.

During the workshops, the facilitator used various facilitation techniques, such as distributing name badges, arranging chairs in a U-shape facing the slideshow, providing snacks and beverages,

including an icebreaker activity, using kraft paper and cardboard as materials for recording results, and more.

2.3.2 Objectives and agenda of workshop 1 "Characterisation of territorial actions aimed at changing phytosanitary practices"

The two sessions of the first workshop took place on February 15th and 16th, 2023. The overall objective was to characterise territorial actions aimed at changing phytosanitary practices in the region. More specifically, there were two types of objectives: a social objective of getting to know and meet each other, and three instrumental objectives: 1) presenting the numeric model (NM) and examples of territorial actions, 2) collectively brainstorming territorial actions for changing phytosanitary practices, and 3) identifying/describing the priority scenarios to be tested in the NM. The agenda for each session was the same and spanned half a day (Table 2).

Table 2 : Agenda of the workshop 1 « Characterisation of territorials actions aimed at changing phytosanitary practices »

Length	Activity
5 mn	Introduction to the workshop
20 mn	Icebreaker
30 mn	Presentation of the *TRAVERSéES* project (activities carried out, key results, and future activities) and territorial actions to be discussed Open discussion
50 mn	Brainstorming: What local initiatives exist / have been tried / could be envisaged to change farmers' plant protection practices?
15 mn	Coffee break
10 mn	Presentation on the role of actions in simulations: how can an action be represented in the numeric model?
45 mn	Group work on selected actions, with a view to incorporating them into the numeric model
10 mn	Cross-reporting
10 mn	Closing and evaluation of the workshop

2.3.3 Objectives and agenda of workshop 2 "Setting up of the numeric model and simulations of territorial actions"

The two sessions of the second workshop took place on April 6th and 7th, 2023. The overall objective was to set up the NM (in order to align it with the Barrois region and its issues) and conduct simulations once the model was set up. The sessions had several specific objectives: 1) collectively define the initial conditions of the NM, including profiles of farmers representative of the Barrois region, 2) collectively discuss and set up territorial actions identified in workshop 1, and 3) collectively define a change scenario, simulate it directly with the NM, and discuss the simulations.

The agenda for each session was the same and spanned half a day (Table 3).

Table 3 : Agenda of the workshop 2 « Setting up of the numeric model and simulations of territorial actions »

Length	Activity
5 mn	Introduction to the workshop
10 mn	Icebreaker
15 mn	Reminder of the context of the workshops, presentation of the results of the previous workshop, introduction of the numeric model
30 mn	Collective definition of initial conditions representative of the Barrois
50 mn	Collective definition of realistic actions of sensibilisation and acquisition of knowledge
15 mn	Identification of action scenarios for phytosanitary practices change
20 mn	Coffee break
40 mn	Simulation results and open discussion
10 mn	Closing and evaluation of the workshop

2.3.4 Workshop end questionnaires

At the end of each workshop, a qualitative questionnaire conducted by the research committee (RC) was distributed to all participants to assess certain indicators of the participatory process, such as transparency, participants' interest in the workshop, the quality of participatory modelling, facilitation, and interactions among participants (Appendix 5). The indicators were chosen based on the list of examples provided by Lisode (2017). Participants took a short amount of time to fill out this questionnaire (approximately five minutes), and most did not elaborate on their responses when requested.

2.3.5 Workshop reports

In the days following the workshops, a report was prepared by the RC for each session. Each report included: in the first part, a recap of the *TRAVERSéES* project context, the organisation, and objectives of the workshop, as well as the presentations made; in the second part, the results obtained, along with observations and notes taken by the entire CR. The reports were then sent to all participants (APO and farmers) within two weeks following the respective workshop.

2.4 Bibliographic research on methods for evaluating a participatory process

Bibliographic research was initially conducted to delve into methods for evaluating a participatory process. Two types of bibliographic resources were explored: internal documents of Lisode and external bibliographic resources. To obtain examples of participatory process evaluations, readings of internal reports and evaluation grids within Lisode for participatory workshops were conducted.

Additionally, search engines such as Google, Google Scholar, and Scholar Vox were explored using keywords in both French and English, such as "evaluation," "effects," "participatory process," "concertation," "participation," "participatory modelling," using search operators AND and OR. In addition to these bibliographic searches, discussions with Lisodians provided insights into the development of a method for evaluating the participatory process and its induced effects on participants.

According to Lisode (2017), evaluating a concertation process is complex due to the multitude of observable indicators. Therefore, it is essential to begin by determining which stages of the process one wishes to evaluate. As illustrated in Figure 6 (next page), the evaluation of participatory modelling can focus on various phases, including: (a) evaluation of the context; (b) evaluation of the project team's strategic choices, such as in steering committees; (c) evaluation of process quality during collective events; (d) evaluation of raw results; (e) evaluation of induced effects; or (f) evaluation of impacts.

The workshop end questionnaires served to assess certain qualities of participatory modelling and some short-term induced effects. Therefore, it was chosen to delve deeper into 1) the evaluation of the quality of participatory modelling, and 2) the evaluation of longer-term effects on participants.

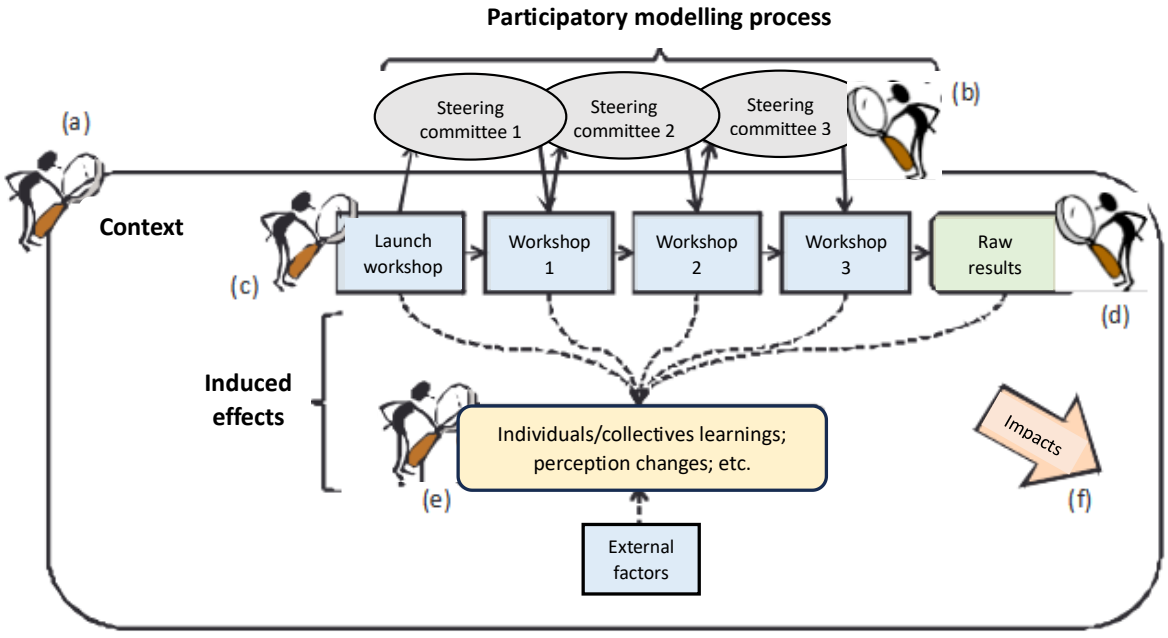


Figure 6 : Focus of the evaluations “along the way”
Source : Adapted from Lisode, 2017

Regarding the evaluation of the participatory modelling process, the study relied on indicators identified by Lisode (2017) and Etienne (2010) used to evaluate a concertation process (Table 4 next page). In this way, the results of the evaluation of the participatory modelling process allow for characterising the form of the participatory approach, ranging from consultation to concertation. Four

out of the five indicators were chosen: the quality of the method used (in this case, participatory modelling), the representativeness of participants, the quality of facilitation, and the alignment of participants' expectations with the process outcomes. The fifth indicator, "quality of interactions among participants," was not selected to avoid adding further complexity to the already dense evaluation. Furthermore, its assessment through the workshop end questionnaires was deemed sufficient.

Concerning the evaluation of induced effects, as defined by Douthwaite et al. (2007), they refer to "changes in behaviours, attitudes, capabilities, knowledge, or conditions (situations) of participants." According to Table 4 and Etienne (2010), three types of effects of the workshops on participants were identified: knowledge acquisition, changes in perception, and changes in attitude.

Table 4 : Examples of indicators that can be used to evaluate a concertation process
Source : Adapted from Lisode, 2017

Evaluated aspects	Indicators	Questions/Statement to be assessed by participants
The project		
Concertation process	Transparency	I consider myself well-informed about the project's objectives and the process I am aware of the consequences of my involvement in this project
	Participants' interest in the project	The project is valuable
	Engagement	I am willing to continue to personally invest in this project
The workshop		
Concertation process	Quality of the specific workshop method	The way of working was effective (it produced good results in a short time)
		The way of working was motivating
	Representativeness	All interests regarding the topic were well represented
	Quality of facilitation	The workshop facilitators facilitated the exchanges well
	Quality of interactions among participants	I was able to express myself as much as I wanted
		I understood the point of view of other participants
	Alignment between participants' expectations and the workshop's outcomes	What were your expectations for the workshop?
		The workshop results align with my expectations
Induced effects Knowledge acquisition Perceptions change	Unforeseen or not otherwise evaluated effects	The workshop was useful to me in other ways that I had not anticipated (please specify)
		In the end, are you satisfied with having attended, and why?
	Individual learning; acquisition of new knowledge; information sharing among stakeholders	I have improved my knowledge of (specify different aspects related to the workshop's objectives)
	Social learning	This workshop allowed me to work with the other participants in a constructive manner
		I have changed my perspective on the other participants

For both types of evaluation, the use of semi-structured interviews with participants and the RC present at the workshops was chosen as the method. This approach allows the interviewee to address topics they deem essential based on the question asked. The interviewer can then adjust their questions based on the main themes pre-identified in the interview guide. This type of interview offers additional advantages. Open-ended questions do not steer interviewees' responses, and the direct and personal interaction between the interviewer and the interviewee facilitates the exchange of spontaneous and more in-depth information (Combessie, 2007).

2.5 Elaboration and conduct of semi-structured interviews with workshop participants and analysis of results

2.5.1 Elaboration of semi-structured interview guides

Four semi-structured interview guides were prepared before the interviews (Appendixes 6 to 10), one for each type of key stakeholder: workshop participants (APO and farmers), the modeller, the coordinator, and the facilitator. All participants who had attended at least one of the two workshops were contacted. Selection was not deemed necessary since each participant represented a valuable resource regarding the issue, and the number of interviews was manageable.

Each interview was structured into three parts:

- Identification of the interviewee to understand their activity and involvement in the *TRAVERSéES* project;
- Understanding their perception of the quality of the participatory process;
- Understanding the effects of their participation in the workshops on themselves.

2.5.2 Conduct of interviews and transcription

Qualitative interviews were conducted with 10 participants and 3 members of the RC (Figure 7).

Figure 7 : Interviewees profiles for the qualitative semi-structured interviews

The 13 interviews were conducted by phone or via video conferencing, with the consent of the interviewees. They lasted an average of one hour. Note-taking was prioritised during the interviews, and audio recording was used as a tool for verification or as a supplement to the notes.

The presentation was detailed to encourage interviewees to provide detailed responses through mimicry. It was emphasised that no judgment would be passed on the answers, to create a trusting environment and obtain responses as spontaneous and transparent as possible. The order and wording of questions were generally adhered to, but they were adapted based on the course of the

conversation. Intervention techniques such as mirror silence, echoing, summarised restatement, specific questioning, or feigned misunderstanding were used to ensure comprehension of responses or to obtain specific details.

The transcriptions were done in two stages: a first complete transcription of the interviews in a Word document, with a summary added at the end of each section; a second transcription using Microsoft Excel to group the responses and associated summaries into corresponding indicators.

2.5.3 Thematic analysis of semi-structured interviews

To characterise the quality of the participatory process and its induced effects on participants, a thematic analysis was conducted. Thematic analysis is a method for analysing qualitative data that allows for addressing a general question, in this case: "What are the results and limits of the participatory process, as well as the effects induced on participants and their limits?". To do this, the responses of the interviewees to the questions of each indicator were categorised as results, limits, or action plan, and then grouped into themes based on the generic question, "What is fundamental in this statement?" (Andreani and Conchon, 2005; Paillé and Mucchielli, 2016). This method was used to analyse the transcriptions conducted using Excel and was carried out using the Table 5 below.

Table 5 : Matrix of qualitative analysis of semi-structured interviews conducted

	Results	Limits	Action plan
Farmer X	Theme X : « … »		
	Theme Y : « … »		
	…		
APO X			
Coordinator			
Modeller			
Facilitator			

A second analysis was conducted to identify correlations between the profile of the interviewees and the results/limits they perceived following their participation in the workshops. To do this, a typology of the interviewees was created based on three criteria (Table 6 next page). The first criterion is the role of the interviewees during the workshops, which distinguishes participants on one hand and the RC on the other. The second criterion is based on the existing relationships between the people present. Finally, the third criterion is based on the interviewees' stance regarding PP.

Table 6 : Typology of interviewees

Criterion 1: Role in the workshops	Participants				Research committee		
Criterion 2: Links between people	Farmers		APO	Other	Coordinator of *TRAVERSéEs* project	Modeller of the numeric model	Facilitator
Criterion 3: Position on PP	Use	Not use	No consultancy/ sales activity	Subject of interest	Subject of study		
Interviewees	Farmer 1 Farmer 3 Farmer 4	Farmer 2 Farmer 5	APO 1 APO 2 APO 5	APO 3 (teacher) APO 4 (retired)	Corinne Robert	Amélie Bourceret	Audrey Barbe

3 Results

3.1 The participatory process: the two participatory workshops

3.1.1 Workshop 1 "Characterisation of territorial actions aimed at evolving phytosanitary practices" results

3.1.1.1 Workshop end questionnaire

This questionnaire allowed the research committee (RC) to evaluate the quality of the first participatory workshop. Several indicators were assessed (Appendix 11). All Agricultural Professional Organisations (APO) and farmers indicated good transparency in the process (clear objectives of the *TRAVERSéES* project and the use of the numeric model (NM)), as well as an interest in the process (useful work). Similarly, both groups reported good quality of participatory modelling (efficiency of the tool), good quality of facilitation (neutrality of the facilitator), and good quality of interactions among participants (balanced participation). However, the acquisition of knowledge following this first workshop was not unanimous: one in five APO disagreed, and two out of six farmers chose "don't know." Furthermore, the quality of the results also showed differences of opinion: three out of five APO "don't know," and one out of six farmers "rather disagreed" regarding the realism of the implementation of detailed territorial actions. Beyond the positive points, these results indicate that the RC should be vigilant regarding the lack of participant learning following their participation and the lack of realism in the actions studied.

3.1.1.2 Workshop report

The results of the two sessions of workshop 1 correspond to the identification of territorial actions aimed at reducing the use of Phytosanitary Products (PP) and the characterisation of one or two of them. All proposed actions were grouped by theme (Appendix 12), such as farmer and agricultural advisor training, valorisation of certain productions, changes in agricultural practices, the need for

financial support, and sharing and exchange among local stakeholders (especially on agricultural practices).

The theme of sharing and exchange among local stakeholders was one of the few themes mentioned by both farmers and APO. Additionally, this theme was the one that occupied the largest portion of the discussion and generated the most proposals in both sessions. For example, APO proposed the creation of exchange opportunities (meals, games) among various agricultural stakeholders in the region, setting up exchanges between different stakeholders (farmers and non-farmers) to discuss the reduction of PP, or the sharing of knowledge and experience through accessible databases. APO ultimately chose to describe an action related to the valorisation theme: "Creation of a sector: 'Barrois protein'" (Appendix 13). Among farmers, actions related to sharing knowledge and information (economic, experimental, etc.) among farmers emerged within the theme of sharing and exchange among local stakeholders. They explained that these actions would help to highlight each other's experiences and results, potentially reducing farmers' concerns about adopting new practices. CUAEs (Cooperative for the Use of Agricultural Equipment) were proposed as a tool to bring farmers together (a developed network of diverse farmers) by organising specific meetings or exchanges on the issue of reducing the use of PP.

The establishment of farmer-researcher networks was also proposed as an action to cross-reference research results and field results obtained by farmers, ensuring the quick adaptation of scientific solutions to specific contexts. This action, "Creation of farmer-researcher networks", along with the action "Promote knowledge sharing among 'unconcerned' farmers" (Appendix 14), was chosen by farmers to be characterised (Table 7).

