Designing Innovative Management for Cultivated Biodiversity: Lessons from a Pioneering Collaboration between French Farmers, Facilitators and Researchers around Participatory Bread Wheat Breeding

Elsa E. Berthet, Sara Bosshardt, Lise Malicet-Chebbah, Gaëlle van Frank, Benoit Weil, Blanche Segrestin, Pierre Riviere, Léa Bernard, Elodie Baritaux, Isabelle Goldringer

sustainability

Article

Designing Innovative Management for Cultivated Biodiversity: Lessons from a Pioneering Collaboration between French Farmers, Facilitators and Researchers around Participatory Bread Wheat Breeding

Elsa T. Berthet [1,*], Sara Bosshardt [2], Lise Malicet-Chebbah [2], Gaëlle van Frank [2], Benoit Weil [3], Blanche Segrestin [3], Pierre Rivière [4], Léa Bernard [4], Elodie Baritaux [4] and Isabelle Goldringer [2]

1 Université Paris-Saclay, INRAE, AgroParisTech, UMR SADAPT, F-75231 Paris, France
2 Université Paris-Saclay, INRAE, Université Paris-Sud, CNRS, AgroParisTech, UMR GQE—Le Moulon, F-91190 Gif-sur-Yvette, France; bosshard@clipper.ens.fr (S.B.); lise.malicet-chebbah@supagro.fr (L.M.-C.); gaelle.van-frank@inrae.fr (G.v.F.); isabelle.goldringer@inrae.fr (I.G.)
3 Center for Management Science, i3 UMR CNRS 9217, Mines ParisTech, PSL ResearchUniversity, F-75272 Paris, France; benoit.weil@mines-paristech.fr (B.W.); blanche.segrestin@mines-paristech.fr (B.S.)
4 Réseau Semences Paysannes, F-47190 Aiguillon, France; pamriviere@protonmail.com (P.R.); semences@ardear-aura.fr (L.B.); elodie.baritaux@ardearcentre.org (E.B.)
* Correspondence: elsa.berthet@inrae.fr

Received: 29 November 2019; Accepted: 7 January 2020; Published: 14 January 2020

Abstract: The industrialization of farming has significantly threatened cultivated biodiversity. Participatory breeding endeavours to overcome this issue by enabling farmers to select a wide range of crop varieties in different conditions, and to foster genetic mixing through seed exchanges, crosses or mixtures. This necessitates the design of new forms of coordination and organization for the farmers and partners involved. This article reports on an ongoing initiative, aiming to facilitate the participatory design of such forms of coordination and organization. It first outlines the method used (Knowledge–Concept–Proposals or KCP®), and how it has been tailored to this highly decentralized context involving politically engaged actors on a quest for autonomy. It then presents the exploratory results of the first two workshops: these include group consolidation, the sharing of heterogeneous knowledge, the generation of innovative ideas, and the elaboration of preliminary projects. Finally, this empirical case is compared with other initiatives supporting the participatory design of natural resource management strategies and tools. Its key original dimensions and benefits are that the workshop protocol is replicable, the data produced can be easily exploited, and it allows for testing hypotheses in the field of design science.

Keywords: participatory plant breeding; farmers' population-varieties; innovative design; dynamic on-farm management; agrobiodiversity; design workshops; participatory research

1. Introduction

1.1. Context of the Study: A Pioneering Initiative to Regenerate Cultivated Biodiversity

Since the domestication of wheat about 10,000 years ago, humans had selected seeds mainly through mass selection [1]. This method involves farmers selecting individual plants from a heterogeneous population on the basis of desirable characteristics, then pooling their seeds and using them to grow the next generation. The majority of cereals grown were thus made up of *population varieties*, that is, heterogeneous populations locally adapted by farmers. Hence, over the centuries, farmers maintained a high level of cultivated biodiversity and adapted their crops to both their farming strategies and environment.

In France, however, as in many other countries worldwide, from the late 19th century, crop improvement started to be professionalized with the creation of major breeding companies [2]. The system whereby farmers bred and managed genetic diversity on farms was gradually replaced with a clear division of labour: crop genetic diversity came to be managed mainly through static ex situ conservation in gene banks and with "elite" homogeneous varieties created by plant breeders, while farmers became end-users of such innovations. Nowadays, crop selection is centralized and seeks to develop varieties showing high potential in environments where the growing conditions are standardized through the use of chemical inputs [3]. Distinction, uniformity and stability (DUS) are considered crucial criteria for supporting the modernization of farming and the development of the agri-food industry.

This innovation regime has not only excluded population varieties from research, the market and agricultural production sites, as these heterogeneous varieties do not comply with the DUS criteria governing registration in the official seed catalogue and therefore seed marketing, but also excluded farmers from the breeding process [4]. This situation has largely contributed to a worldwide reduction of cultivated diversity in agriculture [5,6], leading to greater vulnerability in global crop production [7].

Agricultural industrialization has contributed to both environmental and social crises through the expansion, intensification and specialization of farms, and also through farmers' loss of autonomy. As a result, alternative approaches have emerged to promote more sustainable and fairer agricultural models. Decentralized on-farm crop breeding, although still marginal in Europe and the USA, has been attracting renewed interest since the 1980s, and especially since the early 2000s. Initiatives involving "alternative" farmers, amateurs, gardeners and consumers have been launched to promote a cultivated biodiversity better suited to the variety of agro-ecological systems that exist. These initiatives have a lot in common with so-called traditional agricultural systems. They are based on the reproduction and selection of genetically heterogeneous populations on farms, therefore allowing for a continuous evolution and adaptation of the populations in response to both natural selection and selection by farmers. Moreover, seed exchanges among actors ensure the large-scale and long-term maintenance of genetic diversity. These populations of cultivated species managed within collectives or networks of actors have been referred to as *crop metapopulations* [8,9].

In France, in 2003, pioneering actors of participatory breeding joined forces to found the farmer seed network *Réseau Semences Paysannes* (RSP). This network now includes about 90 organizations. It is organized into species-based groups, as well as transversal groups in charge of sanitary or legal questions, for instance. The working group on wheat and small grains is particularly active. In 2006, farmers and actors from different RSP organizations involved in wheat growing, milling and baking, facilitators from these organizations and RSP, as well as researchers from INRAE's Diversity, Evolution and Adaptation of Populations (DEAP) team, launched a research programme for the participatory breeding of bread wheat.

The initial objective of this collaboration between the RSP group and the DEAP research team was to develop a methodology for selection and evolutionary management, based on decentralization and co-construction by farmers and researchers. This methodology aimed to (i) foster the creation of population varieties suited to local conditions and farmers' practices, (ii) develop operational methods and tools for on-farm diversity management and selection, and (iii) support actors' learning and strengthen their autonomy in seed management and selection [10,11]. Over the years, a series of different research programmes has allowed for the development of experimental frameworks tailored to small-scale on-farm trials, of statistical methods to analyze them, and of tools to implement them [12,13]. Furthermore, many population varieties have been created and are now grown for production in farmers' fields. Finally, tools and methods to organize the collective management of seeds by farmers have also been developed.

In recent years, thanks to growing interest in farmers' seed autonomy and decentralized participatory breeding, the number of RSP member organizations and participating farmers has grown considerably [14]. The network has started to face new challenges associated with new needs: supporting newcomers, exploiting and disseminating a large body of knowledge and skills to a growing number of actors, overcoming new kinds of risk (for instance, surrounding production, the law, property rights, etc.). Issues around collective action (how to coordinate the maintenance of genetic diversity, how to avoid free riding, etc.) have also become increasingly salient. Moreover, farmers are seeking to develop new practices, such as mixtures of wheat populations that raise new seed management issues.

1.2. The Challenge of Decentralizing the Management of Agricultural Biodiversity

The decentralization movement witnessed in the field of crop breeding echoes the growing interest in decentralizing natural resource management (NRM). Many scholars have stressed that the failure of approaches, based on the centralized allocation of resources between potential users or on end-of-pipe solutions, is mostly due to the complex and adaptive nature of socio-ecological systems [15,16]. They have also identified approaches involving local users as often more suitable and sustainable than those relying mainly on expert knowledge [17–20].