Table 7 : Characterisation of the action « Creation of farmer-researcher networks» carried out by farmers in workshop 1

Description of the action	Effect of the action Why ?	Origin/Impetus of the action
-Creation of farmer-researcher networks through fundamental research on agricultural operations. -Test and measure long-term farmer practices. -Practices performed by farmers: new tests and measures.	-New knowledge. -Production of systemic knowledge under real conditions to provide trends. -Allows farmers to better understand their operations, compare their results, for personal decision-making. -Farmers, agricultural policies, agricultural networks. -High impact: dissemination to other farmers of the results on operations and from the territory. - Initial group carrying the project.	-Presentation of the project through a medium disseminated at the territorial scale (existing networks, CUMA, etc). -Common question to be defined based on the farmers' diagnosis. -Define more precise questions and find corresponding scientific knowledge.

Implementation Where? When?	Funding & Resources	Implementation With whom?
-Shared protocol: farmers, researchers, students. -Measures taken by farmers, researchers, and students. -Data acquisition and management tools. -Training on the tools. Creation of a project database. -Indefinite duration, with milestones every 4 years, 1 meeting every 6 months. -Entire Barrois. -On a plot representative of the operation.	- Water Agency, Region. -Research Project. -Financing the commitment of farmers, researchers, students. -Financing the project manager. -Financing the tools.	- Base network: farmer-researcher-students. -Farmers: committed, volunteers, transitioning, from different regions of the same territory (15-20). -Researchers: public/private (5). -Students: school, university, agricultural high schools. -Dissemination of validated results within the project's base network. -Dissemination of results in the territory's agricultural networks, to the APO. -Pilot project for a national network of farmer-researchers.
Feasibility (territorial scale)	**Limits**	**« Sustainability»**
-Temporal investment: 4 years (and +). -Project financing (equipment, tools, participants). -Implementation of a manager and partnership. -Mobilisation of participants (farmers, students, researchers).	- Diversity of conditions because of real conditions -> difficulty comparing analyses. -Few or no results in fundamental research. -Fate of the data. -Time, complexity. -Links, cohesion between stakeholders.	- Partner with universities -> dissemination of the project, students. -Long duration to ensure project flexibility. -Need for permanence of the manager to feed the project's network. -Step 3, 4 years -> collective definition of a new question.

The two sessions of workshop 1 ultimately achieved the social and instrumental objectives set up by the CR, namely: 1) getting to know each other and meeting, 2) presenting the NM and examples of territorial actions, 2) collectively brainstorming territorial actions, and 3) identifying/describing the priority actions to be tested in the NM.

3.1.2 Workshop 2 "Setting up of the numeric model and simulations of territorial actions" results

3.1.2.1 Workshop end questionnaire

This questionnaire allowed the RC to evaluate the quality of the second participatory workshop. Several indicators were assessed (Appendix 15). All APO and farmers indicated good quality of participatory modelling (efficiency of the tool), good quality of facilitation (neutrality of the facilitator), and good quality of interactions among participants (balanced participation). The acquisition of knowledge is nearly unanimous. However, the quality of the results shows differences

of opinion regarding their realism and coherence. Furthermore, two indicators received low scores, mainly from farmers: representativeness and transparency during the workshop. Indeed, half of the farmers believe that the interests of all stakeholders concerned with the issue of reducing the use of PP were not represented during the workshop, and the objectives of using the NM in the project were not clear. These results indicate that the RC should be cautious in selecting the stakeholders invited to the participatory process and in clarifying their presentation of the objectives of the NM.

3.1.2.2 Workshop report

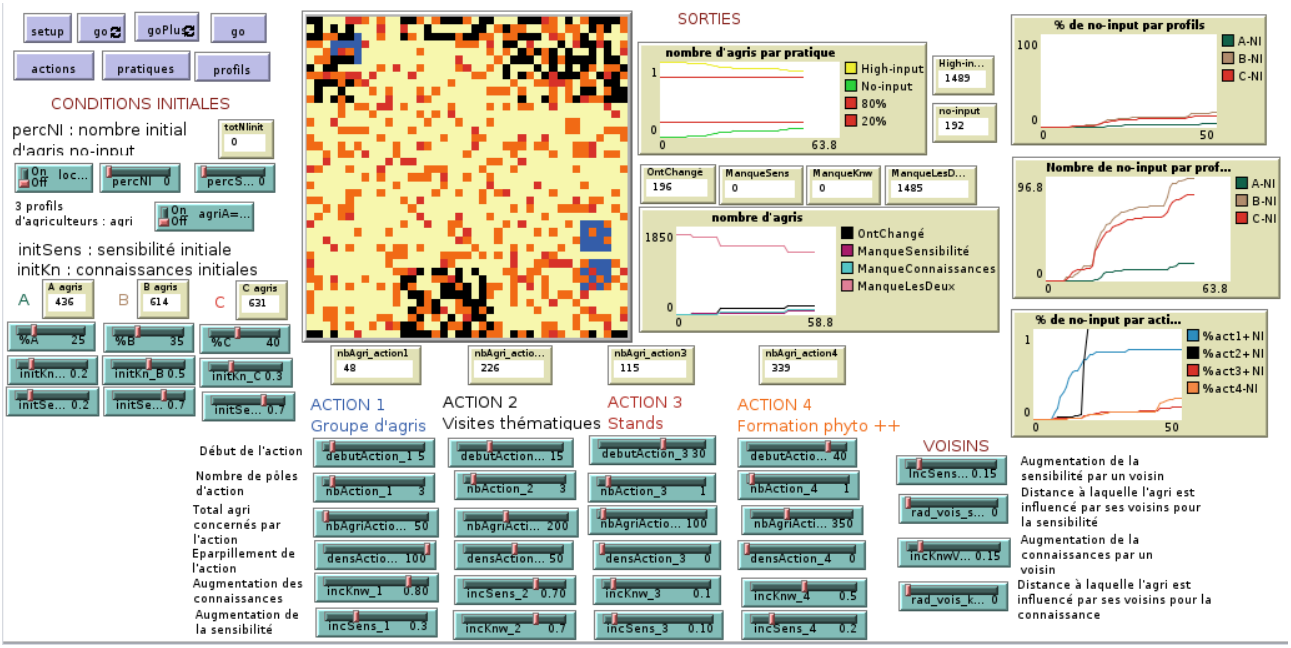
The results of the two sessions of the workshop correspond to the definition of the initial conditions of the NM, especially the "profiles" of farmers present in the Barrois region (Table 8 on the following page). The NM simulates a limited number of farmers with unique characteristics that impact their choices of phytosanitary practices. The session with the farmers helped define most of the characteristics of the profiles, which were validated and possibly supplemented by APO.

Five profiles of Barrois farmers were defined and differentiated based on their production, their proportion in the area, their type of phytosanitary practices, and their level of knowledge and sensitivity. According to the farmers, Profile A (primary production other than arable crops) corresponds to farmers who dedicate less time to arable crops, with a relatively high level of PP use. Next, the group described two profiles of farmers followed by technicians: Profile B, followed by a "neutral" technician (e.g., CA type), and Profile C, followed by a "sales-oriented" technician (e.g., cooperative type). Indeed, the farmers differentiated these two profiles based on their technician's profile (their company, input sales activities, knowledge, skills, curiosity, etc.) and, consequently, the influence they can have on farmers' choices and their changes in phytosanitary practices. APO added that the role of the technician is not necessarily to provide technical instructions but primarily to help farmers become their own advisors. According to the group, the level of knowledge of farmers in these profiles would reflect the knowledge level of the technician who follows them. In terms of proportion, the group estimates that Profiles A, B, and C represent the majority of farmers in the Barrois region (95%), with a majority of Profiles B and C. Finally, two contrasting profiles were defined. Profile D (curious farmers who experiment, are willing to take risks, etc.) sparked significant discussions regarding the type of phytosanitary practices. The group agreed that the level of PP use was variable, with some farmers having a relatively high level and others with a relatively low level. Despite these differences, this group is characterised by a unanimously considered high level of knowledge and sensitivity. Finally, Profile E reached a consensus, comprising farmers in extensive agriculture with relatively low input levels, which seem to be related to moderate performance. However, these two profiles represent a small percentage of farmers in the area.

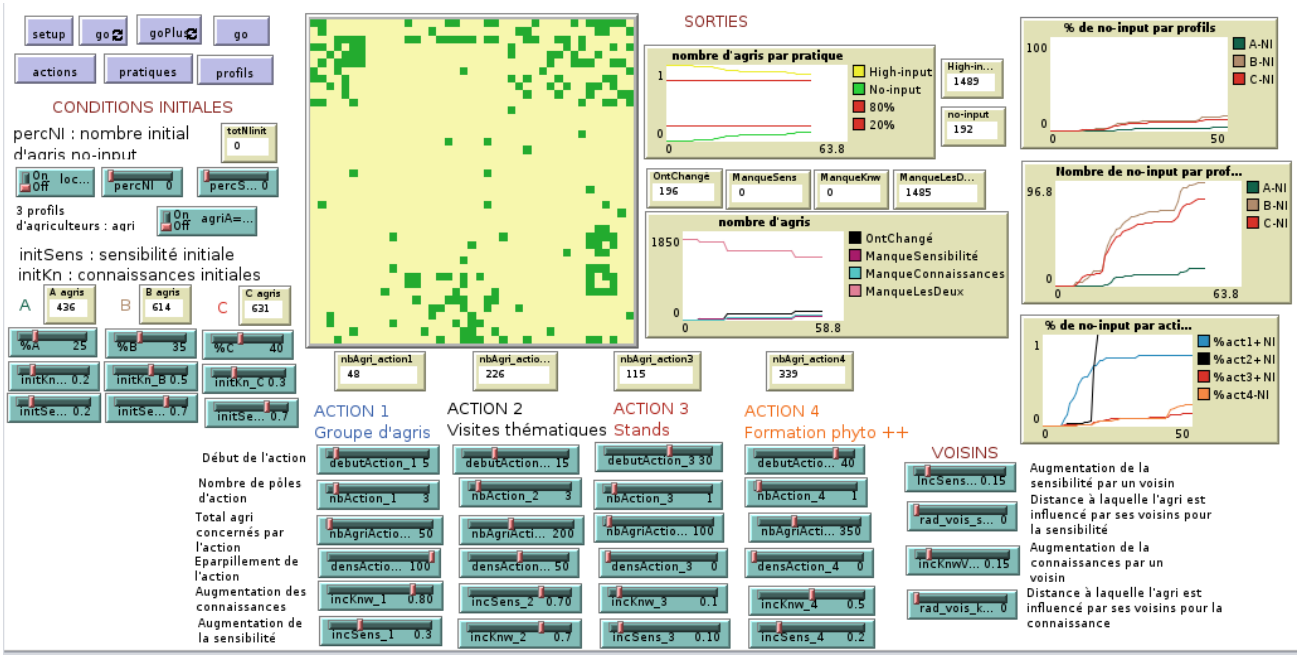
Table 8 : Definition of the Barrois farmers' profiles according to the participants of workshop 2

	Profile A	Profile B	Profile C	Profile D	Profile E
Profile Description	Farmers - winegrowers / farmers - breeders. Major crops are not the main production	Farmers - winegrowers / farmers - breeders. Major crops are not the main production	Farmers advised by a sales-interested technician	Curious farmers who want to experiment and are willing to take a risk to try things out	Farmers in extensive agriculture
Proportion in the territory	25%	35%	35%	2-3%	2-3%
Type of phytosanitary practices	High level of use	Reduction trend of around 30%	Reduction trend	Variable (both high and low levels)	Rather low level
Level of knowledge	2-3/10	5/10	2-3/10	8-9/10	5/10
Sensitivity level	2-3/10	6-7/10	6-7/10	7-8/10	5/10
Additional information from APO	Many (in Haute-Marne) are mixed farming-livestock breeders. Profiles E and C can also be found in this profile	These are generally "neutral" technicians. The reduction level (e.g., 30%) depends on the advisors	Technicians are both sellers and buyers. The reduction trend will depend on trust in the technician	-	-

Then, certain actions identified during workshop 1, such as group experimentation with farmers or personalised support, were further analysed and characterised according to various criteria of the NM. Subsequently, the modeller simulated several combinations of previously characterised actions in the NM, and the results (Figure 8) appeared consistent to the participants. The results from the NM simulations were thus validated by the participants.



1) Definition of action parameters for simulation (farmer groups, thematic visits, booths, training).



2) Results of the simulation (1)

Figure 8 : Simulation results of the effect of territorial actions on the level of PP use through *INRAE*'s NM

The two sessions of workshop 2 ultimately achieved the instrumental objectives set up by the CR, which were: 1) collectively define the initial conditions of the NM (profiles of farmers representative of the Barrois), 2) collectively discuss and set up up territorial actions identified during workshop 1, 3) collectively define a change scenario to simulate directly with the NM and discuss the results.

3.2 Evaluation of the participatory process

The participatory process of the workshops was evaluated based on the following four indicators: 1. The quality of participatory modelling in the workshop, 2. The quality of its facilitation, 3. The representativeness of the participants, and 4. The alignment between participant expectations and workshop outcomes. For each indicator, textual analysis of the topics discussed allowed for the identification of themes and their assessment in terms of quality and/or limits (Appendix 16).

3.2.1 Indicator 1: Quality of participatory modelling

3.2.1.1 Results

The recurrence of certain topics allowed for the identification of several qualities of participatory modelling grouped into the following themes: 1) The participatory and multidisciplinary approach of the workshops, 2) The presentation and setting up of the NM, 3) Discussion topics, 4) Effective organisation of workshop sessions, 5) Communication of results.

3.2.1.1.1 Theme 1: The participatory and multidisciplinary approach of the workshops

All stakeholders participating in the participatory process appreciated the participatory and multidisciplinary approach of the workshops. Furthermore, participants and the RC seem to have benefited from this participatory approach in different ways.

All farmers and APO described the participatory approach as "*very important*," "*interesting*," and "*useful*". Some explained that these workshops allowed them to contribute to the progress of a research project, to "*communicate*" about the issues of PP, to express their opinions, and to "*feel listened to*". One farmer added that this "*co-construction*" of territorial actions represented "*a questioning of research and farmers to identify solutions to the problems"*.

Additionally, all farmers and APO mentioned that this participatory and multidisciplinary form of workshops allowed them to make new acquaintances or reconnect with familiar individuals with more or less diverse profiles. As two APO indicated, these interactions facilitated the creation or strengthening of certain connections, particularly bringing together researchers from *INRAE* and the agricultural community of the Barrois region around a common issue. Indeed, the participatory nature of these workshops seemed to bridge, at least temporarily, the gap between the world of research and the agricultural world, which was still described as "too distant" by APO and farmers.

INRAE researchers also characterised the participatory and multidisciplinary approach of these workshops as "*very important*" and "*very interesting*". Like APO and farmers, they acknowledged

that these participatory workshops allowed them to meet new people, especially stakeholders from the Barrois region, and to set up their NM (3.2.1.1.2) with the participants. As emphasised by one APO, this participatory approach provides a certain consideration and valorisation of local knowledge by the CR.

This participatory and multidisciplinary approach to the workshops thus seems to benefit farmers and APO from a social and even psychological perspective on the one hand, and researchers from a social and instrumental perspective on the other hand. These bilateral benefits of the participatory process align well with the objectives of the workshops set up by the RC (1.4.1). Furthermore, the co-design of territorial actions between local stakeholders and the CR, through this participatory process, seems to support their legitimacy; they could thus be the subject of new research projects on the agroecological transition of the Barrois region and, consequently, be the subject of new funding opportunities.

3.2.1.1.2 Theme 2: Presentation and setting up of the numeric model

The coordinator indicates that participatory modelling was beneficial for three reasons. Firstly, it allowed *INRAE* researchers to work on the presentation of their NM in a concise and simplified manner for the participants. Additionally, participatory modelling helped them set up their NM by collectively identifying territorial actions and other data that were coherent with the Barrois region. Indeed, one APO explained that the NM simulations yielded results that "*could be satisfactory*" as they seemed consistent with their field observations.

Finally, participatory modelling gave researchers new ideas for model development, such as adding stakeholders (e.g., APO), which initially only represented farmers. The participatory approach to modelling thus allowed researchers to enhance their social skills (presentation, simplification), obtain the desired data, and ultimately validate the quality of their NM simulations, which aligns with the objectives set up for the workshops (2.3.1).

3.2.1.1.3 Theme 3: Discussion topics fostering new insights

Regarding the content of the workshops, the selected topics such as the description of territorial actions and profiles of Barrois farmers are deemed "*interesting*" by the facilitator. These topics allow for a more distant exploration of the theme of phytosanitary practice transition, avoiding getting stuck in unproductive debates about the challenges of PP reduction. In fact, reflecting on the description of territorial actions and profiles of Barrois farmers allowed participants to "*leave room for their imagination*", dream, and even evolve in terms of perception and practice. Indeed, some farmers saw their perception of their agricultural practices evolve (3.3.2.1.1).

The topics of the participatory process were able to trigger new reflections among some participants, particularly in terms of agricultural practices, representing the first step in a process of changing practices.

3.2.1.1.4 Theme 4: Efficient organisation of workshop sessions

The modeller and three other APO mentioned the advantage of separating farmers and APO into two distinct sessions. Since participants belong to the same region, it was very likely that some farmers and APO had a professional relationship. According to them, this provided each participant with the opportunity to express themselves without being influenced by the presence of other participants, thus ensuring transparent discussions and results.