Furthermore, although the NRM literature tends to posit resources as a given, and actions to manage them as a known variable, this field is often confronted with a multiplicity of questions and challenges, concerning the nature of these resources, their management, the organization of stakeholders, the changing context, etc. [21]. In the specific case of crop varieties, the latters' identity as a resource has been called into question: they are no longer homogeneous elite varieties for which the environment is standardized, but mixtures of varieties adapted to specific production conditions. Hence, managing population varieties raises new issues, to do with evolutionary processes, for example, but also with organization and coordination (for instance for the management of crop metapopulations). Beyond its complexity, the management of cultivated biodiversity must contend with many unknowns [22] and unpredictability, such as the behavior of a variety mixture on the middle-term. It thus seems particularly relevant to involve stakeholders, not only to leverage their experience to identify the most appropriate management and collective action strategies, but also because including different stakeholders' knowledge in a structured way helps to unleash creativity and to design new solutions ([23] quoted by [24]).

Attention has therefore been directed at approaches with multiple actors involved in NRM design processes to varying degrees. However, empirical and scientific evidence suggests that joint natural resource management and governance processes are often difficult to achieve in practice (see for example [17,25,26]. Such decentralized approaches operate on the assumption that actors agree on common rules and practices, engage in conflict resolution, share information, and coordinate usage [20,27]. Scholars have stressed the limits of existing methods for facilitating participation (see for example [25,28]). First, such methods generally do not include stakeholders in all stages of the process [29]. Second, they are often considered inadequate for making efficient use of the participants' time and effectively achieving objectives [30]. Third, the credibility of participatory approaches can suffer if decisions are rejected by a higher-level decision-making entity or if the participants do not have sufficient expertise to meaningfully engage in the technical debates [25]. Finally, the outcomes of such approaches may not be lasting, especially when the processes involved are not appropriated by stakeholders or not institutionalized [25].

Most participatory methods primarily focus on dialogue and communication as the keys to better collaboration between stakeholders [31]. They are particularly concerned with the issues associated with collective problem farming, which is often seen as a prerequisite to the successful implementation of a collaborative process [32]; with social learning [33]; and with power asymmetries and conflicts between stakeholders [34]. Yet, in the case of participatory wheat breeding in France, conflict resolution and collective problem farming were not so much of an issue as fostering social learning and designing new solutions to enhance interactions between participatory breeding stakeholders. While most participatory approaches endeavour to involve stakeholders in the process of deciding between different options, design approaches focus rather on the generation of new options [24,35].

In line with research focused on developing participatory design methods in the field of natural resource management (see for instance [24,36,37]), researchers on the INRAE DEAP team, in partnership with a design science researcher (INRAE SADAPT team), proposed to adapt and apply a collective design method to the specific context of participatory wheat breeding. This initiative was launched in response to the partners' call for new approaches that would allow the research team to support local collectives in mobilizing knowledge to design wheat mixture selection and management methods tailored to their specific context. This request was formulated following recent findings from the evaluation of on-farm wheat mixture selection methods [38]. The main goal was to co-design highly concrete and operational methods for the design and management of population mixtures over time that were tailored to local contexts and farmers' objectives. The proposed approach had to incorporate the very strong collective dimension of the management of cultivated diversity.

After presenting how the design methodology was adapted to the specific case of participatory wheat breeding in France, we present the preliminary findings of this ongoing research. We discuss these in relation to the literature on participatory design methods for supporting NRM decentralization and innovation. This research highlights that the results of the first applications of the collective design method to this context are very encouraging, particularly pointing to the participants' strong engagement in the workshop activities, positive feedback about the knowledge sharing stage, and project ideas that seem interesting for the actors. Furthermore, an interesting and novel aspect of this method is that as well as supporting the collective design process, it allows the research team to raise and study new research questions in both genetics and design science.

2. Materials and Methods

In order to meet the actors' expectations of both enhanced social learning and the design of new tools, methods and strategies for managing cultivated biodiversity, the researchers proposed to apply a collective design method. From the range of existing methods (see [24,35]), they chose the KCP® (Knowledge–Concept–Proposals) method [39,40]. This collective design method seemed particularly suitable: first, it was designed to lead a large group to collectively build an innovation strategy; and second, it relies on collective design workshops that foster knowledge sharing, the identification of knowledge gaps, and the exploration of innovative ideas.

The KCP® method draws on the Concept–Knowledge (CK) theory [41,42], one of the most recent design theories. According to this theory, a design process starts with a *concept*, a proposal that is partly unknown but imaginable. A concept is considered "non-observable" insofar as one does not know whether it exists, but it is "desirable" by virtue of at least one desirable property. The objective of the design process is to generate at least one object with this desirable property. The theory distinguishes between two spaces: the space of concepts and the space of knowledge (see Figure 1). These two spaces grow together: formulating a new concept leads to seeking new knowledge, which can result in the formulation of another new concept, and so on.

As in other agricultural contexts where the KCP® method was applied, the ongoing design process, applied to participatory wheat breeding, works with farmers' time constraints. However, the present KCP® protocol differs from previous ones due to the decentralized nature of participatory breeding: a generic protocol for a one-day workshop is replicated in different areas where farmer collectives are interested in getting involved. So far, two workshops have been organized: one in central France in May 2019 with 18 participants (including the workshop's organizing team), and another in the Rhone-Alpes region of France in July 2019 with 33 participants. Both took place on a farm. Other workshops are planned in other areas of France in the coming months.

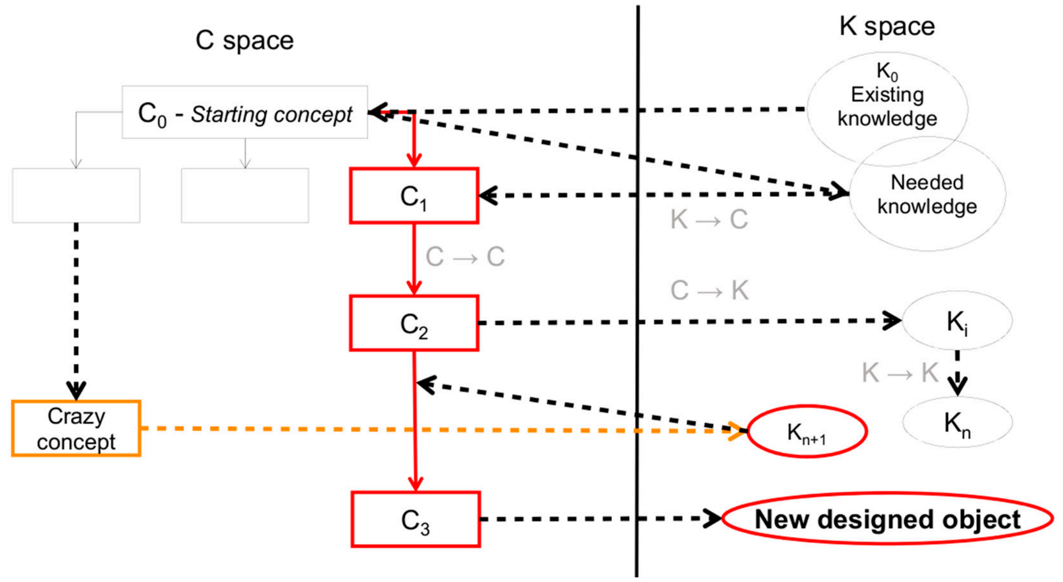

Figure 1. Schematic representation of the CK (Concept–Knowledge) theory. The two spaces are linked by operators (C→K, K→K, C→C, K→C). The path highlighted in red leads to the design of a new object.

Each workshop focuses on the design of "a participatory method for the on-farm selection and management of wheat mixtures", so as to be concrete enough to engage the participants in the design process, while steering them to think of useful generic tools, methods and strategies for the development of participatory breeding and the collective management of agrobiodiversity.

The team organizing the design process was comprised of a design science researcher (an expert in the KCP® method), two genetics researchers involved in the participatory wheat breeding project for several years (experts in the field), two successive trainees in both fields (design and participatory breeding), and two RSP national facilitators (also experts in the field). Furthermore, each workshop was co-organized with the facilitator(s) of the local group concerned. The local facilitators provided knowledge of the local context, thus allowing for the tools to be tailored to the needs of the collective. They also contacted potential participants (mainly farmers, bakers and other facilitators) and determined the location of the workshop. Generally speaking, 20 to 30 participants are expected to attend such workshops, so that the facilitators can split them into subgroups with up to 6 people in order to foster exchanges and ensure facilitation. The local facilitators and hosting farmers handled most of the logistics around the organization of each workshop.

The KCP® method has already been described extensively in several articles (see [24,35,37,40]). We thus briefly present the different phases of the method and how they were implemented in our case (see Figure 2).

2.1. The Four Stages of the KCP® Process

2.1.1. Phase D: Diagnosis and Framing of the Design Process

This phase takes place prior to the workshop and is carried out by the KCP® organizing team. Its purpose is twofold: first, to identify the objectives, the workshop participants, and the practical organizational details, and second, to develop a range of tools to facilitate both knowledge sharing and the design process:

- **Exploratory control maps**: These tools were developed and used by the organizing team to undertake a first exploration of each spotlight concept (SC). The elaboration of these tools was guided by the formalism of the CK theory, which allowed for structuring and extending the exploration process (see [42]). The organizing team built them prior to the workshops and then completed them with the concepts generated in the workshops, thus creating *detailed design maps* (see Figure 1 and Figures S1–S5 in the Supplementary Materials).

- **Mood boards**: These tools aim to facilitate participants' exploration. One mood board per spotlight concept was produced, to boost creativity by presenting inspiring pictures (see Figure S6 in the Supplementary Materials).
- **Project canvas**: This was prepared to guide participants in writing down their ideas when detailing a project idea. It is structured into categories such as innovation project description, knowledge and resources needed, actors involved, etc. (see Figure S7 in the Supplementary Materials).

In our case, we included two other steps: The first step was the elaboration of Knowledge synthesis sheets that reported knowledge drawn from the participatory research project and other studies. Their content was mainly based on research papers and PhD theses [38,43] (see Figure S8 for the index and Figure S9 for an example in the Supplementary Materials). These sheets were co-constructed by the DEAP team and the RSP prior to the workshop and were handed out to participants during Phase K of the workshop [38,43]. The second step was for the KCP® organizing team to formulate "spotlight concepts" to steer the creativity phase (see the description of Phase C below).

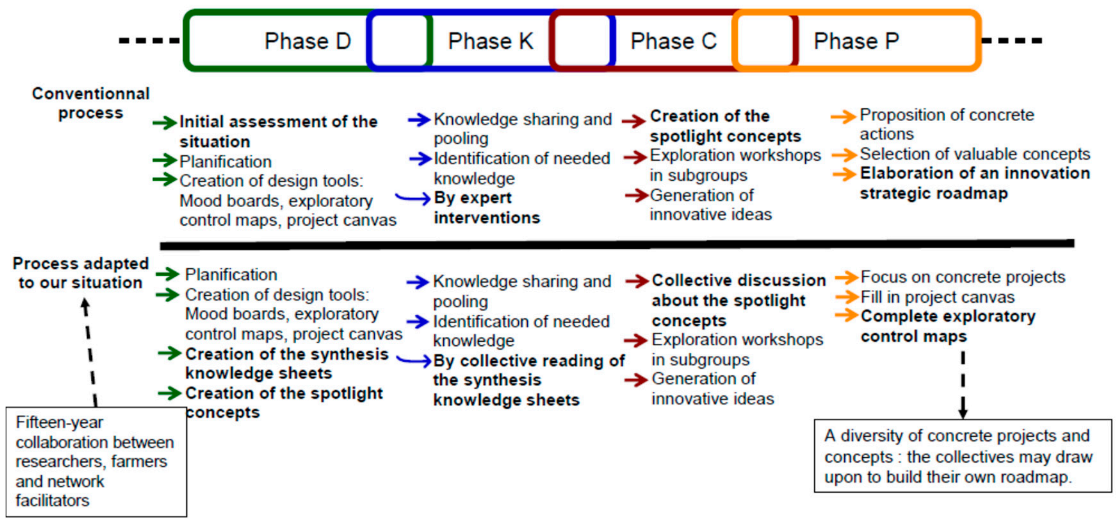

Figure 2. Comparison between the conventional implementation of the KCP® (Knowledge–Concept–Proposals) method and our adaptation. For each stage, the differences are highlighted in bold.

2.1.2. Phase K: Knowledge Sharing

The objectives of this phase are to contribute scientific knowledge, to identify knowledge gaps and start filling them, and to share individual knowledge and experience. Phase K generally relies on expert presentations. In our case, we used the knowledge synthesis sheets as a medium for knowledge transfer and collective discussion. In each workshop, participants were split into subgroups of two to six people. Each subgroup had to read one knowledge synthesis sheet, then present it to the rest of the group. For each sheet, after a short presentation, all participants were invited to share their thoughts about the topic discussed in the sheet and/or their own experience. The research team also received feedback on the knowledge synthesis sheets, which allowed for these to be improved from one workshop to the next.

2.1.3. Phase C: The Exploration of Spotlight Concepts

Phase C is guided by a directed creativity approach. Building on the first two phases, the organizing team prepares spotlight concepts and proposes them to the workshop participants. These concepts need to be both precise and open enough to allow all the participants to engage with them and propose original ideas. In our case, due to limited time, the organizing team prepared five spotlight concepts ahead of Phase K that the participants could select or marginally reformulate. These concepts were formulated with a view to foster reflection on crucial problems surrounding the selection of bread wheat population mixtures. The five spotlight concepts proposed were the following:

1. Disseminating knowledge rather than seeds;
2. Safely creating and managing mixtures;
3. Democratizing the creation of a mixture;
4. A mixture that gets better with time;
5. A mixture that saves time.

The participants were split into subgroups of five or six people. The subgroups were composed in such a way as to reflect a mix of backgrounds (professionally or within the field of participatory breeding). Each subgroup explored one spotlight concept and could use the mood board at its convenience. The organizing team's two experts in charge of methodology acted as facilitators for the different subgroups.

Phase C was conducted as it would in classic implementations of KCP®, though it was shorter than usual. After a short period of individual reflection, the participants shared their ideas. On paperboards, each subgroup categorized the individual ideas written down on post-its. At the end of this phase, the results consisted mainly of a poster compiling the ideas of each group. In the first workshop, 40 min were allocated to exploration in subgroups; this was extended to 60 min in the second workshop. Each group reported its results to all participants, and discussions ensued.

2.1.4. Phase P: The Elaboration of Proposals

The aim of this phase is to build a design strategy for the collective (identify projects for the short, middle and long terms, allocate tasks, identify relevant partnerships, etc.). In our case, the main objective of Phase P was to elaborate concrete projects (for which suitable means, actors, partnerships, etc., would be identified). Each group chose one or two valuable ideas among those they explored in Phase C, and filled in the project canvas to flesh out its project. In the first workshop, 30 min were allocated to exploration in subgroups; this was extended to 45 min in the second workshop. Again, following the subgroup stage, each subgroup reported its results to all the other participants and discussions followed.

Each design workshop was organized, in such a way as to fit in with the participants' constraints and expectations; that is, the workshops had to be held over one day and include times for experience sharing that were important to participants. These moments included the discussions in Phase K, the lunch break, and the visits of the hosting farmer's experimental plots as part of the participatory wheat breeding programme.

3. Data Analysis

All the workshops were recorded for each phase and each subgroup. Each recording was transcribed.