Furthermore, three APO and three farmers explained that the organisation of sessions (balance between presentation time and speaking time, icebreakers, sequencing of steps, etc.), including the number of participants (a maximum of 6 participants per session), allowed them to work quickly and dynamically while providing enough time and space for expression.

The organisation of the participatory approach thus appeared to be effective as it ensured a certain quality of results within a limited duration.

3.2.1.1.5 Theme 5: Communication of results

According to three APO, the communication of workshop results to all participants in the form of detailed reports allowed them to "*continue certain reflections*" and visualise the results of the other group.

This continuity of knowledge transfer contributed to the extension of reflections among some APO.

Despite the previously identified qualities of the participatory process, it also exhibits several limits.

3.2.1.2 Limits

The recurrence of certain topics allowed for the identification of several limits of participatory modelling grouped into the following themes: 1) The complexity of the NM and its presentation, 2) Limited time and interactions, 3) Lack of adaptation in the communication of results, and 4) Occasionally challenging communication between the two partners.

3.2.1.2.1 Theme 1: Complexity of the numeric model and its presentation

During the workshop sessions, several general questions were raised about the functioning and representations of the NM. A certain difficulty in understanding it was observed among the majority of participants. This difficulty was confirmed through interviews with each participant, except for one APO who was already familiar with the world of research. They found the NM "*incomprehensible*", "*hyper-complex*", and "*abstract*". Indeed, representing the Barrois region through a mosaic of "*small squares*" of different colours based on phytosanitary practices is a form of representation that is too abstract for farmers to relate to. As one farmer explained, farmers prefer things to be "*concrete*". Two farmers noted that this presentation showed a "*complete disconnect between research and the field*" and that the field "*lacked the capacity to understand this tool*". Furthermore, the presentation of the various functionalities and variables of the NM seemed to hinder

understanding despite their brief oral explanations. The RC acknowledged that this difficulty in understanding the NM for participants was not adequately anticipated and could have been mitigated through simplification of their discourse during the workshops. According to the facilitator, the co-construction of the NM could have facilitated participants' understanding and ownership of the model, allowing them to focus more on discussions. The modeller mentioned that better understanding of the NM had been observed among other farmers during individual presentations conducted as part of axis 3 of the *TRAVERSéES* project.

This difficulty in understanding the NM was also experienced during the internship. The very name of the tool, "numeric model," only evoked a vague notion. It was only after discussions with various stakeholders (more or less related to numeric modelling) and bibliographic research that a comprehensive understanding of the tool was established over several weeks.

All farmers and four out of five APO experienced some difficulty in grasping the NM after the workshops. This participatory modelling tool lacks simplification and/or popularisation to be understood and appropriated by the participants.

3.2.1.2.2 Theme 2: Limited time and interactions

Regarding the conduct of the workshops, a lack of time was mentioned by three farmers. They felt that the duration of the workshops was too short to allow for a proper assimilation of the information exchanged. "*It was so packed, so dense that I didn't retain anything*", one of them remarked. They questioned whether the workshops were adapted to the participants: "*I had the impression that you were intervening in a professional environment that you didn't fully understand*". Furthermore, the modeller mentioned a lack of interaction during the simulations in the second workshops between the participants and the CR. She explained that the lack of time did not allow her to obtain more detailed feedback from the participants on the results, thus limiting the validity of the NM validation.

The coordinator and the facilitator also recognised time as a limiting factor in the workshops. The facilitator explained that the choice of two half-day workshops two months apart was a compromise between the possibilities and capacities of the participants, as well as those of the CR. Indeed, despite the interactive approach of the workshops, they required a certain level of concentration. According to the facilitator, mobilising operational stakeholders with often busy schedules to participate in a half-day reflection process was a maximum limit to ensure their participation. Several participants had mentioned their difficulty in making themselves available for more than half a day when they were invited to the workshops.

On the other hand, another farmer pointed out that the time allocated to informal discussions was limited compared to the collective work time. According to him, this lack of time affected group cohesion. He added that sharing contacts within the group of participants, such as "*names, email addresses, or phone numbers*" could have facilitated group cohesion. He also mentioned that the

communication of contacts among participants was not conducive during the workshops due to limited time management.

Ultimately, the temporal difference in stakeholders' involvement in agroecological transition was highlighted by one farmer and the modeller. The farmer noted that, despite the participatory approach to research, it was carried out over a short period (a few years), relative to his agricultural activity. The modeller also mentioned this temporal gap between the activities of researchers and local stakeholders on the issue of PP, and indicated that this could ultimately limit the long-term effects of the *TRAVERSéES* project.

Time seemed to be a limiting factor both for the quality of results in participatory modelling, for the learning of some participants, and for the cohesion of the participant group.

3.2.1.2.3 Theme 3: Lack of adaptation in the communication of results

The communication of results in the form of detailed reports was questioned by two farmers. They explained that the reports were "too long" to read. They preferred summary sheets that highlighted the workshop conclusions. According to them, there is a need for adaptation in the communication of results to avoid this disconnect.

While the writing of results in the form of reports convinced three APO (3.2.1.1.5) some farmers preferred a more concise format. Here, as with the NM (3.2.1.2.1) there is a need for simplified knowledge transfer from the RC to the participants.

3.2.1.2.4 Theme 4: Occasionally challenging communication between the two partners

During axis 4, the facilitator indicated that the co-organisation of the two workshops with the rest of the RC was sometimes "challenging." On one hand, the explanations provided by the researchers about the NM were communicated to the facilitator late, delaying her understanding and ownership of the tool. On the other hand, the differences in discipline (modelling/facilitation) led to different perspectives between the researchers and the facilitator, especially regarding the participatory approach.

Through these occasionally divergent views, a certain epistemological difference between the two partners is evident. This difference lies in the choice of the level of participant involvement in the construction of the NM. In our case, the researchers built the NM based on literature and interviews conducted with local stakeholders (axis 3 of the *TRAVERSéES* project). However, local stakeholders did not have the opportunity to participate in the design of the NM, which may have led to the NM having a different representation than what was expected by the stakeholders.

This first indicator on the quality of participatory modelling reveals various qualities and limits of the process. What is interesting to observe in Table 9 below is the difference in the number of

limits identified between the participants and the CR. Participants are the ones who identified the most limits in participatory modelling, which aligns with the fact that they did not participate in the development of its objectives.

Table 9 : Assessment of the qualities and limits of participatory modelling of the workshops identified by the interviewees

Indicator 1 : Participatory modelling		
Interviewees	Qualities	Limits
Participants and research committee	- Participatory and multidisciplinary approach -Effective organisation	
Research committee	-MN presentation and setting ups	-Delicate communication between partners
Participants	-Interesting topics for discussion -Communication of results	-MN complexity -Limited time and interaction -Lack of adaptability in communicating results

3.2.2 Indicator 2: The quality of workshop facilitation

Interviewees mentioned several qualities of workshop facilitation without mentioning any limits. On one hand, it was recognised as "*important*", even "*crucial*", by all the participants. All the farmers highlighted the courteous, attentive, and supportive environment they experienced during the workshops, and in which they actively participated. They described it as "*everyone*", "*listening*", "*respectful*", "*courteous*", "*non-judgmental*", and "*without prejudice*". According to three farmers and three APO, the facilitation created a serene atmosphere that allowed participants to express themselves in a "*transparent*" manner despite differences in activities and opinions. On the other hand, the facilitator made sure to give everyone the opportunity to speak and shared speaking time among those who wanted to participate, as noted by all the participants.

All the stakeholders present at the workshops acknowledged that, with good collective intentions, the facilitator was able to ensure a high quality of participatory modelling facilitation. Thus, the facilitator indirectly contributed to the qualities of the participatory modelling process mentioned earlier (3.2.1).

3.2.3 Indicator 3: Participant representativeness in workshops

3.2.3.1 Results

According to *INRAE* researchers, participants represented a "*diversity of profiles*" of local stakeholders. For instance, farmers had varying phytosanitary practices, ranging from Organic Agriculture (OA) to Conventional Agriculture (CA), and even High Environmental Value (HEV)

practices. Additionally, APO had diverse professional backgrounds, such as agricultural advisors from CHamber of Agriculture (CHA), agricultural advisors from Cooperative for the Use of Agricultural Equipment (CUAE), agricultural advisor from Group of Organic Farmers (GOF), National Forest Park project manager, teacher in an agricultural college, and retired farmer. These diverse profiles provided sufficient information sources to achieve the workshop's objective of NM setting ups.

However, despite this achieved objective, several limits regarding participant representativeness were raised by different stakeholders.

3.2.3.2 Limits

The absence of "*unconvinced*" stakeholders at the workshops emerged as a major limitation in terms of participant representativeness. Four out of five farmers, along with the coordinator and two APO, questioned the selection of participants invited to the workshops. Firstly, farmers highlighted the absence of certain central stakeholders in the socio-agrosystem, such as consumers, cooperatives, public policy representatives (elected officials), environmental organisations (water agencies), and banks, among others. One farmer explained that excluding all relevant stakeholders from the problem at hand amounted to "*efforts in vain"*. Secondly, four farmers, along with *INRAE* researchers, observed that the majority of farmers present at the workshops were already "*convinced*" and committed to reducing the use of PP. They acknowledged that the lack of participants representing conventional or less "*convinced*" farming approaches was a bias in the participatory process. According to some farmers, this lack of diversity among participants and within the group of farmers limited discussions, debates, and consequently, the quality of workshop results.

Nonetheless, the coordinator and facilitator justified the selection of invitees with two arguments. Firstly, participant selection criteria were applied: participants had to work in the Barrois region and express interest in continuing with the project. Secondly, practical considerations guided the choice of participant types: the selection of stakeholders did not extend beyond APO and farmers because they represented sufficient diversity for NM setting ups. Additionally, mobilising participants for the workshops faced several challenges. The facilitator explained that the time dedicated to participant mobilisation was constrained by project organisation and contingencies. She also noted that, due to the Barrois study area, being distant from their headquarters in Paris and Montpellier, direct contact with potential participants was limited. Consequently, mobilising stakeholders from private organisations and/or those directly involved in PP use (cooperatives, PP vendors, merchants, conventional farmers) was complex. Furthermore, these stakeholders were scarce in the region and often hesitant to engage in discussions of such sensitive topics.

While the workshops did not have a specific objective to mobilise all socio-agrosystem stakeholders in the Barrois, the lack of representativeness among participants, particularly the absence of

‘unconvinced’ stakeholders, led to some frustration among participants, especially farmers. These participants seemed to want these meetings to bring together different socio-agrosystem stakeholders, particularly the ‘unconvinced’, to provide them with opportunities for exchanges and interactions. This could be an initial step in changing their perception of PP use and thus promoting their agroecological transition.

This third indicator of participant representativeness in workshops highlights a major limit recognised by all stakeholders: the absence of ‘unconvinced’ stakeholders regarding the reduction of PP use.

3.2.4 Indicator 4: Discrepancies between participant expectations and workshop results

Participants identified two main discrepancies between their expectations and the workshop results: the utility of the NM, and the workshop discussion topics. These discrepancies stem from two limits mentioned by the interviewees: the lack of co-construction of workshop objectives and, more broadly, the lack of co-construction of the *TRAVERSéES* project objectives with Barrois stakeholders.

Three farmers, three APO, and the facilitator highlighted the lack of co-construction of workshop objectives with local stakeholders: "*The workshops did not allow for reconciling your expectations and mine. I didn't find a construction that adequately addressed economic and environmental issues*", explained one farmer. Like other farmers, he mentioned having expectations of concrete outcomes from the workshops. They expected more operational workshop objectives and greater consideration of their urgencies for their agroecological transition. They particularly emphasised the "*need for support*" from competent organisations, support from influential stakeholders (consumers, merchants, cooperatives), and "*medium to long-term financial assistance*." In response, the workshop results, as well as the NM, did not meet these expectations. All farmers and four of the APO questioned the utility of the NM, with one farmer asking, "*What can you do with it in the field?"*. Another farmer noted a "*complete disconnect between research and the field's needs*".

Furthermore, three farmers questioned the relevance of workshop discussion topics (territorial action characterisation, profiles of Barrois farmers, etc.) and their place in the project. According to them, although these topics were interesting, they came late in the project stages and confined participants to discussions that had already been extensively explored. Indeed, two farmers explained that these "*areas of reflection*" had already been studied "*decades ago*", and they wanted research to undertake projects for farmers as major stakeholders in the agroecological transition.

Underlying the lack of co-construction of workshop objectives, the facilitator highlighted the lack of co-construction of the *TRAVERSéES* project with Barrois locals. Despite the project's partnership with three GIEEs, the facilitator, like two farmers, mentioned that concertation with local stakeholders prior to project development was limited. Once the project was written, adapting it to

participant expectations became more constrained. The facilitator cited the example of the carbon-PP nexus[7], which had been repeatedly mentioned by Barrois stakeholders as an area of interest at the project's outset up. Despite Lisode's proposal, the topic was not included by *INRAE*.

All farmers and three out of five APO highlighted a discrepancy between workshop objectives and their expectations. The lack of co-construction of workshop objectives, and more broadly, the *TRAVERSéES* project objectives, was identified as a major cause of this discrepancy by these participants, as well as the facilitator.

The evaluation of the participatory process through various indicators has revealed its qualities and limits as perceived by different stakeholders. While all stakeholders were satisfied with the workshop facilitation, the majority of participants pointed out limits in participatory modelling, participant representation, and alignment with participant expectations. The lack of co-construction of workshop objectives emerged repeatedly as a major issue. According to Lisode's participation scale (2017), the collective definition of territorial actions and farmer profiles resembles concertation because the proposals were co-constructed between participants and the RC. Nevertheless, the participatory process in the two workshops appears to lean more toward consultation than concertation, as participants were not involved in the development of the process and its objectives. Furthermore, given that the research project aims to generate knowledge rather than operational outcomes, the participatory process is primarily an information exchange. However, Mendez (2016) advises that participatory processes should lead to the implementation of actions or improvements so that participants can receive support for their agroecological transition.

3.3 Evaluation of the effects of the participatory process on participants

The effects of participation in the workshops on the participants were assessed using the following three indicators: 1. Knowledge acquisition, 2. Evolution of perceptions, 3. Implementation of new actions. For each indicator, textual analysis of the topics discussed allowed for the identification of different themes and their limits (Appendix 16).

3.3.1 Indicator 1: Knowledge acquisition

3.3.1.1 Results

The recurrence of certain subjects allowed for the identification of various knowledge acquisition areas among the participants following their participation in the workshops: 1) Participatory methodology, 2) Stakeholders and the functioning of the territory, 3) Modelling, 4) Territorial actions for agroecological transition.

[7] Study of the entire life cycle of PP (including their associated greenhouse gas emissions from production, transportation, application, and the agricultural practices surrounding them) in order to minimise the carbon footprint of agriculture while maintaining agricultural yields that ensure food security.

The modeller and an APO indicated that their participation in the workshops or in their organisation had taught them various concepts related to participatory methodology. According to the modeller, it is an approach that can pose many "challenges" and require a lot of time, especially for mobilising stakeholders, organising workshops, and working with participants. The APO mentioned that the participatory approach used during the workshops allowed them to experiment and retain certain "*tools*" that could assist them in their professional activities, such as setting up the room, making participants feel comfortable (name badges, icebreakers), and engaging them, as well as the materials used (papers, boards, etc.). The challenge of mobilising participants over time was mentioned by both the APO and the modeller. They realised the difficulty of long-term mobilisation of stakeholders in a research project, especially when the research team is distant from the study area.

On one hand, two farmers from the "using PP" typology explained that the exchanges in the workshops allowed them to learn about "new opinions," including different agricultural and phytosanitary practices from their own. On the other hand, *INRAE* researchers indicated that these workshops allowed them to deepen their knowledge of the heterogeneity of agricultural practices in the Barrois region. The modeller particularly highlighted her discovery of certain roles of APO.

Two APO and one farmer indicated that these workshops allowed them to understand the "*work*" of modelling conducted by research, especially through the setting of a tool like the NM. One APO, familiar with the research domain, was able to define the NM: "*I understood that it was a simplification of reality, and that it should not be expected to perfectly reflect reality"*. Furthermore, *INRAE* researchers stated that these workshops greatly contributed to their learning about participatory modelling, especially about "*what can be done in participatory modelling workshops, what can be done with the model, and the presentation of the model*."

Several participants mentioned their learning about ideas for agroecological transition actions in the territory. Three farmers provided an example of a territorial action discussed during workshop 1: the creation of a "*farmers-researchers network*". According to one APO, "*agroecological transition involves not only technical challenges*". Indeed, he observed in the workshops, as did the modeller, the importance of the social aspect of transition. He explained that this was raised several times during the workshops, particularly through the definition of territorial actions such as sharing and exchanging among stakeholders in a territory. Furthermore, the modeller indicated that these workshops allowed her to understand the importance of the economic difficulties that farmers face, especially when reducing the use of PP.