The exploratory control maps provided the starting point for our analysis. For each spotlight concept, the ideas raised during the first workshop were extracted and put on exploratory control maps to build the "detailed design maps" (see Figure 3). The organizing team compiled all new data on the same detailed design maps, so as to track and exploit the results of each workshop. Moreover, the organizing team colour-coded the concepts to identify their degree of originality (according to the topic experts). Five categories of concepts were distinguished:

- **Known concepts (KC)**: These concepts are mentioned on the exploratory control map; they are already known and applied by several local farmer groups;
- **Original concepts (OC)**: These concepts are mentioned on the exploratory control map; they exist but are rarely used by local farmer groups;

- **Innovative concepts (IC)**: These concepts were identified on the exploratory control map, thanks to the use of the formalism of the CK theory, but they were unknown to or not used by local farmer groups;
- **Known generated concepts (KGC)**: These concepts were not mentioned on the exploratory control map but emerged from the workshops; these concepts were already known and used by several local farmer groups;
- **Innovative generated concepts (IGC)**: These concepts were not mentioned on the exploratory control map but emerged from the workshops; these concepts were unknown to or not used by local farmer groups.

The results of each workshop were synthesized in a report. Each report has the same format and includes a description of the KCP® design process context and methodology, copies of the posters from Phase C and the project canvas completed in Phase P, as well as the completed detailed design maps. Each report was sent to all workshop participants (which means that participants of Workshop 1 can find out the outputs of Workshop 2, and vice versa). The detailed design maps are expected to evolve as feedback is received from the contributors.

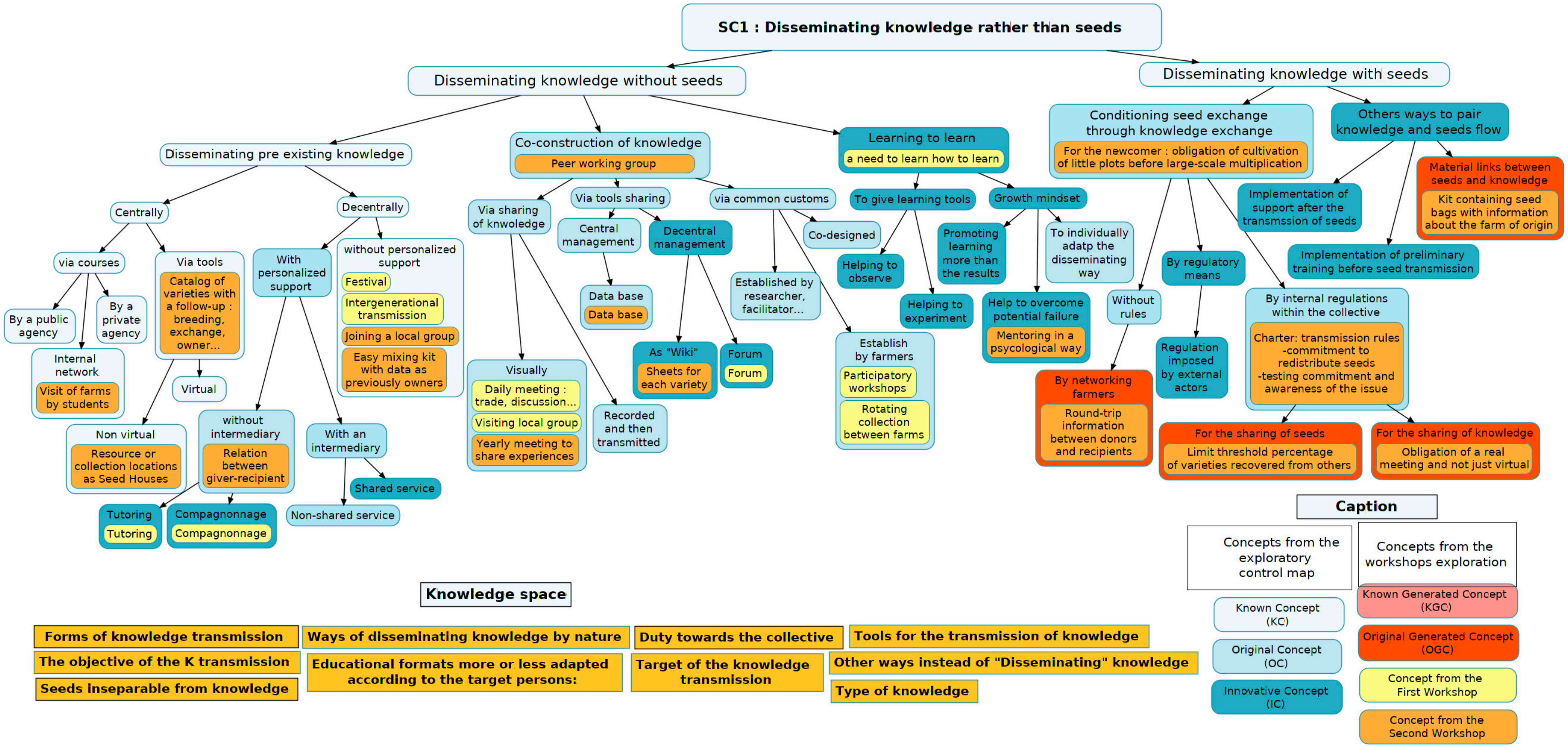

Figure 3. Detailed design map for Spotlight Concept 1: "Disseminating knowledge rather than seeds." This map combines the exploratory control map and the concepts that emerged from the first and second workshops (see Concept Space). The Knowledge Space refers to the knowledge needed for the elaboration and the exploration of the concepts. The caption provided relates to the categorization of the concepts based on their degree of innovativeness and whether they were on the exploratory control map or whether they only arose from the workshops.

4. Results: Main Outputs of the Workshops

4.1. Knowledge Sharing

Overall, all workshop phases, even informal ones, gave room for participants to share both scientific and empirical knowledge with each other, be it during the collective reading and discussion of the knowledge synthesis sheets, the lunch break, the phases of exploration in subgroups, the collective presentation of conclusions, the elaboration of projects, or the visits to the experimental plots.

The knowledge synthesis sheets handed out during the workshops provided the participants with various types of knowledge: (i) theoretical scientific knowledge on the selection differential and the response to selection, as well as the evolutionary forces at work in the management of populations in the field; (ii) information about experimentation protocols and results, such as the evaluation of mixture breeding and management practices, or the participatory design of crop mixture ideotypes; and (iii) general knowledge, such as the benefits of mixtures of varieties and the collective management of crop diversity.

The collective discussions about these sheets addressed topics such as the traceability of components in mixtures, the taste quality of such mixtures, selection praxis and tools. The co-construction process of knowledge synthesis sheets is valuable in several ways: it makes it possible to hybridize scientific knowledge and practitioners' knowledge, as well as to convey scientific knowledge to a large range of people (knowledge is made accessible thanks to simple figures and clear examples, and the knowledge synthesis sheets are meant to be available online). It also makes it possible to identify missing knowledge that needs to be produced, a key objective of applying the KCP® method. For example, workshop participants expressed their need for decision support tools for on-farm breeding practices, and for establishing links between the breeding of wheat variety mixtures and bread taste quality. The discussions on the knowledge synthesis sheets allows the research team in charge of their elaboration to continuously improve and complete them based on the various actors' expectations (farmers, bakers, facilitators, etc.), and to identify new sheets to create. For example, at the start of the participatory breeding project, the farmers, network facilitators and researchers co-designed observation criteria to perform selection on wheat populations; but the farmers or facilitators who joined more recently were not familiar with the reasons behind these choices. The researchers therefore decided to create a new sheet presenting the elaboration context and evolution of these criteria.

4.2. Concept Exploration

The detailed design maps, built from the exploratory control maps completed with the outputs of Phase C, provide an overview of the concepts explored by the participants. This tool, used as a CK referential [44], makes it possible to distinguish the paths spontaneously explored from the more original ones.

Figure 3 presents the detailed design map for the first spotlight concept (Disseminating knowledge rather than seeds), which draws on the results of the first two workshops organized. See Supplementary Materials (Figures S1–S5) for the detailed design maps of the five spotlight concepts.