3.3.1.2 Limits

Although these workshops were able to provide some knowledge to the participants, they did not lead to the acquisition of "*useful*" knowledge for them. Indeed, all the participants have belonged to and worked in the Barrois region for several decades. The topics discussed in the workshops, such

as defining territorial actions for reducing PP use or defining the profiles of Barrois farmers, are subjects that already seem to be part of their expertise, and that may have allowed them to confirm their knowledge. Most farmers indicated that the type of knowledge they expected from these workshops was more technical knowledge to implement the discussed territorial actions (3.2.4).

Therefore, all participants seem to have benefited from some acquisition of knowledge on the main topics of the workshops (territorial actions and profiles of Barrois farmers) or related topics (participatory methodology, stakeholders and territory, modelling). However, farmers questioned the usefulness of the main topics for their own agricultural activities. Indeed, defined by the main objective of the workshops (setting and simulations of the NM), these topics seem to place the participants in different positions in an information exchange process. The research committee can be perceived as both the sender and receiver of information, while the participants are seen as senders only.

3.3.2 Indicator 2: Evolution of perceptions of other participants

3.3.2.1 Results

Following their participation in the workshops, various participants were able to perceive changes in their perceptions of other participants such as 1. Farmers, and 2. APO.

3.3.2.1.1 Farmers

Farmers "using PP"

Two farmers from the "using PP" typology evolved in their perception of their own agricultural practices. They mentioned that their participation in the workshops allowed them to become aware of "*the diversity of farmers present*" and the "*efforts*" that some make based on different "*priorities*" than their own. This allowed them to "*question their practices*." Additionally, the third farmer "using PP," who is HEV certified, indicated that these workshops reinforced his stance on PP use. Furthermore, the modeller noticed that, even though a farmer belonged to the "using PP" typology, he actively contributed ideas during the workshops.

Farmers "not using PP"

The two farmers from the "not using PP" typology strengthened their perception of their own agricultural practices. They emphasised that the theme of reducing PP use chosen by the research committee allowed them to reinforce their views.

3.3.2.1.2 APO

An APO from the "no advisory/sales activity of PP" typology was strengthened in their professional role and approaches, particularly after reading the discussions in the farmers' workshop regarding agricultural advisors. Furthermore, the modeller and the coordinator mentioned that, as a result of these workshops, they discovered the roles of certain APO. Specifically, they noticed the influence

of their values and beliefs on their professional activities: "*changes occur based on the individual, their beliefs, and motivations.*" The modeller gave an example of an APO who chose an agricultural advisory activity of the "no advisory/sales activity of PP" typology for reasons of conviction, without any obligation from their hierarchy.

3.3.2.2 Limits

Although these workshops were able to provide new perceptions of farmers and APO to some participants, not everyone changed their perception.

Farmers' perception of APO has strengthened. According to all farmers, APO are "*key*" stakeholders in agroecological transition who should adopt a "*neutral*" stance regarding PP and a transversal approach toward farmers to help them "*become their own advisors*".

Farmers' perception of researchers has also strengthened. On one hand, four farmers and two APO noted that researchers are still too "*disconnected*" from the field, and there is a real need for "*communication between the two ends of the chain*". They described research as "*lagging behind*" compared to "*advances in the field*". Some cited the lack of prior concertation before the workshops, leading to inconsistency with the needs of the field (3.2.4). On the other hand, one farmer and two APO emphasised that the "*scientific, structured, and serious*" work of researchers remains "*fundamental,*" particularly for producing knowledge that, in the long term, will enable farmers to make "*better choices*". Furthermore, the *INRAE* researchers also confirmed their perception of their research. Both emphasised the importance of collective work with local stakeholders to enrich their research process and results. The modeller added that this is a difficult task to anchor in reality, with its impacts on participants being difficult to perceive.

Therefore, there have been some changes in perception among farmers and APO following the workshops. Two farmers "using PP" in particular changed their perception of their own phytosanitary practices. However, the mixed perception of farmers regarding researchers has strengthened. This can be explained, in part, by the organisation and method of the workshops chosen by the research committee, which did not meet the expectations of the majority of participants. Furthermore, the participatory process remains relatively short to induce a change in participants' perception of the rest of the group.

3.3.3 Indicator 3: Implementation of new actions

3.3.3.1 Results

The modeller indicated that this rich experience in participatory modelling prompted her to propose a participatory modelling course as part of her professional activities as a teaching researcher in modelling. The coordinator mentioned new perspectives for actions such as the valorisation of the NM in the St. Clay laboratory (near their own), as well as workshops in the Barrois region.

3.3.3.2 Limits

Following their participation in the workshops, all participants stated that they did not implement new actions related to their professional activities. Indeed, the results of the workshops were not useful to them for making changes in their activities or practices since they did not have this objective.

> Thanks to their enriching participation in the workshops, *INRAE* researchers are contemplating or implementing new actions within the framework of the *TRAVERSéES* project and even beyond it. However, the implementation of new actions was not mentioned by the rest of the participants. Indeed, knowledge acquisition and changes in perception during the participatory process remain insufficient to induce a change in activity or practice, especially regarding PP use.

The evaluation of the effects of participation on the participants has highlighted differences between the RC and the participants. Participants appear to be the type of stakeholders that have evolved the least in terms of knowledge acquisition, changes in perception, and implementation of new actions. This difference can be explained by the participants' role in the participatory process as information providers, and more generally by the characteristics of the participatory process (duration, objectives, method).

4 Discussion and propositions

The study focused on the two participatory workshops co-organised by Lisode and *INRAE* as part of axis 4 of the *TRAVERSéES* project. Its objectives were 1) to evaluate the participatory process of the workshops, and 2) to assess the effects of participation in the workshops on the participants.

The following two questions emerged from these objectives: "What are the qualities and limits of the participatory modelling process?" and "What are the effects of the participatory process on the participants?"

The exploratory analysis of the participatory processes helped prepare for the organisation, implementation, and observation of the workshops in the form of participatory modelling. This ultimately allowed for the collective collection of data, in concertation with farmers and APO (Agricultural Professional Organisations) from the Barrois region, which was necessary for the setting of the numeric model (NM). Firstly, workshop 1 revealed territorial actions primarily related to sharing and exchanging information among stakeholders in the socio-agrosystem, with the aim of reducing the use of phytosanitary products (PP) in their region. Secondly, workshop 2 described heterogeneous profiles of Barrois farmers, particularly based on the type of phytosanitary practices and advisory organisations. These two workshops ultimately allowed for the setting of the NM and the simulation of combinations of territorial actions. Participants recognised a certain realism in the

results, which partially validated the quality of the NM made by *INRAE*. Finally, end-of-workshop evaluations in the form of questionnaires allowed participants to assess certain workshop criteria. Both workshops showed good quality in participatory modelling and facilitation. However, some participants assessed a lack of representativeness of the stakeholders present at the workshops, as well as a lack of understanding of the NM and its objectives.

Semi-structured interviews with almost all the participants from both workshops and the research committee (RC) were conducted to evaluate the participatory process of the workshops as a concertation process according to Lisode's participation scale (2017). Firstly, the evaluation of the participatory process revealed several limits: the lack of adaptation of the NM and the presentation of results to participants, limited time and interactions, lack of representativeness of the participants present, and a mismatch between the participants' expectations and the workshop results. Secondly, the evaluation of the induced effects on participants revealed limited long-term effects in terms of knowledge acquisition, changes in perceptions, and the implementation of new actions.

Following these results, it is important to note the limits and constraints that the study faced during its design and analysis.

4.1 Study limits

Firstly, the time allocated to the study was limited. The initial study had to be redirected for academic reasons and resulted in a new research question initiated in mid-July, less than a month before the end of the internship. The definition of objectives, data collection methodology, and analysis of study results were therefore based on limited time, with one week of literature research and open discussions.

According to Guérin-Schneider et al. (2010), "To be objective, evaluation must be conducted following certain methodological and ethical principles such as those developed by the American Evaluation Association (2004): utility, feasibility, decency, accuracy, competence, integrity, honesty, etc." However, the evaluation method in the form of semi-structured interviews was studied for only a week and a half, limiting the ability to assess the feasibility and accuracy of the method.

On one hand, the evaluation of the participatory process was restricted to a post-workshop study. According to Lisode (2017) and Etienne (2010), it is important to evaluate the process during its implementation through observations. These could not be carried out according to the study's objectives since they were not yet known. This could represent a limitation to the accuracy of the method, thus limiting the comprehensiveness and quality of the results.

On the other hand, although semi-structured interviews allowed for detailed responses, conducting them by phone or video conference could limit exchanges and interactions with the interviewees. The comprehensiveness of the results may have been limited compared to in-person semi-structured interviews.

Furthermore, although the qualitative approach of semi-structured interviews has the advantage of obtaining detailed responses, it is a time-consuming method of transcription that also requires cross-referencing results with quantitative analysis. Due to time constraints, there was some lack of completeness, especially in the detail of keywords mentioned by the interviewees. The lack of a quantitative/qualitative combination may have limited the complete and nuanced analysis of the results.

The qualitative evaluation of the process using multiple indicators also has limits. On one hand, Etienne (2010) and Lisode (2017) recommend focusing on only a few indicators to avoid difficulties and ensure systematic evaluation. The choice of multiple indicators may have limited the precise analysis of each of them. On the other hand, Lisode (2017) and Etienne (2010) describe the evaluation of the induced effects on participants as more challenging. These effects can result from other external factors and involve social and cognitive themes that require specific skills. The results of induced benefits, therefore, need to be nuanced.

It is also important to note that not all interviewees participated in the participatory process in the same way: some attended only the first workshop, some only the second, and some attended both. The results may be unevenly influenced by different levels of participation by workshop participants.

Finally, the evaluation of this process tries to remain humble. Indeed, it is integrated into the fourth and final year of the *TRAVERSéES* project. The overall understanding of the project's construction, the progress of the initial axes, and the interactions among the various project stakeholders may thus be incomplete despite bibliographical research and discussions with different partners.

4.2 Participation in research projects

PP represent a sociotechnical lock that several research programs, such as the *Ecophyto* plans, are attempting to resolve. According to Guichard et al. (2017), "unlocking (...) can only come from a simultaneous and coordinated mobilisation of all concerned stakeholders, that is, all stakeholders in agriculture and food (consumers, processors, distributors, producers, etc.). A strategy for massive PP reduction should integrate a systemic vision, taking into account the interdependencies linking all stakeholders making up the production and marketing system specific to each agricultural sector." Furthermore, the majority of participants in the participatory workshops of the study highlighted the lack of representativeness of the participants present (traders, cooperatives, politicians, consumers, processors, etc.), as Grohens (2021) also noted in her study during axis 1 of the *TRAVERSéES* project. This can be explained by internal technical mobilisation difficulties within the RC, as well as by stakeholders withdrawing during the process. Indeed, some stakeholders (e.g., cooperatives, researchers) participated in the early stages of the project but did not respond to subsequent mobilisations. The participatory approach of the workshops and, more broadly the *TRAVERSéES* project, therefore encounters internal and external difficulties in mobilising stakeholders, especially

those who are less convinced of the importance of PP. The project's vision of the socio-agrosystem is thus limited to a representation of primarily "convincing" stakeholders.

Additionally, the research focus of the project is solely on reducing the use of PP and appears to neglect its interconnections with other elements of the socio-agrosystem. As Guichard et al. (2017) explain, phytosanitary practices are part of a socio-agrosystem composed of interdependent elements. Although the main goal of the project is participatory modelling of a research model, rather than the actual reduction of PP use in the Barrois region, the issue of reducing PP use must be addressed in a systemic way to avoid overlooking its complexity.

Furthermore, this study also demonstrates the misalignment of participant expectations with the results obtained, particularly due to the lack of concertation by the RC with local stakeholders in defining project objectives. However, as Mendez (2016) emphasises, even if this concertation does not take place during project proposal writing, the key lies in the adaptability of the project to the needs of the field. However, as revealed since axis 1 and according to the results of this study, the *TRAVERSéES* project struggles to take into account field needs (including operational needs) and tends to resemble consultation more than genuine concertation. This lack of adaptability can be explained, in part, by the conditions of research work. Researchers are constrained by deliverable requirements that tend to consume a significant amount of time, often at the expense of mobilising stakeholders, for example (Latour, 1994). These deliverables are a favoured form of presenting results in order to showcase and justify project funding (Hubert and Louvel, 2012). Faced with the complex management of their multidisciplinary team, accountability to funders, and the difficulties of mobilising local stakeholders, both researchers and project coordinators may find themselves in an uncomfortable position.

4.3 Proposals

The proposals have been developed taking into account the issues of participation, particularly concertation, discussed earlier. They aim to promote processes of concertation between researchers and local stakeholders.

On one hand, the basic components of the NM used in the *TRAVERSéES* project could serve as a basis for co-creating secondary components of the NM with local stakeholders before its setting. A new territory could be chosen, such as the laboratory of *INRAE* researchers in Saclay (next to Paris). This adaptation and reworking of the NM for a new territory could then be the subject of a new research project. The co-construction of secondary NM components with local stakeholders would allow these stakeholders to take ownership of the NM and ultimately be able to reuse it.

On the other hand, the research subject of reducing the use of PP in the Barrois region could be the focus of a new research project that offers an approach to the issue at the level of agricultural practices. It could integrate a concertation process from the outset up to ensure alignment between

participant expectations and project results.

Thus, the two proposals detailed here are: 1) a participatory modelling research project in Saclay, and 2) a participatory research project for the agroecological transition of the Barrois territory.

4.3.1 Proposal 1: "Participatory modelling research project in Saclay"

The study conducted on the participatory approach of the two workshops in axis 4 of the *TRAVERSéES* project revealed limits in its participatory modelling. Among these limits were mentioned the lack of alignment between participant expectations and the results obtained, the lack of representativeness of stakeholders (especially the "unconvinced"), the lack of simplification of the NM and its presentations, as well as time constraints. This research project proposal would incorporate these limits through the co-construction of the NM.

The main objective of the research project would thus be to co-create an NM with a group of stakeholders from Saclay, supported by a CR. The ultimate goal would be the ownership of the NM by Saclay's stakeholders. The project would be divided into four main stages, over a total duration of six months, as represented in Figure 9 (next page).

Research project on the participatory modelling in Saclay:
Co-construction the NM with Saclay stakeholders

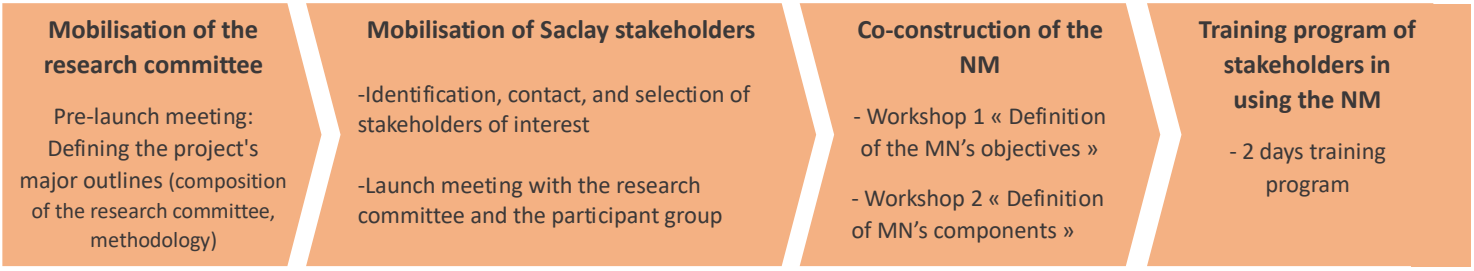


Figure 9 : The major steps of proposal 1 "Participatory modelling research project in Saclay"

4.3.1.1 Mobilisation of the research committee

To successfully carry out this research project, it is first important to mobilise a transdisciplinary team of researchers, including modelling researchers, agronomic scientists, and participation scientists. It could involve re-engaging members of the *TRAVERSéES* project's research committee (Corinne Robert, researcher in ecological regulation of pests and modeller at *INRAE UMR ECOSYS*, Saclay; Amélie Bourceret, modelling researcher; Audrey Barbe, agronomist engineer and consultant at Lisode) to benefit from their expertise for this project similar to the *TRAVERSéES* project.

Once the core of the RC is formed, an initial in-person meeting could be organised in Saclay to collectively define the general objective of the project, discuss the initial methodological steps, as well as partnerships and roles within the project. The composition of the RC can also be adjusted as needed.

4.3.1.2 Mobilisation of local stakeholders

Before initiating the NM co-construction process, it is important for the RC to assemble a group of stakeholders representative of Saclay who are willing to participate in the research project.

This mobilisation could be carried out by the consultant from Lisode. Her objective would be to create a group of about ten stakeholders representative of Saclay who are interested and available from the beginning to the end of the project, while fostering group cohesion. Here are the steps to follow for this second stage.