In total, this detailed design map shows 30 concept exploration paths (a path starts with the spotlight concept and finishes with a concept at the end of a branch). These paths are comprised of 53 concepts: 12 known concepts (KC), 19 original concepts (OC), 18 innovative concepts (IC) and 4 innovative generated concepts (IGC). Of these 53 concepts, 21 were explored during the exploration in subgroups: 5 during the first workshop only, 14 during the second workshop only, and 2 during both workshops. Of the 30 concept exploration paths, 12 were explored by the workshop participants. A high number of paths means that the exploration was wide; a high number of concepts per path means that the exploration was deepened. Lastly, 4 innovative proposals were formulated during the second workshop, which led to the creation of 4 new concepts in the detailed design map, considered as innovative generated concepts (IGC).

The main quantitative results of Phase C, in terms of the exploration of all spotlight concepts, are summarized in Table 1.

Table 1. Quantitative results of the exploration in both workshops.

	Workshop 1		**Workshop 2**		**In Common**
Spotlight Concept 1 (51 pre-identified concepts)	7 paths explored 10 proposals		12 paths explored 17 proposals		2 explored concepts KC: 1 / OC: 1 / IC: 0
	Explored concepts: 7	KC: 1 / OC: 2 / IC: 4 / IGC: 0 / KGC: 0	Explored concepts: 16	KC: 4 / OC: 6 / IC: 2 / IGC: 0 / KGC: 4	
Spotlight Concept 2 (64 pre-identified concepts)	15 paths explored 21 proposals		19 paths explored 27 proposals		8 explored concepts KC: 2 / OC: 6 / IC: 0
	Explored concepts: 16	KC: 3 / OC: 7 / IC: 2 / IGC: 2 / KGC: 2	Explored concepts: 20	KC: 4 / OC: 10 / IC: 4 / IGC: 1 / KGC: 1	
Spotlight Concept 3 (43 pre-identified concepts)	9 paths explored 27 proposals		14 paths explored 34 proposals		9 explored concepts KC: 4 / OC: 4 / IC: 1
	Explored concepts: 14	KC: 5 / OC: 7 / IC: 1 / IGC: 1 / KGC: 0	Explored concepts: 19	KC: 7 / OC: 6 / IC: 3 / IGC: 3 / KGC: 0	
Spotlight Concept 4 (63 pre-identified concepts)			10 paths explored 26 proposals		
			Explored concepts: 11	KC: 1 / OC: 6 / IC: 4 / IGC: 1 / KGC: 1	
Spotlight Concept 5 (45 pre-identified concepts)			9 paths explored 33 proposals		
			Explored concepts: 11	KC: 2 / OC: 3 / IC: 6 / IGC: 1 / KGC: 0	

For each workshop and each spotlight concept, this table presents the indicators taken from the detailed design maps. In the first line of each concept row, the term "path" refers to the entire path, from the spotlight concept to a final concept, and the term "proposal" refers to the ideas contributed by the participants during the workshops. The second line shows the number of concepts explored and their type (KC, OC, IC, KGC, and IGC—see Materials and Methods).

In all subgroups, a significant number of paths were explored (7 to 19), as well as of concepts (7 to 20), and innovative concepts, whether previously identified in the exploratory control map or not (IC or IGC), were proposed. The number of exploratory paths covered during the workshops, as well as the number of original and innovative concepts produced, give an idea of the quality of the exploration: Was it broad, thus covering a variety of ideas? Were the ideas proposed original?

Examples of innovative concepts and proposals generated during the workshops are: "to build material links between seeds and knowledge", with the proposal "a kit containing seed bags with information about the farm of origin" (spotlight concept SC1); "[the collective facilitates] access to land", with the "sharing of crop rotations" (SC2); and "involve actors of the whole supply chain in participatory breeding activities", with "the involvement of distributors in conservation activities" (SC3).

4.3. Project Elaboration

Regarding the project canvas completed by the participants during Phase P, the first two workshops produced nine projects that the organizing team classified into three categories: projects around risk pooling, projects relating to the transmission of knowledge, and projects establishing rules and practices to facilitate the collective management of wheat mixtures.

Two projects addressed the issue of risk pooling. The first proposed financial pooling involved a range of actors, so that the farmers would not be the only ones to carry the risk. The second suggested a form of pooling based on land sharing between farmers, which would entail a coordination of practices (around crop rotation, organic farming, etc.).

The three projects addressing the transmission of knowledge not only stemmed from the first spotlight concept, but were explored in various subgroups. The aim of these projects was to redefine the collaboration between farmers, so as to expand the practice of participatory breeding and the collective management of mixtures. Projects included tutoring for new entrants, drawing up a charter to define everyone's involvement, and creating an "easy mixing kit" containing seeds and informational sheets for those wanting to try to make mixtures. The projects also included the establishment of rules and principles, such as mutual listening in discussion groups, and the integration of new entrants.

The last category of projects focused on the establishment of rules and practices to facilitate the collective management of wheat mixtures. This was a large category, which included the following three projects: a pool of rules to enhance seed quality, traceability tools, and the creation of a brand to promote crop mixtures. The drafting of a charter to define each contributor's involvement was also mentioned. Two main considerations underpin these projects. First, better structuring the network would afford greater visibility for each member; and second, the various actors of participatory wheat breeding should be more attentive and involved (for example, consumers could favour flour with a label identifying that it is made from a wheat mixture over conventional flour).

Finally, new tools for collective action were proposed, such as a common charter, the pooling of plots and equipment, and the federation of all the actors in the sector around risk management.

5. Discussion

5.1. An Empirical Case in Line with Recent Applications of KCP® in NRM Contexts

This research is part of a body of empirical work aimed at deploying collective design approaches articulating KCP® for the development of new natural resource management methods (see for instance [24,36,37,45]). Table 2 presents some of the similarities and differences between the present case and previous ones.

5.1.1. The Contribution of KCP® to Social Learning

KCP® is a design method focused on generating ideas, but knowledge sharing and social learning are also key aspects of this method. The workshops provide knowledge-sharing spaces for actors with heterogeneous knowledge [35]. First, knowledge sharing is crucial, both to getting all participants to contribute to the design process and to prepare the generation of ideas. Second, the design goal requires knowledge management [46]: The KCP® method aims to build up knowledge, sometimes turning tacit knowledge into explicit knowledge. This accumulation, combined with a search for novelty, allows for identifying knowledge gaps and thus guiding learning strategies. As Roberts [47] stresses, "knowledge of unknowns can help to target and drive explorations for new knowledge" (p. 220). Moreover, the detailed design map is an interesting tool to identify poorly explored paths. Finally, the KCP® method allows for restructuring knowledge by grouping similar ideas or highlighting existing contradictions.

A main challenge with such participatory approaches is overcoming the dichotomy between generic expert knowledge and local practitioner knowledge. To this end, various strategies have been adopted across the different cases mentioned in the literature. For instance, Labatut and Hooge [37] sought to balance the intervention capabilities of all participants by prioritizing "experience sharing" structured around examples, over the sharing of "formalized knowledge" based on conceptual models. In our case, the knowledge synthesis sheets replaced the time devoted to expert presentations and made room for collective discussions and receiving feedback from practitioners.

Table 2. Main similarities and differences between the case presented and previous applications of KCP® in NRM contexts.

Main Similarities with Previous Applications of KCP® in NRM Contexts	• Short and limited number of workshops. • An emphasis on hybridizing scientific and empirical knowledge. • The generation of innovative ideas is central to the process; tools are developed to facilitate this: spotlight concepts, mood boards. • The innovative design phase fostered by the application of KCP® is part of a longer-lasting collective process.
Main Differences with Previous KCP® Applications and Originality of the Present Case	• The objective was not so much to build a collective goal or shared vision of the issue at stake as to foster interpersonal knowledge and the building of collective projects. • No preliminary interviews were held to establish a preliminary diagnosis, but the process fit within a long-lasting collaboration between researchers and practitioners. • Phase K was based on knowledge synthesis sheets and not expert presentations. • The focus is not really on the legitimacy of the participatory design process, but on appropriation and follow-up by stakeholders. • The workshop protocol is replicable in the decentralized breeding groups, thus allowing for it to become a research protocol in itself and to exploit data on a large scale and over the long term. • The outputs of the workshops (detailed design maps) may be used to steer collective innovation at various scales (local and national).