This mobilisation would take place over a period of two months, with the following stages:

1) Preparation of a presentation (oral and written) of the project with the RC;
2) Identification of different groups of interested stakeholders and stakeholders present in the region;
3) Selection of about ten interested stakeholders per group;
4) Phone contact with the selected stakeholders to introduce them to the general objective and methodology of the project and invite them to participate;
4') Scheduling a meeting at the organisation's headquarters if mobilisation, especially of private organisations, proves to be difficult, and arranging for travel;
5) Selection of project participants from organisations willing to participate, based on the following selection criteria:

- The organisation has the ability to commit to the project long-term.
- The organisation belongs to a group of stakeholders not already represented.
- If the stakeholder's group is already represented, the organisation is different from the one(s) already present.

6) Organising a welcome meeting between the RC and the group of participants in Saclay to allow people to meet, initiate group cohesion, share expectations, and present the next steps of the project.

4.3.1.3 Co-construction of the numeric model

The co-construction of the NM with the group of participants aims to take into account their expectations in order to create a tool that will be useful and mobilisable for them. It will take the form of two half-day workshops (Figure 10).

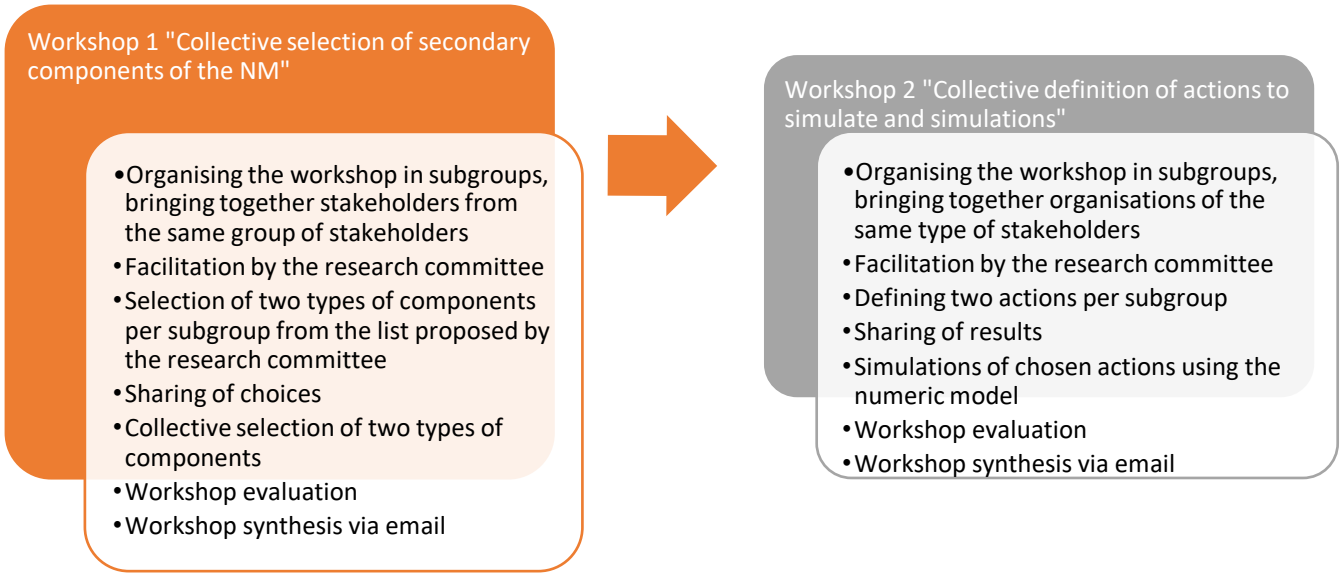


Figure 10 : The organization of the two participatory workshops in proposal 1

Collective selection of secondary components of the NM (workshop 1) would allow participants to choose the components for which they wish to observe results following the simulation of an action. These components can be ecological (disease spread, drought, etc.), economic (profits, costs, subsidies, etc.), and social (network membership, knowledge acquisition, awareness). They will be presented to subgroups in the form of a list and examples.

The collective definition of actions (workshop 2) would ultimately allow the simulation of the impact of actions or combinations of actions on the previously chosen components of the NM.

Workshop end evaluations can be conducted using the Most Significant Change (MSC) method proposed by Etienne (2010). This method suggests, instead of the traditional evaluation method in the form of a question grid, a more meaningful evaluation of participants on a specific theme in order to allow the RC to adjust their approach as closely as possible to the participants' needs. A detailed protocol is provided in Appendix 17.

4.3.1.4 Training program in numeric model operation

The training program in NM operation, conducted by the CR, would enable participants to understand the functioning of the NM, its representations, and to carry out simulations. For this purpose, the training would last two days and follow the following main points:

1) Description of how the NM works
2) Description of its components
3) Simulation tests
4) Evaluation of the training
5) Deliverable on the operation of the NM and its components

4.3.1.5 Budgeting

Action plan	Description	People involved	Periode	Number of days	Budget (€)	
Mobilisation of the research committee					0,00	0%
Contact the *TRAVERSéES* research committee		Corinne Robert, Amélie Bourceret, Audrey Barbe	2 weeks	2	0,00	0%
Gather the research committee	Project structure: objectives, methodology, and modalities	Research committee	1 week	2		
Mobilisation of Saclay stakeholders					15250	52,5%
Prepare the project presentation	Oral, written, and slides version. Description of the project's objectives, methodology, and modalities	Research committee	1 week	2	400 + 400 + 1500 = 2300	15,1%
Identify the various groups and select	Cooperatives,	Research	2 weeks	4	800 +	30,2%

stakeholders of interest present in the Saclay territory	Agricultural Chambers, syndicate, farmers, consumers, local food vendors, environmental associations, public policies	committee			800 + 3000 = 4600	
Contact the selected stakeholders	Email/phone call At least 10 stakeholders per group of stakeholders of interest	Audrey Barbe	2 weeks	2	1500	9,8%
Visits to the organization's headquarters if appointments are scheduled	Travel. Written presentation support and slides	Audrey Barbe	1 week	3	2250	14,7%
Select participants/identify the final group of participants	Based on the positive responses According to the selection criteria	Research committee	2 weeks	2	2300	15,1%
Organize and conduct the welcome meeting between the research committee and the participant group	At Saclay Meeting report	Research committee and participants group	1 week	2	2300	15,1%
Co-construction of the NM					13800	47,5%
Organize, facilitate, and analyse the results of workshop 1	Facilitation MSC evaluation Workshop synthesis	Research committee and participants group	1 week	4	4600	33,33%
Organize, facilitate, and analyse the results of workshop 2	Facilitation MSC evaluation Workshop synthesis	Research committee and participants group	1 week	4	4600	33,33%
Training program in using NM	Facilitation Deliverable 'User Manual'	Research committee and participants group	1 week	4	4600	33,33%
TOTAL EXPENSES					29050	100%

The remuneration of the RC has been estimated based on internal data. The cost of a consultant has been estimated at approximately €750 excluding taxes per day. The cost of a researcher has been estimated at €4,000 per month, which is €200 per day. These estimates are approximate.

4.3.1.6 Points to consider

The availability of the identified RC may be uncertain, so it is important to plan for knowledge transfer if one of the individuals is unable to participate in this new project.

The scheduling of workshops should be such that all members of the participant group and the RC are available.

Facilitation should ensure that everyone respects the supportive workshop environment and that everyone has the opportunity to speak.

Expenses related to mission expenses (transportation, lodging, meal allowances) for the RC have not been taken into account. Therefore, the budgeting of the action plan is underestimated.

4.3.2 Proposal 2 "Participatory research project for the agroecological transition of the Barrois territory"

The study conducted on the participatory approach in the two workshops of axis 4 of the *TRAVERSéES* project has shown limits in the participatory process. Among them, the lack of operational objectives, the mismatch between participants' expectations and results obtained, the lack of representativeness of stakeholders (especially the "unconvinced"), and the lack of time were mentioned. This research project proposal would incorporate these limits through the co-construction of a research project for the agroecological transition of the Barrois.

The main objective of the research project would be to co-create a research project for the agroecological transition of the Barrois with a group of Barrois stakeholders, accompanied by a CR. The ultimate goal would be the implementation of one or more actions chosen by the participants. The project would be divided into four main stages, over a total duration of two years (Figure 11)

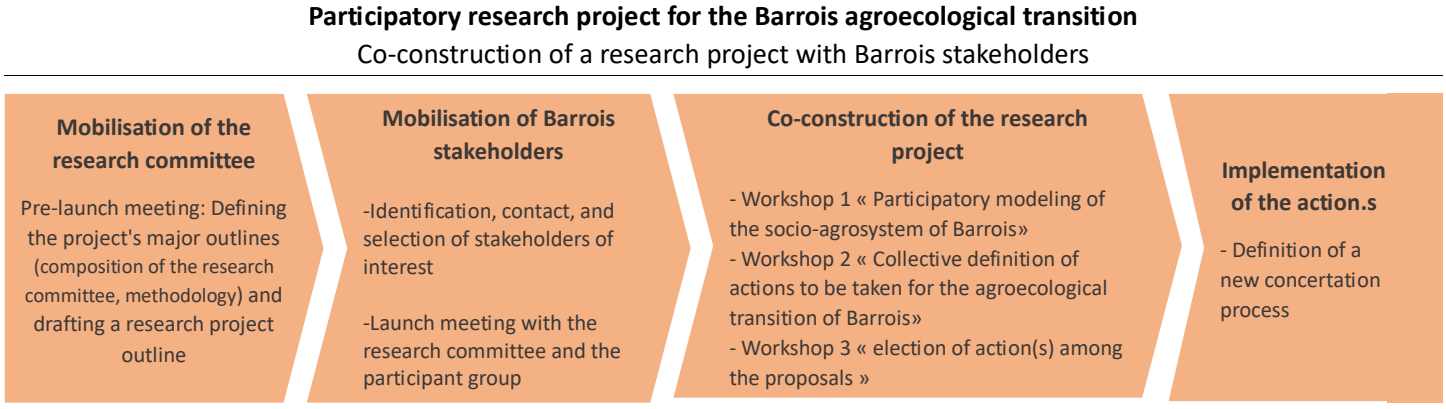


Figure 11 : The major steps of proposal 2 "Participatory research project for the agroecological transition of the Barrois territory"

4.3.2.1 Mobilisation of the research committee and mobilisation of local stakeholders

The methods for mobilising the RC and local stakeholders can follow those of proposal 1 (4.3.1.1;4.3.1.2).

4.3.2.2 Co-construction of the research project

The co-construction of the research project with the participant group aims to take into account their expectations in order to establish one or more actions that will be useful to them for their agroecological transition. The co-construction of the project will take the form of three initial one-day workshops (Figure 12).

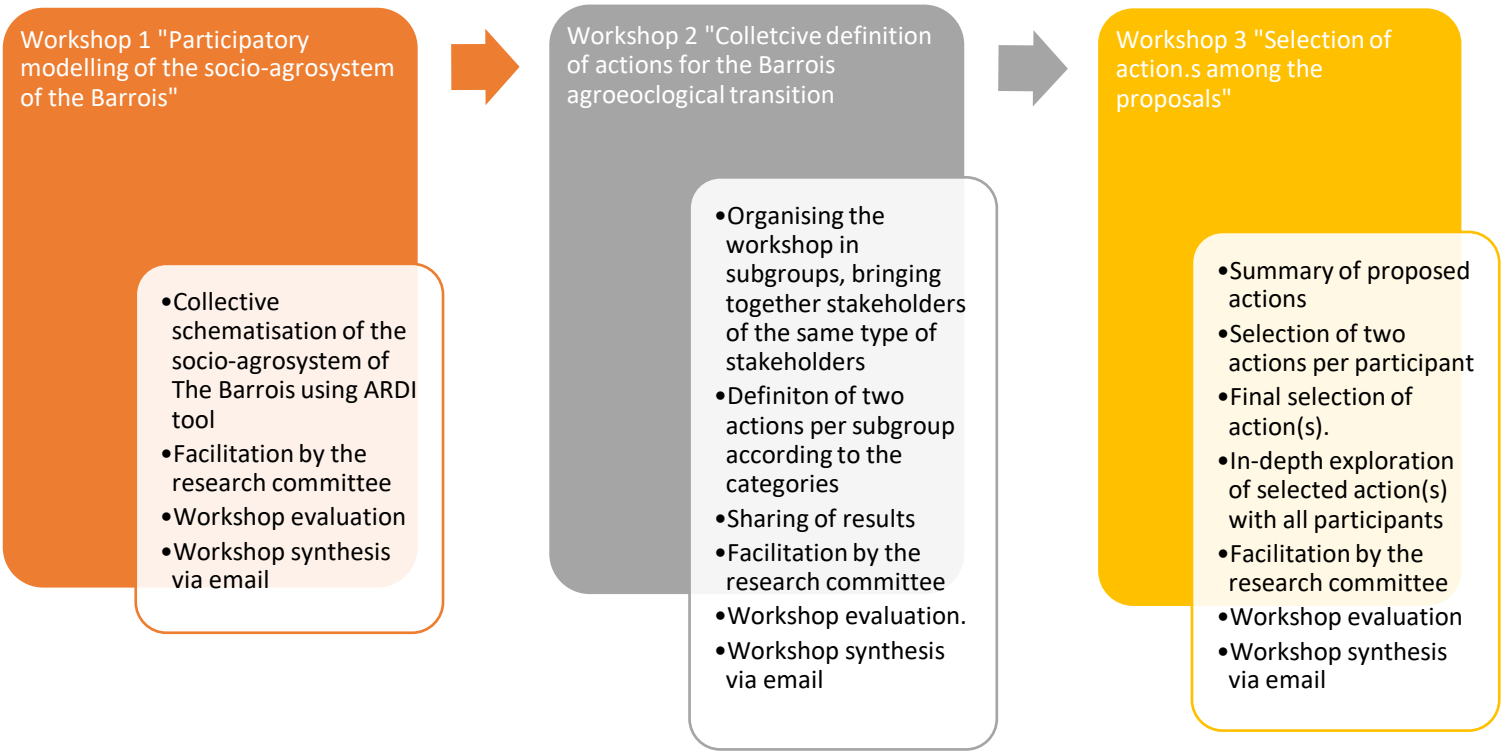


Figure 12 : The organization of the three participatory workshops in proposal 2

The participative modelling of the socio-agrosystem of the Barrois region (workshop 1) would allow participants to co-create a collective vision of the system. ARDI is a tool for conceptualising a system, which allows factual description by bringing together on the same diagram the hypothetical Stakeholders and Resources of the system, connected by Dynamics and Interactions, based on a Problematic, Spatial, and Temporal scale (ComMod, 2009).

The collective definition of actions to be taken for the agroecological transition of the Barrois (workshop 2) would enable each group of stakeholders to identify short-term actions (approximately within 1 year) that they would like to implement as part of the agroecological transition of the Barrois. These actions should be detailed to address the following categories:

- Action description
- Effect of the action / Why?
- Origin / impetus of the action
- Implementation: where, when?
- Technical means
- Financial needs

- Participants
- Limits
- Sustainability

The selection of actions from the proposals (workshop 3) would allow the group of participants to choose one or more actions that interest them. Once the action(s) are identified, the RC can plan a new concertation process to implement the action(s).

4.3.2.3 Budgeting

Actions à mener	Description	People involved	Periode	Number of days	Budget (€)	
Mobilisation of the research committee					0,00	0%
Contact the *TRAVERSéES* research committee		Corinne Robert, Amélie Bourceret, Audrey Barbe	2 weeks	2	0,00	0%
Gather the research committee	Project structure: objectives, methodology, and modalities	Research committee	1 week	2		
Mobilisation of Barrois stakeholders (same budgeting than proposition 1)					16050	53,80%
Co-construction of the research project					13800	46,20%
Organize, facilitate, and analyse the results of workshop 1	Facilitation MSC evaluation Workshop synthesis	Research committee and participants group	2 weeks	4	4600	33,33%
Organize, facilitate, and analyse the results of workshop 2	Facilitation MSC evaluation Workshop synthesis	Research committee and participants group	2 weeks	4	4600	33,33%
Organize, facilitate, and analyse the results of workshop 3	Facilitation MSC evaluation Workshop synthesis	Research committee and participants group	2 weeks	4	4600	33,33%
TOTAL DEPENSES					29850	100%
Implementation of the action.s					150000	83%
New concertation process	To define according the action.s choosen	Research committee and participants group	1 year and a half	-	-	-
ESTIMATION TOTAL EXPENSES					179850	100%

The remuneration of the RC has been estimated using the same method as in proposal 1 (4.3.1.5).

4.3.2.4 Points to consider

The same points of attention as in proposal 1 should be considered. Furthermore, it is also important

to be vigilant about the realism of the proposed actions, especially in terms of time and the required funding for their implementation. To address this, the new concertation process should include the development of a schedule and a provisional budget, prepared with the input of all participants and the CR.

5 Conclusion

In the face of the growing challenges of agroecological transition, especially the need for research concertation with local stakeholders, the *TRAVERSéES* research project was initiated as part of the *Ecophyto II+* plan. Its fourth axis aimed to develop a numeric model (NM) simulating trajectories of changes in phytosanitary practices, particularly through participatory modelling with stakeholders from the Barrois region.

This study involved the evaluation of the two participatory modelling workshops of the fourth axis of the *TRAVERSéES* project. Specifically, this evaluation was divided into two assessments. The first focused on the quality of the participatory process itself, and the second on the effects on the participants. To achieve this, an initial exploratory analysis of participation and the *TRAVERSéES* project contributed to the design, implementation, and observation of the two workshops. Following literature research on methods for evaluating participatory processes, it was decided to assess four indicators of the quality of concertation: the quality of participatory modelling, the quality of facilitation, the representativeness of participants at the workshops, and the alignment between participants' expectations and the workshop results. For this purpose, semi-structured interviews were conducted with 13 available participants who had taken part in the workshops.

Three major limits of the participatory process were highlighted. Firstly, a certain lack of quality in participatory modelling was noted due to the complexity of its tool (the numeric model). Furthermore, some participants emphasised the lack of representativeness of the stakeholders present at the workshops, especially those described as "unconvinced" by the reduction of phytosanitary products (PP). Finally, the misalignment between participants' expectations and the workshop results highlighted the lack of concertation by the research committee (RC) with the participants in defining the workshop objectives and, more broadly, the objectives of the *TRAVERSéES* project. The participatory process then resembled a form of consultation rather than a form of concertation. The evaluation of the effects on participants revealed limited changes among participants in terms of knowledge acquisition, shifts in perception, and the implementation of new actions. The results showed a closer connection between the research world and the field, but a persistent difficulty for the RC in reconciling their research with the needs of the field.

Two proposals were formulated, taking into account the previously identified limits of the two participatory workshops. The first proposal involves the co-construction of a numeric model with

local stakeholders to tailor the tool to their needs and ensure their effective ownership of the tool. It would take the form of a one-year research project, supervised by a transdisciplinary CR, and would be carried out through two participatory workshops and training on how to use the numeric model. The second proposal also takes the form of a research project. It involves the co-construction of a research project where concertation with various stakeholders would take place prior to the project's writing, allowing for the collective definition of project objectives and methods.

While research projects like *TRAVERSéES* tend to embrace a participatory approach, they must continue to move towards concertation to fully harness the potential of this approach and contribute more significantly to the agroecological transition of all stakeholders.

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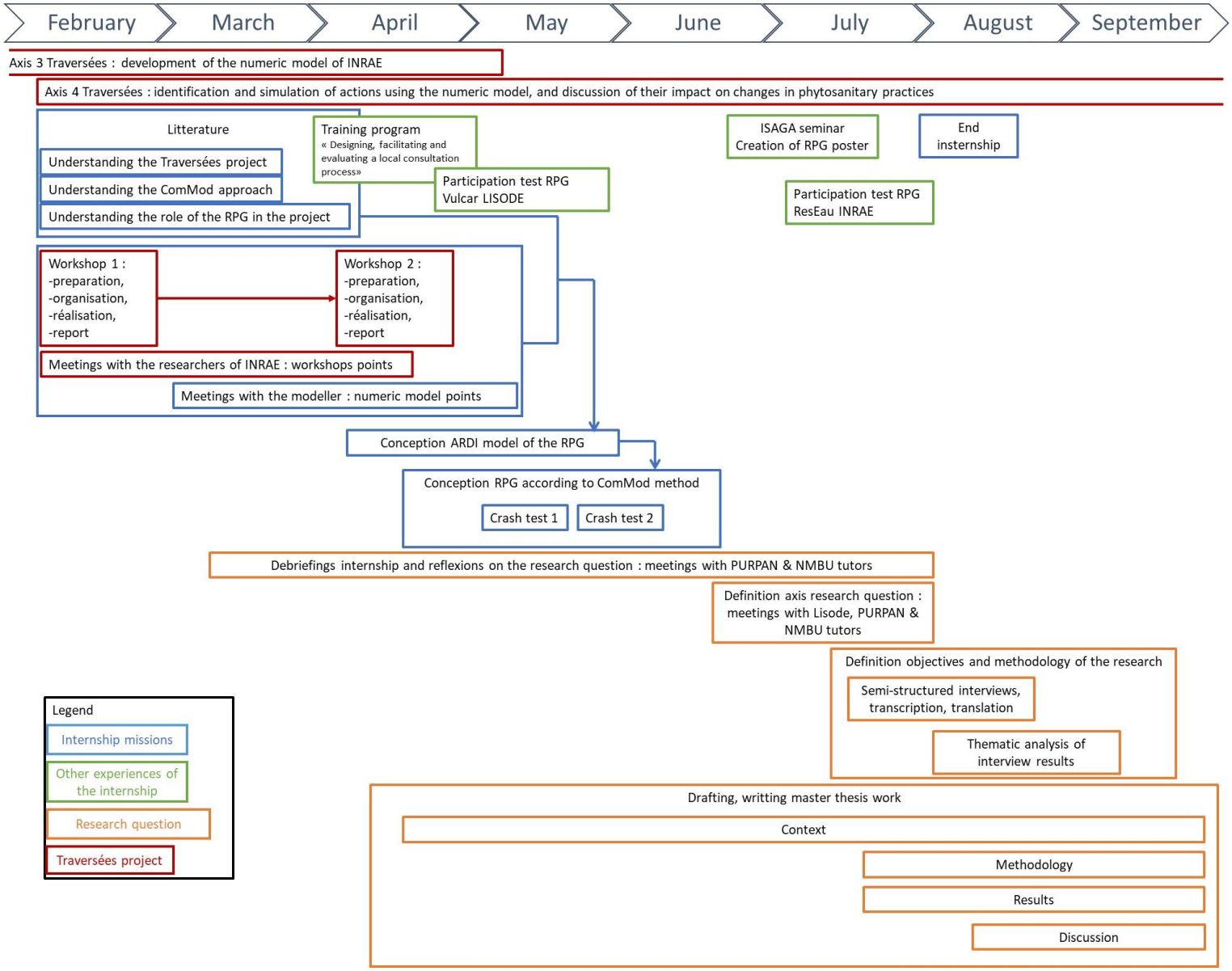
7 Appendices

Appendix 1 : (Adapted from) Arnstein citizen participation scale

Levels	Qualification	Definition
1	Manipulation	These levels presuppose a passive public to whom we provide information that may be partial and incomplete
2	Education	
3	Information	The public is informed about what is going to happen, what is happening and what has already happened
4	Consultation	The public has a voice but no power to have their views taken into account
5	Implication	Public opinion has some influence, but it is still those in power who take the decisions
6	Partnership	The public can begin to negotiate with decision-makers, including agreement on roles, responsibilities and levels of control
7	Delegation of powers	Partial delegation of powers
8	Citizens control	Total delegation of decision-making and action

Appendix 2 : Timeline of the internship and the study



Appendix 3 : Poster presented at the 54th ISAGA conference in La Rochelle

Role-Playing Games designed to characterize and discuss local and collective actions that impact the change of agricultural and phytosanitary practices in the Barrois (France)

Auteurs : Coraline Reynaud[1], Audrey Barbe[2], Jean-Emmanuel Rougier[3], Amélie Bourceret[4], Léa Grohens[5], Marie Pradeille[6], Faustine Honoré[7], Elliot Meunier[8], Corinne Robert[9]

[1, 2, 3, 5] Lisode, Montpellier, France ; [4] INRAE, Montpellier, France ; [6] Université Sciences et Lettre, Paris, France ; [7] UMR LADYSS, INRAE, Paris, France ; [8] UMR ECOSYS, INRAE, Paris, France ; [9] UMR ECOSYS, INRAE, Paris, France

1st Role-Playing Game : "La Traversées du Barrois"

Game objectives
Tool to explore the conditions of agricultural practice changes in the Barrois region

Identification of practice changes' conditions : past changes, reasons, ressources, ways

Type of game
Construction of the socio-agrosystem based on players' self-assessment, and identification of the factors of the socio-agrosystem evolution

Public
8 role-players : 7 farmers,
1 Professional Agricultural Organization

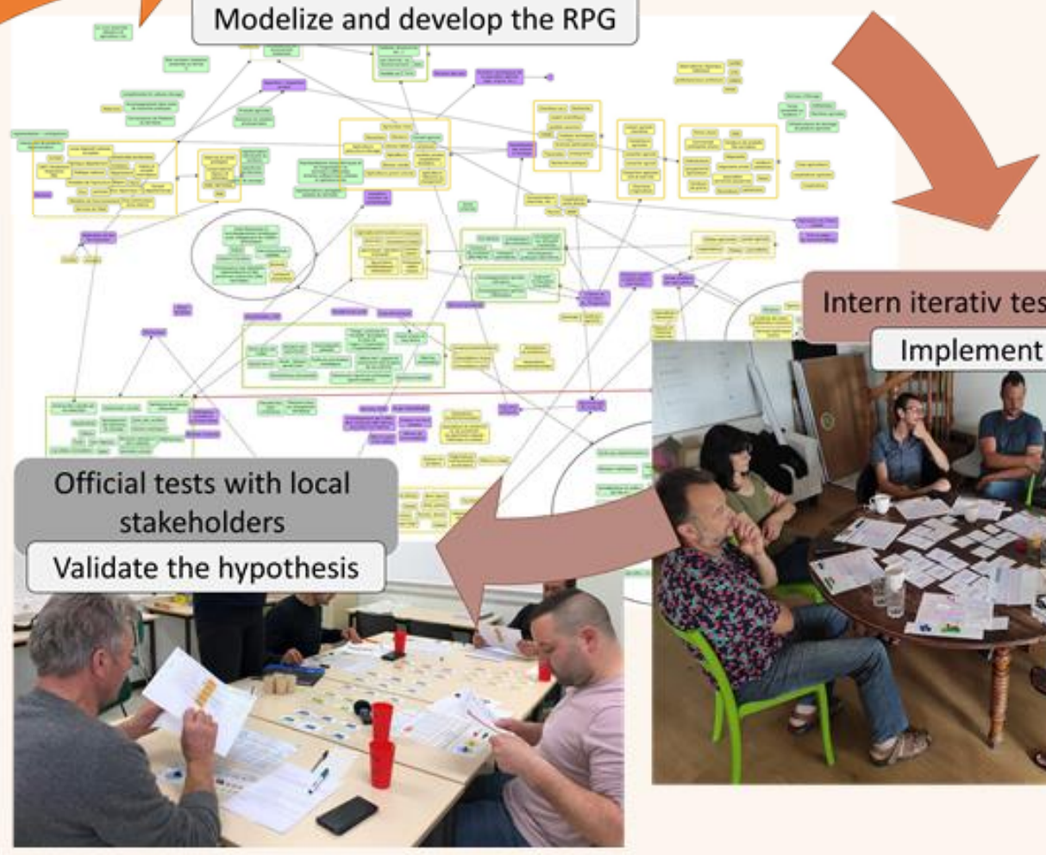
Conception's method

ARDI and ComMod methodologies

Modelize and develop the RPG

Exploratory and « card game » interviews, online surveys

Identify initial hypothesis



Official tests with local stakeholders

Validate the hypothesis

Intern iterativ tests of the RPG

Implement the RPG

Results
PAOs discussed on new strategies to strengthen their support for farmers in their practices change such as long-term support, technical exchanges on all types of productions, collective advice session, communication and coordination with other PAOs. Farmers identified other levers for their agroecological transition such as local markets opportunities, moderate investments, knowledge exchanges and mutual aid, transition of phytosanitary products' use (…)

2nd Role-Playing Game : "La Transition du Barrois"

Game objectives
Tool to characterize and discuss local and collective actions that impact the change of agricultural and phytosanitary practices in the Barrois region

Valorisation of these practice changes' conditions as levers for phytosanitary practice changes

Type of game
Simulation of disease impact on farmer's incomes, and identification of pathways towards pesticide's use reduction

Public
7 role-players : 6 farmers,
1 Professional Agricultural Organization

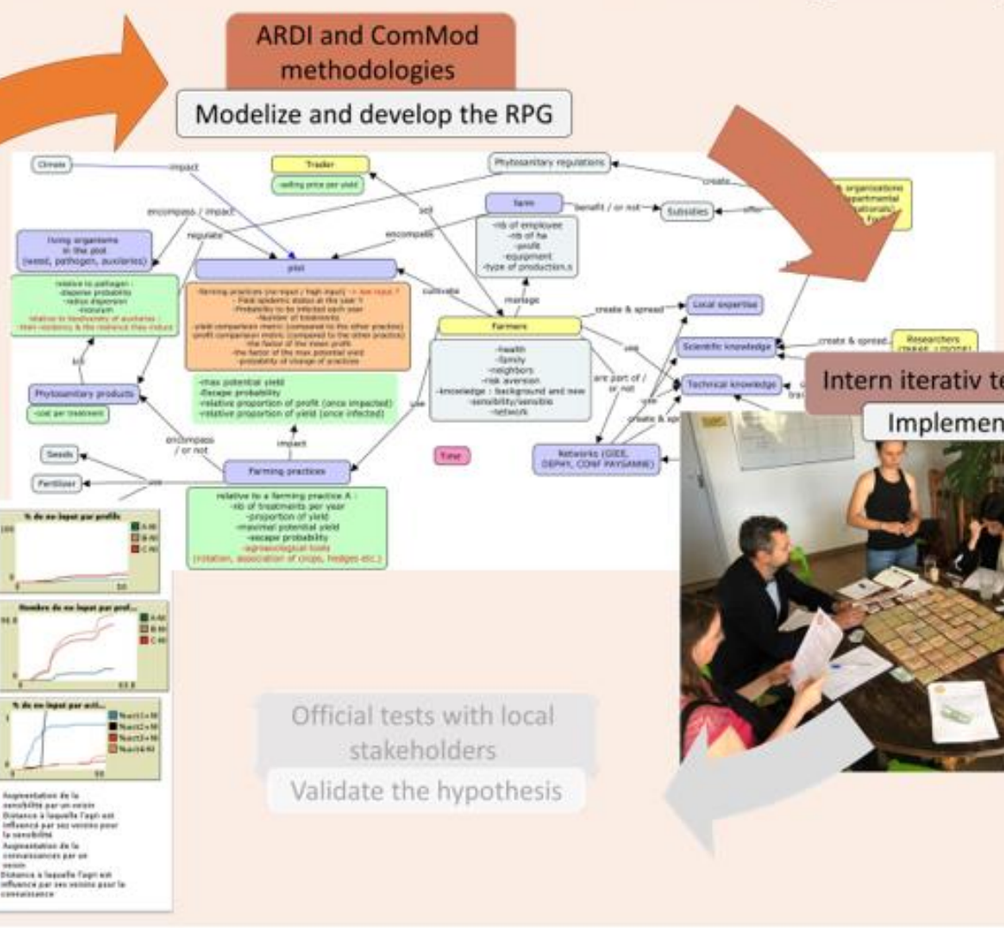
Conception's method

ARDI and ComMod methodologies

Modelize and develop the RPG

2 workshops
INRAE IT model

Identify initial hypothesis



Official tests with local stakeholders

Validate the hypothesis

Intern iterativ tests of the RPG

Implement the RPG

Appendix 4 : Identity and review of the participation of APO and farmers in the TRAVERSéES project and in the two workshops of axis 4

Identity	**Activity**	**Prior participation in the *TRAVERSéES* project**	**Participation in workshop 1 and/or 2 of axis 4**
APO 1	Head of Evaluation and Economic Studies, National Forest Park	Axis 1	Workshop 1
APO 2	Animator of Groupement of Organic Farmers of Haute-Marne	Axis 2	Workshop 2
APO 3	Teacher at Chaumont agricultural college	No	Workshop 1
APO 4	Retired breeder	Axis 1	Workshop 1 et 2
APO 5	Organic technician advisor of Chamber of Agriculture of Haute-Marne	No	Workshop 1 et 2
APO 6	Technician advisor, CUAE of Grand-Est region	No	Workshop 1 et 2
Farmer 1	Farmer, crops, HVE	No	Workshop 1 et 2
Farmer 2	Farmer, crops, livestock, methaniser, OA	No	Workshop 1 et 2
Farmer 3	Farmer, crops, CA	Axis 2 et 3	Workshop 1 et 2
Farmer 4	Farmer, crops, CA	Axis 1	Workshop 2
Farmer 5	Farmer, crops, OA	Axis 2	Workshop 1 et 2
Farmer 6	Farmer, crops, SCA	Axis 3	Workshop 1
Student 1	Student, agricultural sciences	No	Workshop 1
Student 2	Student, agricultural sciences	No	Workshop 2

Appendix 5 : Types of indicators assessed using the example of the workshop 1 end questionnaire

Anonymous evaluation of the workshop 1 on "Territorial actions to support changes in phytosanitary practices" - *TRAVERSéES* project - February 2023, Chaumont

To help us improve our processes, please answer the following questions

Legend:

- Participants' interest in the workshop
- Transparency
- Quality of results
- Acquisition of knowledge
- Quality of participatory modelling of knowledge
- Quality of animation
- Quality of interactions between participants

	Somewhat agree	Somewhat disagree	I do not know	If negative answer, please explain
The workshop was useful				
The objectives of the TRAVERSéES project are clear				
The objectives of using the numeric model in the project are clear				
The next stages of the project are clear				
Are the territorials actions detailed relevant to the Barrois area? If not, why not?				
The implementation of detailed territorials actions seems realistic for the region. Why is this?				
I learnt new things at this workshop				
The way we worked (facilitation/discussion) was effective				
The facilitator was neutral with regard to the content of the discussions				
I was able to express my ideas				

Recommandations :

……

……

Appendix 6 : Introduction to the interview guides used for interviews

Introduction of the interviewer, objectives, and interview conditions

As part of my final dissertation in the Master's program in Agroecology, I am seeking to evaluate the participatory process in which you have participated and its potential induced effects. To do so, I would like to interview various participants in the workshops, including yourself. During this interview, which will last approximately 1 hour, I will ask you a series of open-ended questions. My objective is to listen and record your responses without passing any judgment; your answers are entirely your own. In order to ensure that I do not miss any details from your responses, would you be willing to allow me to record our conversation? Once I have collected your responses and those of other participants, I will analyse them to address the research question of my dissertation, which I will be sure to share with you once it is completed.