The facilitation of knowledge sharing starts prior to the workshops. In most cases of implementation of KCP® for NRM, existing but scattered knowledge was gathered through preliminary interviews. For instance, Pluchinotta et al. [24] combined scientific knowledge from the literature with expert knowledge gathered through interviews and participatory processes previously carried out in the same area, and then wrote down the information collected and shared it with all workshop participants. In other cases, relevant experts were identified and briefed before the first Phase K workshop [36,45]. In the present case, the workshops were organized as part of a long-standing collaboration between researchers and farmers, who had precisely identified knowledge sharing as a topical challenge, and had planned the elaboration of knowledge synthesis sheets.

5.1.2. A Focus on Structuring Exploration and Generating Novel Ideas

Traditional participatory approaches generally focus on the identification of problems and the collective evaluation of known alternatives. The structuring of exploration (mapping the unknown, linking knowledge to concepts, etc.) and the formulation of innovative alternatives are generally not put forward or managed explicitly [24]. These objectives are central to the KCP® method, designed to help a large collective to develop innovative projects. Phase C of the workshops we organized followed the standard rules of KCP® (exploration of spotlight concepts in subgroups). Although this phase was very short (about one hour of exploration per subgroup), the workshops generated innovative technical and organizational projects, and explored quite uncommon paths such as risk pooling between farmers.

5.1.3. A Lesser Focus on Power Asymmetries and Conflicts

Compared to other participatory methods, such as ComMod for instance, power asymmetries and conflicts are less explicitly at the core of a KCP® process [35]. Nevertheless, in several empirical cases [36,37] the KCP® workshops aimed at overcoming a locked-in collaboration situation and defining common projects to bring together stakeholders with diverging interests. However, in our case, issues of conflicts and power between the workshop participants were all the less taken into account that the relations between the stakeholders of participatory breeding are generally not conflictual, and the trust between farmers, facilitators and researchers, built over a long-lasting collaboration, is solid (besides, the atmosphere at both workshops was very friendly). Hence, in our case, although disagreements and tensions with external actors (such as private breeding firms) do exist and were often mentioned during the workshop exchanges, it was less at stake to overcome conflicts and power asymmetries than to strengthen collective action for the management of cultivated biodiversity.

Generally speaking, for KCP®, the initial diagnosis developed by the researchers helps the organizing team to draw up a list of participants in order to include a diverse range of not only stakeholders but also perspectives [48]. In our case, for the first workshops, the organizing team invited farmers from several generations, as well as bakers, researchers and network facilitators. Other actors, such as prescribers (of rules, standards, laws, etc.) and supply chain intermediaries, may have been missing, and it could be valuable for future workshops to open up the range of participants.

5.2. Endeavours to Overcome Participation Pitfalls

Like other scholars who have applied KCP® for NRM, we strove to overcome various problems associated with participatory processes.

First, in order to work with farmers' time constraints, we organized a one-day design workshop. This matched the strategies adopted by former implementations of KCP® for NRM. However, a core difference between this case and previous ones is the highly decentralized context of participatory breeding. We chose to organize one workshop per local wheat breeding group and to replicate the same protocol in several areas. Thus, each local group is able to contribute to the design process on its own, and in turn, the knowledge derived from the multiple workshops benefits all local groups.

Participatory processes are often seen as time-consuming and inefficient. We planned the workshops so that each phase would be quite short, with clear objectives and facilitation tools (such as spotlight concepts, mood boards, and a project canvas). The participants interviewed at the end of the workshops felt that they had gained new knowledge and had produced concrete outputs using an original approach. Another drawback, frequently mentioned in participatory processes, is that outputs of such processes are often limited to a collective proposal to reframe a problem. The KCP® approach, even when adapted to NRM constraints, results in a range of new ideas, as well as concrete proposals and a prioritization of potential actions.

The issue of the legitimacy of the participatory process and of its organizing team is often seen as a challenge and may hinder the success of a project. Labatut and Hooge [37] outlined their efforts to build this legitimacy and its importance for the long-term success of their project. The composition of the KCP® organizing team is crucial: It needs to include not only researchers but also representatives of a range of stakeholders, and expert(s) both in the design method and in the field, etc. In the present case, the strong involvement of researchers who had built trust with both farmers and facilitators was very helpful, as were holding the workshops on local farms and involving the farmers in their organization.

5.3. A New Protocol That Fits in with the Ongoing Participatory Research Project

The whole KCP® protocol was designed to facilitate its replication in different places where participatory bread wheat breeding collectives are set up. A range of tools are now ready to use: The lists of spotlight concepts and the related mood boards, the detailed design maps, and the project canvas. The workshop programme is also established and logistical parameters are now calibrated. Thanks to these features, this participatory design process can be deployed on a large scale and allows for multiple cumulative explorations. The outputs of the workshops, in particular the detailed design maps, because they are comparable and cumulative, become collective innovation steering tools at various scales: at the local scales (the local collectives may use them to build their local strategy), but also at a national scale (the RSP may use them to identify valuable paths for the whole PPB community).

Significantly, these tools were co-designed with the various partners involved. Moreover, they are relatively open-ended and can be adapted to better fit in with the specific expectations of local actors. This is crucial for participatory research, as it conditions its success through the involvement of non-research actors. This reflects the concerns of INRAE DEAP researchers to first co-design all participatory research tools, and then make these tools both adaptable to local situations and useful for answering new research questions. These workshops are thus, both a tool to support practitioners in their project to improve the collective management of cultivated biodiversity, and a research tool to help address research questions in the field of design science. If several other workshops were to be organized, the protocol set up in this research project would make it possible to formulate preliminary hypotheses, for instance, about the impact of group composition or of spotlight concept formulation on the quality of the exploration.

So far, only two workshops have been implemented. Moreover, they took place very recently (less than six months ago at the time of writing this paper). The interpretation of the results is therefore in its early stages, and only offers tentative hypotheses that could be studied in the future. Yet, looking at the three spotlight concepts that were explored in both workshops, for instance, we can see that in the second workshop, more paths were explored, but fewer original and innovative concepts were proposed (see Table 1). What is more, the projects proposed in Phase P were more technical and less original in the second workshop than in the first. An exploratory hypothesis we formulated, in this respect, is that subgroup composition may have a role to play. In the first workshop there were more newcomers, and in the second workshop there were more experienced participants. The latter had more knowledge and experience on the subject than the newcomers, which may have led to more ideas but also more conventional ones than in the first group, where participants may have had fewer barriers to their creativity. Nevertheless, it is important to note that there was more time for exploration and a larger number of participants in the second workshop, which could have allowed for more ideas to be generated.

We also compared the different spotlight concepts. Neither workshop produced new concepts for the first spotlight concept, compared to the exploratory design map, whereas several were generated for the other spotlight concepts. This might be due to the fact that its preliminary exploration was more extensive than that of the other concepts. It could also be due to the formulation of the spotlight concepts. However, these results are only based on the comparison between two workshops; in order to refine and test our hypotheses, it would be necessary to organize and analyze other workshops.

For each spotlight concept, we also compared the overlap between the different explorations carried out during the first two workshops, that is, the number of common concepts proposed and similar paths explored (Table 1). The first spotlight concept was explored in a very different way by the two subgroups, and there were few common paths. There was greater overlap in the exploration results for the second and third spotlight concepts. We suggest two hypotheses in this respect. First, the formulation of the concepts might influence the degree of diverging explorations (based on a more or less open-ended or focused formulation, etc.). The way the mood boards are prepared may also influence the scope of the exploration. Second, the facilitation of the exploration carried out by the subgroups plays a role in overcoming fixation effects.

5.4. Some Limits of and Avenues for the Collective Design Approach Presented

As mentioned above, the results of this ongoing research are preliminary and the hypotheses proposed on the relationships between group composition or spotlight concepts and the quality of the exploration would require a larger number of design workshops to be tested.

The protocol chosen for this research also presents some limitations for the participants.

First, a one-day exploration workshop is very short: with more time, one could go further in the exploration of ideas and the development of concrete projects. Second, the workshop's syntheses capture many of the outputs, but they do not account for the wealth of all the discussions. That being said, all discussions were filmed. Third, such a collective design process requires a lot of preparation work, as well as robust theoretical and methodological knowledge. It will, therefore, not be easy for the wheat breeding collectives to reproduce the workshops without any further support. Fourth, even though they take place on farms and catering expenses are kept to a minimum, organizing decentralized workshops is quite costly; this participatory design process requires funding to be sustained in the long run. Last but not least, these workshops were designed to bring together mainly farmers, bakers and participatory breeding facilitators. No institutional actors, who could play a role in changing the legislation for instance, take part in the process. A diagnosis of stakeholders could be useful to conduct, in order to involve all relevant actors. For the moment, this is an in-house approach, which would probably stand to gain in the future by involving outsiders. Yet, this could generate conflict, which would require careful consideration during the preparation phase. Finally, it remains to be seen how the collectives will appropriate the system put in place. Several avenues may be envisioned: to make it an iterative dynamic, with workshops reproduced in the same collectives in one or two years; to organize design workshops on other issues; to shift this initiative to a national scale with a national workshop to build on all the decentralized workshops, etc.

6. Conclusions

Participatory Plant Breeding (PPB), though still marginal in developed countries, is a key strategy for maintaining cultivated biodiversity. However, it requires a profound renewal of the interactions between farmers, and between farmers and supply chains or extension services. In an attempt to foster democratization and empowerment to develop PPB, a partnership between practitioners and researchers has adapted a participatory design method, KCP®, to this field. As with other cases of KCP® application to NRM, this method was useful to foster valuable dialogue between practitioners, to share both scientific and empirical knowledge, to generate a diversity of ideas and to propose concrete though preliminary projects. Equally valuable, the protocol designed for the implementation of the KCP® method in this particular context allows for its replication, as well as the exploitation and sharing of the results. This protocol could thus be used as an important facilitation tool for the PPB community. This workshop design could also be used as an experimental tool to test hypotheses in design science. This empirical case, though recently launched and still ongoing, thus offers a promising example which could promote participatory research and improve the collaboration between researchers and practitioners to better manage threatened natural resources.

Supplementary Materials: The following are available online at http://www.mdpi.com/2071-1050/12/2/605/s1, Figures S1–S5: Detailed design maps for the spotlight concepts 1, 2, 3, 4 and 5: These maps combine the exploratory control map and the concepts that emerged from the first and second workshops. The K space refers to the knowledge needed for the elaboration and exploration of the concepts. The caption provided relates to the categorization of the concepts based on their degree of innovativeness and whether they were on the exploratory control map or whether they only arose from the workshops; Figure S6: Mood boards relative to the five spotlight concepts; Figure S7: Project canvas relative to the spotlight concept "Conveying knowledge rather than seeds", completed by a subgroup from the first workshop; Figure S8: Table of contents of the knowledge synthesis sheets. Those in bold are already created. The others are under development; Figure S9: An example of knowledge synthesis sheet: Evolutionary forces at work in the management of populations in the field (originally in French).

Author Contributions: Conceptualization, E.T.B., S.B., G.v.F., B.W., B.S., P.R. and I.G.; data curation, S.B.; formal analysis, E.T.B., S.B., L.M.-C., G.v.F. and I.G.; funding acquisition, E.T.B., G.v.F., P.R. and I.G.; methodology, E.T.B., S.B., L.M.-C., G.v.F., P.R., L.B., E.B. and I.G.; supervision, E.T.B., G.v.F. and I.G.; visualization, E.T.B., S.B. and L.M.-C.; writing—original draft, E.T.B., S.B., L.M.-C., G.v.F. and I.G.; writing—review and editing, E.T.B., L.M.-C., G.v.F., B.W., B.S., P.R., L.B., E.B. and I.G. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by a grant overseen by the French National Research Agency (ANR) as part of the "Investments d'Avenir" Programme (LabEx BASC; ANR-11-LABX-0034), in the frame of the INDISS project.

Acknowledgments: The authors would like to thank the workshop participants, the farmers who hosted the workshops and the facilitators of the local collectives for their help. The authors thank Catherine Pasquier for the video recording, Marianne Cerf for her methodological support and Nonta Libbrecht-Carey for the English editing. Data collection and analysis was funded by INRA (UMR SADAPT, UMR GQE—Le Moulon). This research was led under the umbrella of IDEAS (Initiative for Design in Agrifood Systems).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Demeulenaere, E.; Bonneuil, C. Cultiver la biodiversité. Semences et identité paysanne. In *Les Mondes Agricoles en Politique. De la Fin des Paysans au Retour de la Question Agricole*; Hervieu, B., Mayer, N., Müller, P., Purseigle, F., Rémy, J., Eds.; Presses de Sciences Po: Paris, France, 2010; pp. 73–92.
2. Demeulenaere, E.; Bonneuil, C. Des Semences en partage. Construction sociale et identitaire d'un collectif paysan autour de pratiques semancières alternatives. *Tech. Cult. Rev. Semest. d'Anthropologie Tech.* **2011**, *57*, 202–221.
3. Ceccarelli, S. Positive interpretation of genotype by environment interactions in relation to sustainability and biodiversity. In *Plant Adaptation and Crop Improvement*; Cooper, M., Hammer, G.L., Eds.; CAB International: Wallingford, CT, USA; Oxon, UK, 1996; pp. 467–486.
4. Bonneuil, C.; Thomas, F. *Gènes, Pouvoirs et Profits: Recherche Publique et Régimes de Production des Savoirs de Mendel Aux OGM*; Éditions Quae: Versailles, France, 2009.
5. Ceccarelli, S.; Valkoun, J.; Erskine, W.; Weigand, S.; Miller, R.; Van Leur, J. Plant genetic resources and plant improvement as tools to develop sustainable agriculture. *Exp. Agric.* **1992**, *28*, 89–98. [CrossRef]
6. Bonnin, I.; Bonneuil, C.; Goffaux, R.; Montalent, P.; Goldringer, I. Explaining the decrease in the genetic diversity of wheat in France over the 20th century. *Agric. Ecosyst. Environ.* **2014**, *195*, 183–192. [CrossRef]
7. Altieri, M.A.; Nicholls, C.I.; Henao, A.; Lana, M.A. Agroecology and the design of climate change-resilient farming systems. *Agron. Sustain. Dev.* **2015**, *35*, 869–890. [CrossRef]
8. Pressoir, G.; Berthaud, J. Patterns of population structure in maize landraces from the Central Valleys of Oaxaca in Mexico. *Heredity* **2004**, *92*, 88. [CrossRef]
9. Van Heerwaarden, J.; Van Eeuwijk, F.; Ross-Ibarra, J. Genetic diversity in a crop metapopulation. *Heredity* **2010**, *104*, 28. [CrossRef]
10. Dawson, J.C.; Rivière, P.; Berthellot, J.-F.; Mercier, F.; Kochko, P.d.; Galic, N.; Pin, S.; Serpolay, E.; Thomas, M.; Giuliano, S. Collaborative plant breeding for organic agricultural systems in developed countries. *Sustainability* **2011**, *3*, 1206–1223. [CrossRef]
11. Rivière, P.; Pin, S.; Galic, N.; De Oliveira, Y.; David, O.; Dawson, J.; Wanner, A.; Heckmann, R.; Obbellianne, S.; Ronot, B. Mise en place d'une méthodologie de sélection participative sur le blé tendre en France. *Innov. Agron.* **2013**, *32*, 427–441.
12. Rivière, P.; Dawson, J.C.; Goldringer, I.; David, O. Hierarchical Bayesian modeling for flexible experiments in decentralized participatory plant breeding. *Crop Sci.* **2015**, *55*, 1053–1067. [CrossRef]
13. van Frank, G.; Goldringer, I.; Rivière, P.; David, O. Influence of experimental design on decentralized, on-farm evaluation of populations: A simulation study. *Euphytica* **2019**, *215*, 126. [CrossRef]
14. Demeulenaere, É.; Rivière, P.; Hyacinthe, A.; Baltassat, R.; Baltazar, S.; Gascuel, J.-S.; Lacanette, J.; Montaz, H.; Pin, S.; Ranke, O. La sélection participative à l'épreuve du changement d'échelle. À propos d'une collaboration entre paysans sélectionneurs et généticiens de terrain. *Nat. Sci. Soc.* **2017**, *25*, 336–346. [CrossRef]
15. Holling, C.S. Understanding the complexity of economic, ecological, and social systems. *Ecosystems* **2001**, *4*, 390–405. [CrossRef]
16. Barreteau, O.; Le Page, C.; Perez, P. *Contribution of Simulation and Gaming to Natural Resource Management Issues: An Introduction*; Sage Publications Sage: Los Angeles, CA, USA, 2007.
17. Ostrom, E. *Governing the Commons. The Evolution of Institutions for Collective Action*; Cambridge University Press: Cambridge, UK, 1990; p. 280.
18. Holling, C.S.; Meffe, G.K. Command and control and the pathology of natural resource management. *Conserv. Biol.* **1996**, *10*, 328–337. [CrossRef]
19. Pahl-Wostl, C. Participative and stakeholder-based policy design, evaluation and modeling processes. *Integr. Assess.* **2002**, *3*, 3–14. [CrossRef]
20. Bodin, Ö.; Crona, B.I. The role of social networks in natural resource governance: What relational patterns make a difference? *Glob. Environ. Chang.* **2009**, *19*, 366–374. [CrossRef]
21. Berthet, E.T.; Segrestin, B.; Weil, B. Des biens communs aux inconnus communs: Initier un processus collectif de conception pour la gestion durable d'un agro-écosystème. *Rev. l'Organisation Responsab.* **2018**, *13*, 7–16. [CrossRef]