Appendix 7 : Interview guide used for participants (farmers and APO)

Semi-structured interview guide for workshop participants (farmers and APO)

Date and hour:

1. Presentation of the interviewer, objectives, and conditions of the interview

2. Questions to the interviewee

Theme/Indicator		Questions
Presentation of the interviewee		- Can you tell me who you are in a few sentences? - Which workshops in the Traversées project did you take part in?
Evaluation of the participatory process	Quality of the participatory modelling	- What do you think of the participative approach of the workshops? - What were your motivations for taking part in the workshops? - What do you think of the way the workshops were organised? - What do you think of the numeric model presented and used?
	Representativeness	- What do you think of the panel of stakeholders present at the workshops?
	Animation quality	- What do you think of animation during the workshops?
	Adequacy between participants' expectations and the results of the workshop	- What do you think of the results of the workshops?
Evaluation of the induced effects	Knowledge acquisition	- What was the main thing you learned from the workshops? - What did you learn about ... ... the different people present at the workshops? ... the Barrois region/agricultural practices/phytosanitary issues? ... the levers of agroecological transition? ... the Traversées research project? ... participatory approach methods? ... the numeric model?
	Change in perception of other participants	- How did your perception of the farmers present at the workshops evolve following your participation in the workshops? - How did your perception of the APO present at the workshops evolve following your participation in the workshops? - How did your perception of the researchers present at the workshops evolve following your participation in the workshops? - How has your perception of participation in agroecological transition research projects changed as a result of your participation in the workshops? - How has your perception of the numeric model changed as a result of your participation in the workshops?
	Implementation of new actions	- Have you thought of any new action as a result of the workshops? - Have you changed your attitude in the way you undertake your work as a result of the workshops? - Did you change your attitude in your professional relationships as a result of the workshops? - Did you undertake any new action as a result of the workshops?
	Other effects	- Have you noticed any other effects or changes as a result of taking part in the workshops?

Appendix 8 : Interview guide used for the modeller

Semi-directive interview guide for the modeller of the numeric model (INRAE researcher)

Date and hour:

1. Presentation of the interviewer, objectives, and conditions of the interview

2. Questions to the interviewee

Theme/Indicator		Questions
Presentation of the interviewee		- Can you tell me who you are in a few sentences? - What is your role in the Traversées project? - What was your role in the two participatory workshops?
The Traversées project: construction and valorisation		- What results would you value at the end of the two workshops? How would you use them? - Are you aware of the prospects for the Traversées project?
Evaluation of the participatory	Quality of the participatory modelling	- What do you think of the participative approach of the workshops? - What do you think of the numeric model presented and used?
	Representativeness	- What do you think of the panel of stakeholders present at the workshops?
	Animation quality	- What do you think of animation during the workshops?
	Adequacy between participants' expectations and the results of the workshop	- What do you think of the results of the workshops? - What do you think the participants gained from the two workshops? In terms of knowledge? in terms of perception? in terms of action?
Evaluation of the induced effects	Knowledge acquisition	- What was the main thing you learned from the workshops? - What did you learn about ... ... the different people present at the workshops? ... the Barrois region/agricultural practices/phytosanitary issues? ... the levers of agroecological transition? ... the Traversées research project? ... participatory approach methods? ... the numeric model? - What did you learn from the workshops in developing the numeric model?
	Change in perception of other participants	- How did your perception of the farmers present at the workshops evolve following your participation in the workshops? - How did your perception of the APO present at the workshops evolve following your participation in the workshops? - How did your perception of the researchers present at the workshops evolve following your participation in the workshops? - How has your perception of participation in agroecological transition research projects changed as a result of your participation in the workshops? - How has your perception of the numeric model changed as a result of your participation in the workshops?
	Implementation of new actions	- Have you thought of any new action as a result of the workshops? - Have you changed your attitude in the way you undertake your work as a result of the workshops?

		- Did you change your attitude in your professional relationships as a result of the workshops? - Did you undertake any new action as a result of the workshops?
	Other effects	- Have you noticed any other effects or changes as a result of taking part in the workshops?

Appendix 9 : Interview guide used for the coordinator

Semi-directive interview guide for the coordinator of the TRAVERSéES project (INRAE researcher)

Date and hour:

1. Presentation of the interviewer, objectives, and conditions of the interview

2. Questions to the interviewee

Theme/Indicator		Questions
Presentation of the interviewee		- Can you tell me who you are in a few sentences? - What is your role in the Traversées project? - What was your role in the two participatory workshops?
The Traversées project: construction and valorisation		- How was the Traversées project developed? with whom else? - What results would you value at the end of the two workshops? How would you use them? - Are you aware of the prospects for the Traversées project?
The two participatory workshops: organisation, realisation and valorisation		- What are the final objectives of the workshops / concertation process? - What is its instrumental objective? - What is its social objective? - What is its democratic objective? - How was the participation process constructed? - What were the challenges in organising the workshops beforehand? - What were the challenges during the workshops? - What do you think now about the choices made by the RC beforehand regarding the organisation of the workshops? What would you change? - What do you think now about the choices made by the RC for the workshops? What would you change? - What issues do you see at stake in participation in research projects, particularly on the agroecological transition?
Evaluation of the participatory	Quality of the participatory modelling	- What do you think of the participative approach of the workshops? - What do you think of the numeric model presented and used?
	Representativeness	- What do you think of the panel of stakeholders present at the workshops?
	Animation quality	- What do you think of animation during the workshops?
	Adequacy between participants' expectations and the results of the workshop	- What do you think of the results of the workshops? - What do you think the participants gained from the two workshops? In terms of knowledge? in terms of perception? in terms of action?
Evaluation of the induced effects	Knowledge acquisition	- What was the main thing you learned from the workshops? - What did you learn about ... ... the different people present at the workshops? ... the Barrois region/agricultural practices/phytosanitary issues? ... the levers of agroecological transition? ... the Traversées research project? ... participatory approach methods? ... the numeric model?

		- What did you learn from the workshops in developing the numeric model?
	Change in perception of other participants	- How did your perception of the farmers present at the workshops evolve following your participation in the workshops? - How did your perception of the APO present at the workshops evolve following your participation in the workshops? - How did your perception of the researchers present at the workshops evolve following your participation in the workshops? - How has your perception of participation in agroecological transition research projects changed as a result of your participation in the workshops? - How has your perception of the numeric model changed as a result of your participation in the workshops?
	Implementation of new actions	- Have you thought of any new action as a result of the workshops? - Have you changed your attitude in the way you undertake your work as a result of the workshops? - Did you change your attitude in your professional relationships as a result of the workshops? - Did you undertake any new action as a result of the workshops?
	Other effects	- Have you noticed any other effects or changes as a result of taking part in the workshops?

Appendix 10 : Interview guide used for the facilitator

Semi-directive interview guide for the facilitator of the workshops (Lisode)

Date and hour:

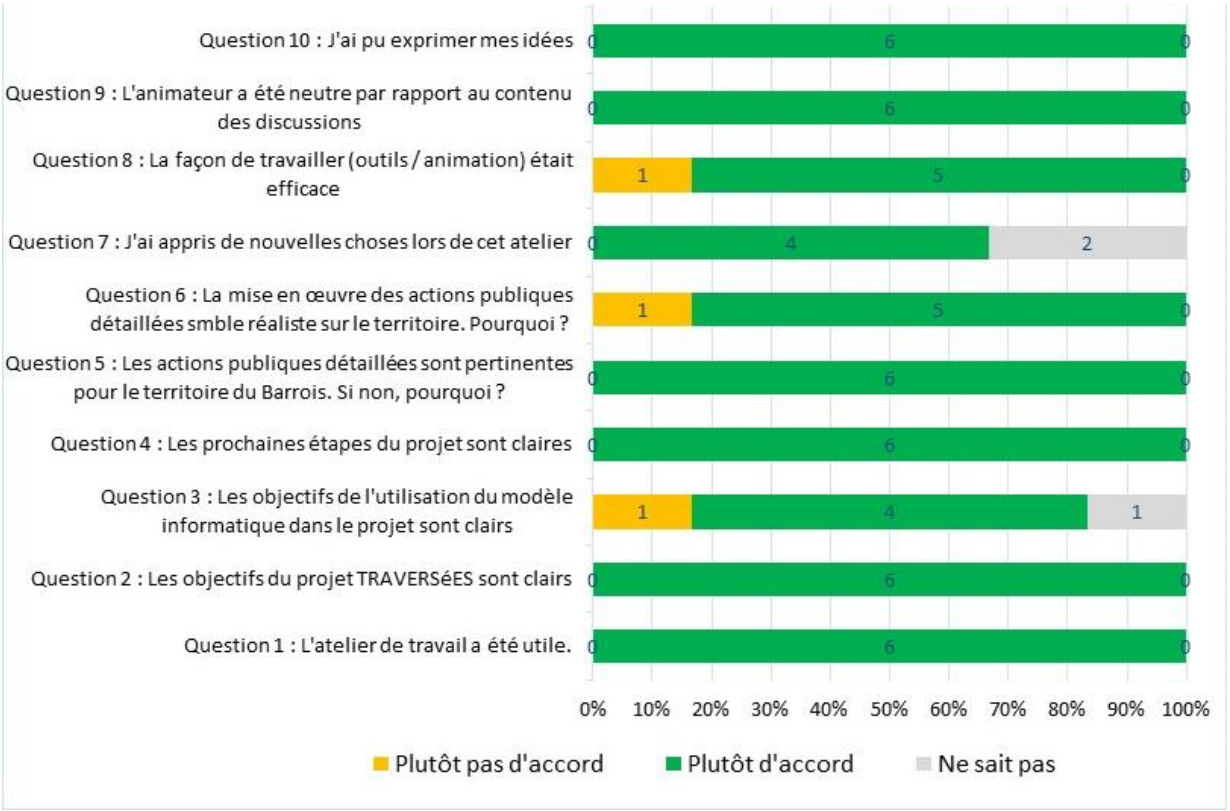
1. Presentation of the interviewer, objectives, and conditions of the interview

2. Questions to the interviewee

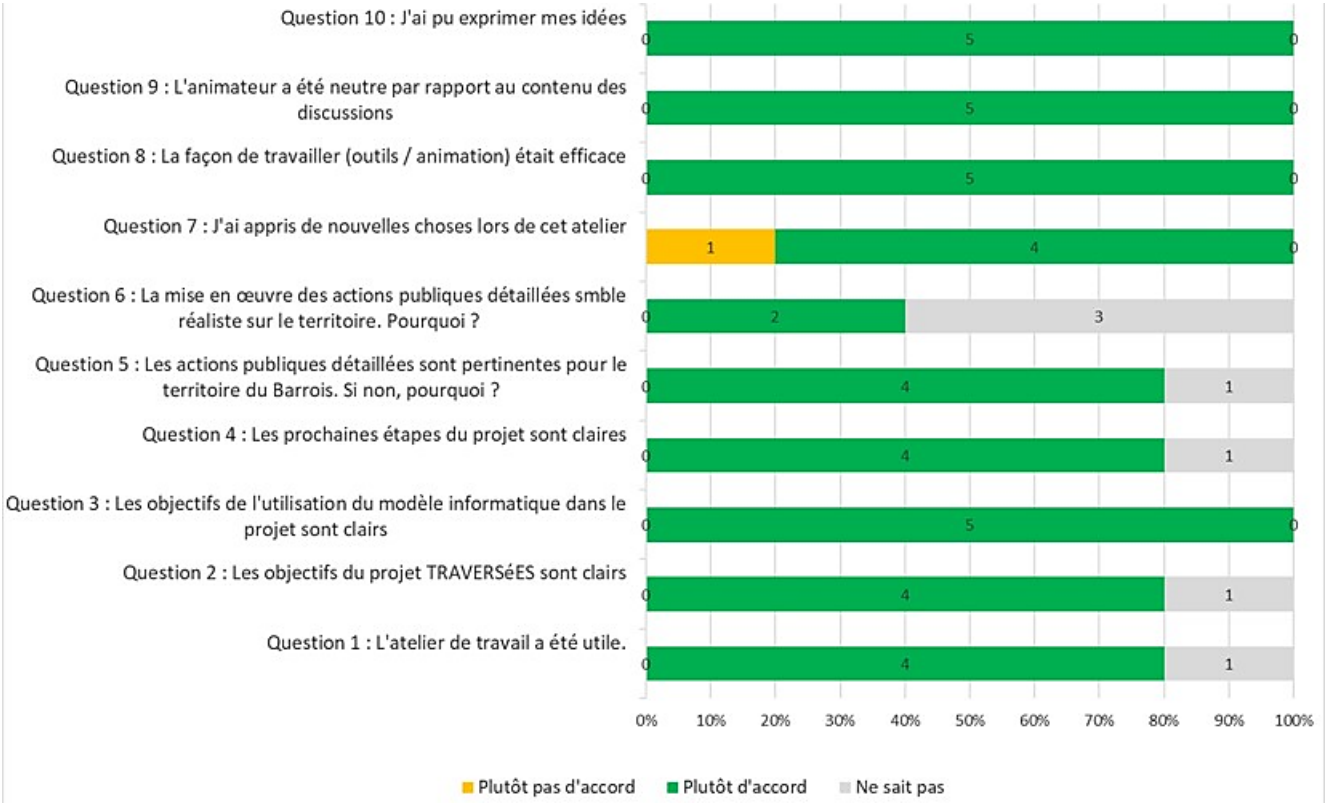
Theme/Indicator		Questions
Presentation of the interviewee		- Can you tell me who you are in a few sentences? - What is your role in the Traversées project? - What was your role in the two participatory workshops?
The Traversées project: construction and valorisation		- How was the Traversées project developed? with whom else? - What results would you value at the end of the two workshops? How would you use them? - Are you aware of the prospects for the Traversées project?
The two participatory workshops: organisation, realisation and valorisation		- What are the final objectives of the workshops / concertation process? - What is its instrumental objective? - What is its social objective? - What is its democratic objective? - How was the participation process constructed? - What were the challenges in organising the workshops beforehand? - What were the challenges during the workshops? - What do you think now about the choices made by the RC beforehand regarding the organisation of the workshops? What would you change? - What do you think now about the choices made by the RC for the workshops? What would you change? - What issues do you see at stake in participation in research projects, particularly on the agroecological transition?
Evaluation of the participatory	Quality of the participatory modelling	- What do you think of the participative approach of the workshops? - What do you think of the numeric model presented and used?
	Representativeness	- What do you think of the panel of stakeholders present at the workshops?
	Animation quality	- What do you think of animation during the workshops?
	Adequacy between participants' expectations and the results of the workshop	- What do you think of the results of the workshops? - What do you think the participants gained from the two workshops? In terms of knowledge? in terms of perception? in terms of action?

Appendix 11 : Results of workshop end questionnaires 1

1) Farmers' results



2) APO' results



Appendix 12 : Overview of the actions proposed at the two sessions of the workshop 1

Session	Category of Ideas	Actions proposed based on participants statements	Additional insights
Farmers	Sharing and exchanges among territory stakeholders (especially on practices)	Farmer-researcher networks.	To compare and align research findings with actual results from farmers in the field, ensuring fast and localized solutions.
		Rethinking the territory's ecosystem from individual plots to broader agroecological components like “land sparing – land sharing.” For instance, plot size, varied mixes...	
		Being listened to by the politicians in the agricultural world and those who implement rules without understanding the consequences.	
		Ending the culture of ignorance and fear.	Sharing knowledge and information (economic, experimental, etc.) allows farmers to understand everyone's experiences, the results obtained, and to consider new practices with possibly less apprehension. The CUMA (a type of cooperative) can act as a platform to unify farmers, arranging meetings or specific exchanges about pesticide practices.
		Freely share company information.	
		Be less individualistic and better share ideas.	
		Engage with CUMA.	
	Training	raining on the environmental and health risks of pesticides.	The Certiphyto training, for instance, is overly regulatory and lacks emphasis on pesticide risks.
		Long-duration trainings, especially for farmers not interested in agroecological transition.	Due to the loss of knowledge among farmers linked to technological advances and sales technicians, long-term trainings spanning years would benefit reflection and evolution of practices. Engaging farmers who are uninterested is a significant challenge for transition.
		Training for agricultural advisors.	There's a need to train increasingly younger advisors who lack experience. Advisors should have a

			supportive attitude, not an expert one, encouraging more lateral than top-down exchanges.
	Valorisation	Better valorize the production of new crops (create channels) to extend rotations.	
APO	Sharing and Exchanges Among Farmers	How can they be enticed to participate in exchanges? Meals, Games, Cooperative games.	Several challenges were noted: Engaging uninterested farmers, transitioning for large-scale farms, and the influence of peers and neighbors. Knowledge sharing can be effectively promoted through farmer groups, as evidenced by APO's experience in CUMA or the DEPHY network. There's also a concept of exchanges between farmers and non-farmers through a citizen convention, allowing different perspectives to be shared and providing a comprehensive view of the issue.
		Increasing opportunities for farmers and non-farmers to speak out and engage in discussions on the topic.	
		Sharing experiences among farmers (new crops, practices).	
		Database of documented experiments accessible to all.	
	Agricultural Practices	Greatly extend crop rotations that include pastures.	Rotations need to be extended, and there's a necessity for introducing cover crops and agroforestry practices to promote beneficial organisms. Establishing markets for the crops grown through these practices is essential for the longevity of these practices.
		Agroforestry, trees-hedges-grassed strips to favor auxiliaries.	
	Valorisation	Creation of marketing channels	
	Financing	Funds dedicated to purchasing equipment for new practices + financing for usage training.	Medium to long-term financial assistance is required. A case in point is the inconsistency in financing equipment without financing its usage training. Assistance could be structured as compensation for "services provided".
		Financial aids with "result obligations".	
	Others	Visualize scenarios of the consequences of not changing.	The aim is to influence all stakeholders, especially those resistant to change or those wielding significant influence in the region.

Appendix 13 : Description of the action "Creation of a sector: ‘Barrois protein’" by the APO of workshop 1

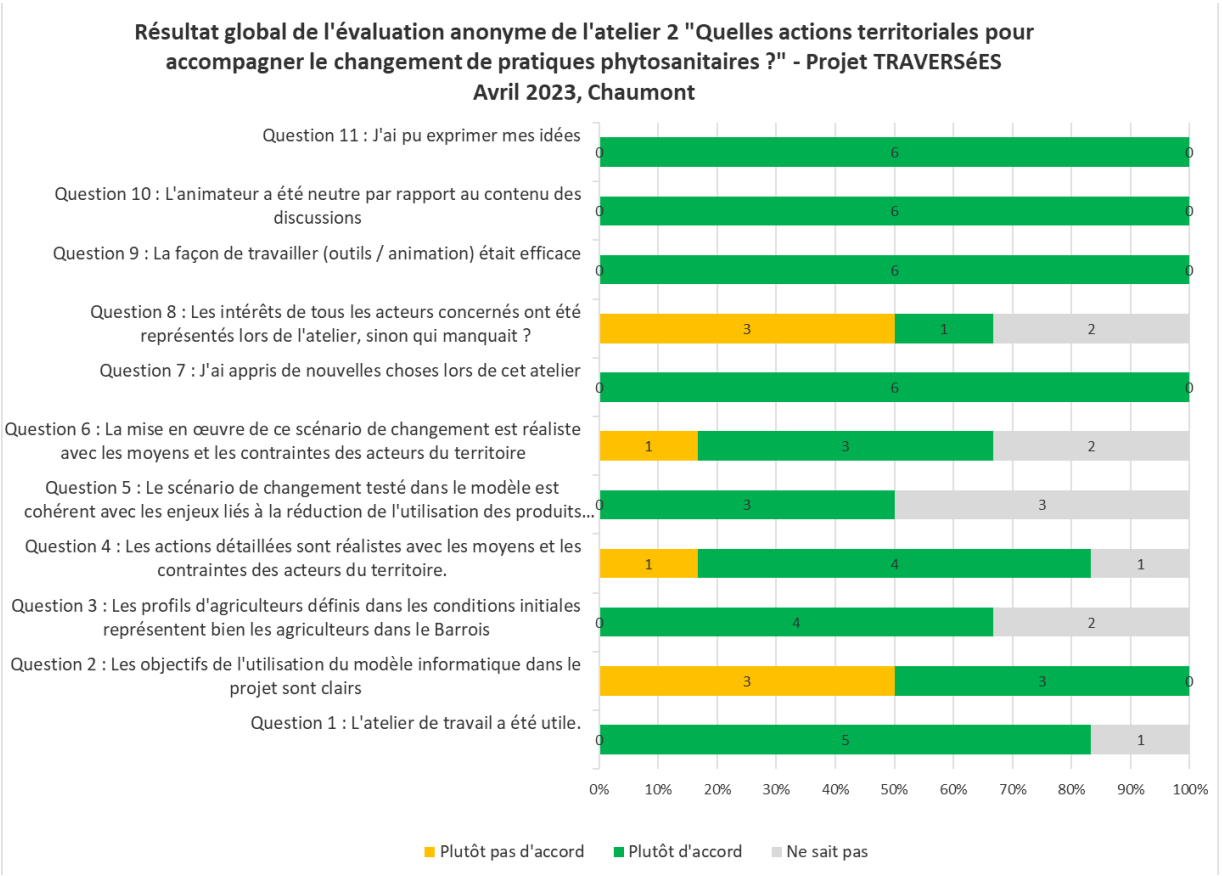
Description of the action	Effect of the action, why ?	Origin/Driving force of the action
Establishment of a supply chain: the protein of Barrois Collective and local organization of the chain (including with local breeders)	Respond to a demand for local and ethical consumption Promote local industries for organic and non-organic farmers, pig breeders New slaughterhouse Variety of animals/animal nutrition	Renovation project for a slaughterhouse already underway: supported by the Departmental Council Allows for an increase in product volume Territorial products Difficulty in valuing organic farmer's harvest Initiative by the Chamber of Agriculture: multi-stakeholder reflection (OS, canteens, etc.), promoting organic farming.
Implementation Where? When?	**Funding & Means**	**Implementation With whom?**
Initial diagnosis Possibility to enter/exit	Territorial Food Project: inter-community, leading structures? Farmers, a collective as a “SCOP” or other to produce and sell	Collective catering structures Everyone who needs proteins: breeders, canteens, retirement homes Support the Chamber of Agriculture (CA) Associations, collective of farmers, GIEE?
Feasibility (territorial scale)	**Limitations**	**"Sustainability"**
	Possibility to buy organic / organic prices during inflation periods Volumes: sufficient threshold for profitability Multiplicity of animals -> multiplicity of crops “Competition” effect if only one protein type	Profitability after a few years.

Appendix 14 : Description of the action "Promote knowledge sharing among the 'unconcerned' farmers" by the farmers of workshop 1.

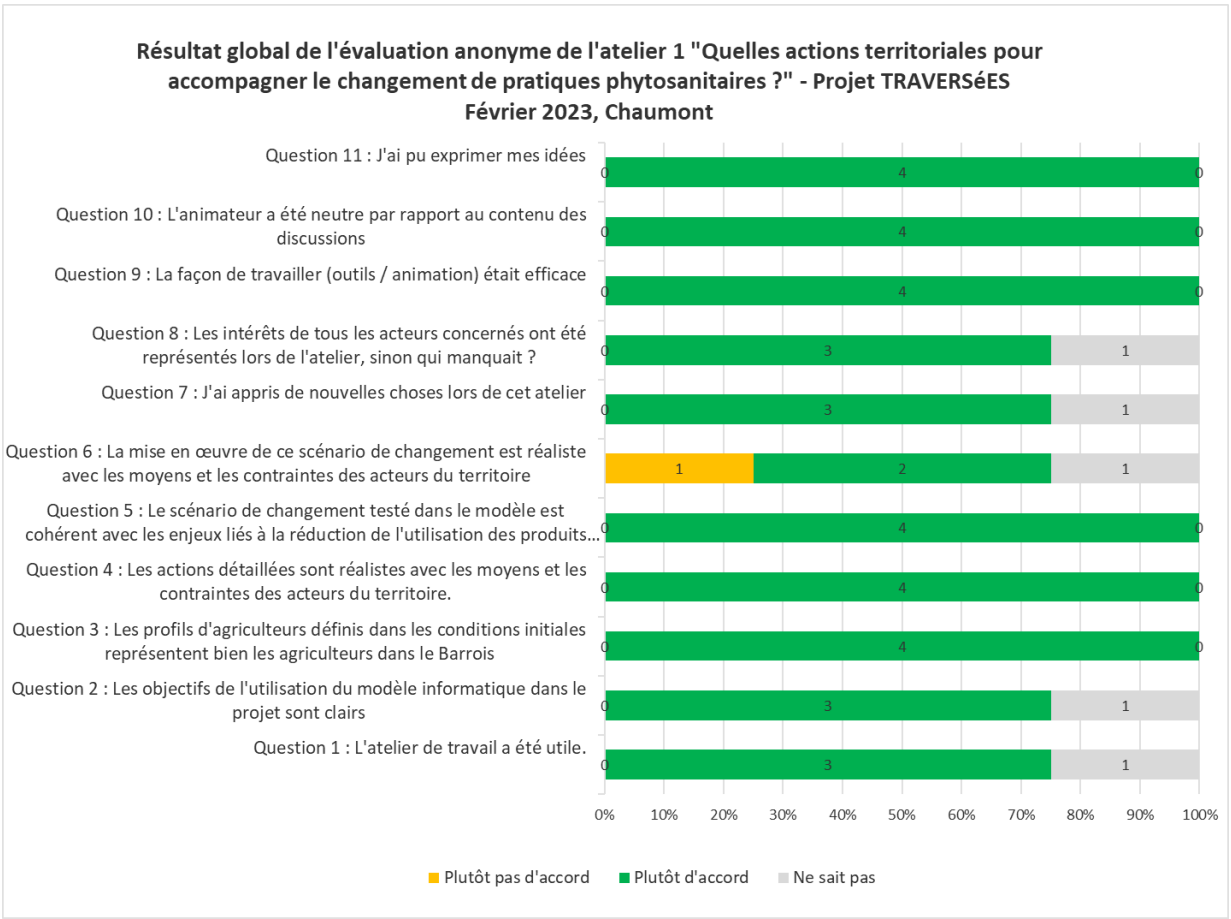
Description of the action	**Effect of the action, why ?**	**Origin/Driving force of the action**
Promote knowledge sharing among "non-concerned" farmers	Show how to finance the "potential shortfall" Different effects between younger generations and those nearing retirement For young people who are (going to) set up For school children For farmers close to retirement	Driven by the CA (neutral regarding phyto) Need to have funding for > 5 years secured.
Implementation Where? When?	**Funding & Means**	**Implementation with whom?**
Bring in external speakers who can "make an impression" Take advantage of agricultural events, fairs, AGMs, … Create events: screening debates Repetitions Visits to pilot farms, reconnect with advisers	Long-term resources (>5 years) SDDEA and AE Direct funding to the farmer Interest in research tax credit To be coupled with a mandatory training scheme when setting up Significant communication needs	To be done with all field people (advisers, cooperatives, ...) Feedback from vegetable growers, fruit growers, ... "Force" phyto sales companies to provide neutral information on these products -> bio-control transition.
Feasibility (territorial scale)	**Limitations**	**"Sustainability"**
Focus on soil type homogeneity, pedoclimatic conditions Smaller than a department National actions (trainings, regulations)	/!\ means to ensure a "group effect" and sustained dynamics /!\ not to criticize systems Family pressure for young people setting up Desire/capacity for change when nearing retirement	Long-term means are needed, otherwise it stops.

Appendix 15 : Results of workshop end questionnaires 2

1) Farmers' results



2) APO' results



Appendix 16 : Analysis of keywords mentioned by the interviewees

Evaluation	Indicator	Theme	Termes	Stakeholders
Participatory processus	1. Quality of participative modeling: the results	The participative and multidisciplinary approach of workshops	*"really important," "interesting," "useful," "communicate," "feel heard," "co-construction," "a questioning of research and farmers to identify solutions to issues," "bringing networks closer together."*	5 farmers 5 APO 2 researchers
		The presentation and setting of the numeric model	*“satisfactory”*	1 APO
		Topics of discussion that lead to new insights	*“interesting," "leaving room for their imagination"*	facilitator
		The effective organization of workshop sessions	*« fast », « dynamic »*	3 APO 3 farmers
		Communication of the results	*"Continuing certain reflections”*	1 APO
	1. Quality of participative modeling: the limits	The complexity of the digital model and its presentation	*"incomprehensible," "hyper complex," "abstract," "small squares," "complete disconnect between research and the field"*	5 farmers 4 APO
		Limited time and interactions	*“It was so packed, so dense, that I didn't retain anything," "I had the impression that you were intervening in a professional environment that you didn't fully know," "the names, email addresses, or phone numbers"*	3 farmers
		The lack of adaptation in communicating results	*« too long »*	2 farmers
		The sometimes delicate communication between the two partners	*« delicate »*	facilitator
	2. The quality of workshop		*"important," "essential," "everyone," "listening," "respected," "courteous,"*	5 farmers 5 APO 2 researchers

	facilitation: the results		*"non-judgmental," "no bias," "transparent"*	
	3. The representativeness of participants attending the workshops: the results		*« diversity of profils »*	2 researchers
	3. The representativeness of participants attending the workshops: the limits		*“ It's work for nothing," "already convinced"*	4 farmers 2 APO coordinator
	4. The inadequacies between participants' expectations and the results of the workshops	The utility of the MN	*"the workshops did not allow us to reconcile your expectations and mine. I did not find a construction that was sufficiently attentive to economic and environmental problems," "What can you do with it in the field?" "Complete disconnect between research and on-the-ground needs," "need for support," "need for medium/long-term financial assistance"*	5 farmers 4 APO
		Topics of discussion in the workshops	*“lines of thought," "there are already decades"*	3 farmers
Effets du processus participatif induits sur participants	1. Knowledge acquisition: the results	The participatory methodology	*« challenges », « tools »*	Modeller 1 APO
		The stakeholders and the functioning of the territory	*« news opinions »,*	2 farmers « using PP »
		Modelling	*« work », « I understood that it was a simplification of reality, that one should not expect it to perfectly reflect reality », « what can be done in participatory modeling workshops, what can be done with the model, to present the model».*	2 APO 1 farmers 2 researchers
		Territorial actions for agroecological transition	*« Farmer-scientist networks », « the agroecological transition*	3 farmers 1 APO

			presents not only technical challenges»	
	1. Knowledge acquisition: the limits		*« (Not) useful», « technical »*	5 farmers 5 APO
	2. The evolution of perception regarding other participants: the results	Farmers « using PP »	*« The diversity of farmers present», « efforts», « priorities», «questioning my practices»*	2 farmers « using PP »
		APO	*« Changes occur based on the individual, their beliefs, and their motivations »*	1 APO
	2. The evolution of perception regarding other participants: the limits	APO	*« Keys», « neutral », « become their own advisor»*	5 farmers
		Researchers	*« distant », «transmission between both ends of the chain», « ground-level advancements », « scientific, structured, and serious», « fundamental», « best choices »*	5 farmers

Appendix 17 : Proposal for an end-of-workshop evaluation protocol based on the Most Significant Change (MSC) method

It can be envisaged that the facilitator invites the different participants (including researchers) to sit on U-shaped chairs, facing a board, for example.

The facilitator could start by explaining the purpose of this final workshop step: 'We would like to evaluate this workshop, more precisely to find out if, as a result of this workshop, you have experienced or observed any significant changes. This could be related, for example, to knowledge acquisition, perception of roles, changes in behaviour or practices, etc.

There will be an individual reflection time followed by a plenary sharing session. The facilitator could reiterate the question by writing it on the board: 'Following this workshop, have you experienced or observed any changes?'

He could then distribute pens and cards of different colours to all participants, with each card having a different change written on it. For example, it could be written at the top of a yellow card 'knowledge acquisition,' on a blue card 'perception of other actors,' and on a green card 'change in behaviour or practices.'

Next, the facilitator could instruct the participants, 'Choose the card that represents the most significant change you have experienced or observed as a result of this workshop. Then, describe the change briefly below the title, starting by indicating whether it is positive or negative. If none of the options match your idea, you can choose the blank white card and write your own experience or observation on it.'

The facilitator would wait for each participant to finish before initiating the plenary sharing: 'Now that everyone has finished, you can take turns showing the card you have chosen and explaining what you have written.'

After their narratives, the facilitator could invite the participants to choose, in a plenary session, the experiences or observations deemed most relevant in each of the considered domains through a show of hands vote. The final choices will then serve as specific points that the research team should take into account for the next steps of the process.