22. Agogué, M.; Berthet, E.; Fredberg, T.; Le Masson, P.; Segrestin, B.; Stoetzel, M.; Wiener, M.; Yström, A. Explicating the role of innovation intermediaries in the "unknown": A contingency approach. *J. Strategy Manag.* **2017**, *10*, 19–39. [CrossRef]
23. Tavella, E.; Franco, L.A. Dynamics of group knowledge production in facilitated modelling workshops: An exploratory study. *Group Decis. Negot.* **2015**, *24*, 451–475. [CrossRef]
24. Pluchinotta, I.; Kazakçi, A.O.; Giordano, R.; Tsoukiàs, A. Design Theory for Generating Alternatives in Public Decision Making Processes. *Group Decis. Negot.* **2019**, *28*, 341–375. [CrossRef]
25. Reed, M.S. Stakeholder participation for environmental management: A literature review. *Biol. Conserv.* **2008**, *141*, 2417–2431. [CrossRef]
26. Hahn, T.; Olsson, P.; Folke, C.; Johansson, K. Trust-building, knowledge generation and organizational innovations: The role of a bridging organization for adaptive comanagement of a wetland landscape around Kristianstad, Sweden. *Hum. Ecol.* **2006**, *34*, 573–592. [CrossRef]
27. Folke, C.; Hahn, T.; Olsson, P.; Norberg, J. Adaptive governance of social-ecological systems. *Annu. Rev. Environ. Resour.* **2005**, *30*, 441–473. [CrossRef]
28. French, S.; Bayley, C. Public participation: Comparing approaches. *J. Risk Res.* **2011**, *14*, 241–257. [CrossRef]
29. Marttunen, M.; Mustajoki, J.; Dufva, M.; Karjalainen, T.P. How to design and realize participation of stakeholders in MCDA processes? A framework for selecting an appropriate approach. *EURO J. Decis. Process.* **2015**, *3*, 187–214. [CrossRef]
30. Burton, P.; Goodlad, R.; Croft, J.; Abbott, J.; Hastings, A.; Macdonald, G.; Slater, T. *What Works in Community Involvement in Area-Based Initiatives? A Systematic Review of the Literature*; Home Office Online Report 53/04; Home Office: London, UK, 2004.
31. Pretty, J.N. Participatory learning for sustainable agriculture. *World Dev.* **1995**, *23*, 1247–1263. [CrossRef]
32. Oppl, S. Supporting the collaborative construction of a shared understanding about work with a guided conceptual modeling technique. *Group Decis. Negot.* **2017**, *26*, 247–283. [CrossRef]
33. Pahl-Wostl, C.; Hare, M. Processes of social learning in integrated resources management. *J. Community Appl. Soc. Psychol.* **2004**, *14*, 193–206. [CrossRef]
34. Barnaud, C.; Van Paassen, A. Equity, power games, and legitimacy: Dilemmas of participatory natural resource management. *Ecol. Soc.* **2013**, *18*, 21. [CrossRef]
35. Berthet, E.T.; Barnaud, C.; Girard, N.; Labatut, J.; Martin, G. How to foster agroecological innovations? A comparison of participatory design methods. *J. Environ. Plan. Manag.* **2016**, *59*, 280–301. [CrossRef]
36. Berthet, E.T.; Segrestin, B.; Hickey, G.M. Considering agro-ecosystems as ecological funds for collective design: New perspectives for environmental policy. *Environ. Sci. Policy* **2016**, *61*, 108–115. [CrossRef]
37. Labatut, J.; Hooge, S. Innovative Design, a Tool to Renew the Management of Common Resources. The Case of a Basque Local Sheep Breed. *Nat. Sci. Soc.* **2016**, *24*, 319–330. [CrossRef]
38. Van Frank, G. Gestion Participative de la Diversité Cultivée et Création de Mélanges Diversifiés de blé Tendre à la Ferme. Ph.D. Thesis, Université Paris Saclay, Saint-Aubin, France, 2018.
39. Hatchuel, A.; Le Masson, P.; Weil, B. Design theory and collective creativity: A theoretical framework to evaluate KCP process. In Proceedings of the International Conference on Engineering Design, Stanford University, Stanford, CA, USA, 24–27 August 2009.
40. Hooge, S.; Béjean, M.; Arnoux, F. Organising for radical innovation: The benefits of the interplay between cognitive and organisational processes in KCP workshops. In *The Role of Creativity in the Management of Innovation: State of the Art and Future Research Outlook*; World Scientific: Singapore, 2017; pp. 205–237.
41. Hatchuel, A.; Weil, B. A new approach of innovative design: An introduction to C-K theory. In Proceedings of the ICED'03, Stockholm, Sweden, 19–21 August 2003.
42. Hatchuel, A.; Weil, B. CK design theory: An advanced formulation. *Res. Eng. Des.* **2009**, *19*, 181. [CrossRef]
43. Riviere, P. Méthodologie de la Sélection Décentralisée et Participative: Un Exemple Sur le Blé Tendre. Ph.D. Thesis, Université Paris Sud, Orsay, France, 2014.
44. Agogué, M. Modéliser L'effet des Biais Cognitifs Sur les Dynamiques Industrielles: Innovation Orpheline et Architecte de L'inconnu. Ph.D. Thesis, Mines ParisTech, Paris, France, 2012.
45. Ravier, C.; Jeuffroy, M.-H.; Gate, P.; Cohan, J.-P.; Meynard, J.-M. Combining user involvement with innovative design to develop a radical new method for managing N fertilization. *Nutr. Cycl. Agroecosyst.* **2018**, *110*, 117–134. [CrossRef]

46. Hooge, S.; Agogué, M.; Gillier, T. A new methodology for advanced engineering design: Lessons from experimenting CK Theory driven tools. In Proceedings of the International Design Conference—Design 2012, Dubrovnik, Croatia, 21–24 May 2012.
47. Roberts, J. Organizational ignorance: Towards a managerial perspective on the unknown. *Manag. Learn.* **2013**, *44*, 215–236. [CrossRef]
48. Bammer, G. Integration and implementation sciences: Building a new specialization. *Ecol. Soc.* **2003**, *10*, 95–107. [CrossRef]