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Does the Availability of Specific Agri-Equipment Influence Cropping System Design? A Case Study of Pulses

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Abstract: Cropping system design is being transformed through the twofold evolution of agricultural practices for an agroecological transition, and of equipment diversification for agrotechnical needs. Among the most well-known drivers there are genetic selection, crop diversification, protein and energy autonomy. Protein and energy autonomy but also crop diversification could be achieved by reintroducing pulses into farming systems. The availability of specific equipment might be the simplest prerequisite for developing agroecological farming practices while supporting these goals. However, the links between pulses and agri-equipment are not clarified in the literature. The aim of this study is to understand recent historical and current links between pulses and equipment and to gain insight into the suitability or even to find shortcomings concerning pulses and available agri-equipment. To this end, 21 key informants were identified in the agronomical, sociotechnical, economic, and political sectors in France. We asked them four questions: (i) Can you describe your professional functions? (ii) Do you think that equipment is related to the design of the culture system? (iii) Do you think that pulses require specific equipment? (iv) How do you define agroecology? Respondents' profiles are equally distributed into profiles directly related to the farmer and profiles not directly related to farmers. All 21 respondents answered questions (ii) and (iv). Only 14 respondents answered question (iii), and most of them are directly related to the farmer. We note that pulses do not require specific agri-equipment in a conventional system. The need for agri-equipment is found in the soil conservation approach where pulses are combined with other crops. Soil conservation approaches appear to achieve agroecological goals through the reintroduction of legumes and the decarbonization of energy associated with reduced mechanical costs and CO_2 emissions. This article presents expert opinions on the impact of equipment in the adaptation of agroecological practices as well as insights into the existing blockages of equipment in relation to soil conservation practices.

Keywords: protein autonomy; crop diversification; key informant approach; sustainable development; agroecology

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1. Introduction

Cropping systems are defined by the combination of crop sequences and agricultural practices [1]. Both of these components are evolving in the response to multiple transitions [2,3].

First, climate change can be described not only as an increase in average temperatures, but also, more specifically, as an alteration in global precipitation patterns, including the amount of precipitation received and the distribution of precipitation over the course of an average year in many locations [4]. As global temperatures rise, soils could contribute to increased amounts of greenhouse gases in the atmosphere and lose their ability to act as a carbon sink [5]. Increased extremes such as peak precipitation events will accelerate soil loss rates, and a decrease in precipitation could conversely lead to a period of drought and an increased risk of direct wind erosion, and even further erosion by a subsequent peak in precipitation [6]. This will reduce soil fertility and thus farm productivity [7].

Second, energy transition, which demands a decrease in energy input, is requiring that to redesign cropping systems be rethought. For example, it appears that nitrogen fertilizers are the first item of energy consumption in agriculture [8,9]. Therefore, the use of pulses in production systems could be necessary for decreasing the use of these nitrogen fertilizers, as they bring reduced nitrogen from nitrogen gas thanks to biological nitrogen fixation by symbiotic bacteria *Rhizobium* sp. Pulse cropping is therefore a method of sustainable agriculture [10].

Third, agroecological transition. Agroecology is a multidisciplinary concept and can be studied at least according to science, social movements, and socio-technical practice [11]. Agroecological transition is linked to the need to develop sustainable agriculture [12,13]. To protect soils against erosion, and to change and optimize agriculture systems, agroecological transition leads to soil conservation agriculture, including no-till practices as well as double and relay-cropping [14,15], in which pulses are very useful.

These evolutions, altogether, create some perceived instability and uncertainty for cropping system design [16], although this social unrest unveils also a new dynamic [17], and it reveals an opening of possibilities and the call to creativity [18]. New crops are being considered to diversify crop sequences, especially to increase the presence of pulses as the best candidates to provide nitrogen [19]. European agronomists are also focusing on the increase in pulse areas in crop sequences for the multiple ecosystem services that these crops can provide, thus contributing to meet the societal expectations [20].

From a global perspective, climate change is highlighting the role of soil management to face uncertainties in water content. This translates into the need to increase soil organic matter to stabilize water availability to cope with increased variability in precipitation [21] and offers the possibility of being a carbon sink [22]. A further consequence concerns the soil practicability and the need to reduce soil compaction, which depend on the development of adapted agricultural equipment.

The availability of specific agricultural equipment (agri-equipment for short) can be considered as the common bottleneck between the introduction of new crops and practices in sequences and the evolution of farming practices, especially those related to soil management. However, scientific literature seems to lack a system approach to relate cropping system design to the evaluation of agri-equipment suitability. Altieri, in his foundation papers of agroecology [12,13], was well focused on practices but not on the choices of specific equipment. Even the change to direct seeding on plant covers, a true technical revolution, has been indicated only as a technical invention by the Allis Chalmers Company (1966), without analysis of the interaction between agricultural practice and the agri-equipment industry. This new technique has only been accepted as evidence [23].

This paper aims to identify the role of agri-equipment in the cropping system design, with a focus on the introduction of pulse crops in French agricultural systems. This case study could be representative of Northern Europe agricultural systems committed to the transition toward sustainable agroecological practices [24]. The agronomic evaluation of agri-equipment suitability to the cropping system design process is poorly addressed as a topic in scientific literature, even though the availability of adapted equipment is highlighted as a major bottleneck both for the diversification of cropping systems [25,26] and sustainable farm management [27]. The focus was on pulses as an example of crops that use both generic equipment and specialized (sometimes highly specialized) equipment [28,29]. The availability and cost of equipment directly influence the feasibility of legume cultivation, as in the case of forage legumes [30–32], and it can be therefore expected to influence the choice to introduce pulses in the cropping system, as suggested by anecdotical observations and prototypes [33,34] that have not yet surveyed in a systematic way

Section 2 presents the conceptual themes that define the boundaries of the present study as defined by three major drivers relating agri-equipment and cropping system design. Section 3 presents the materials and methods that are based on a key informant approach to provide an overview of the emerging topics and define the research agenda based on a system perspective. Section 4 presents the analytical results of these qualitative

interviews. In Section 5, before concluding and discussing perspectives, the results are discussed in comparison with thematic literature.

2. Three Drivers Relating Agri-Equipment and Cropping System Design

The following paragraphs address the known drivers connecting agri-equipment and cropping system design.

2.1. Homogenization and Specialization

The increasing availability of agri-equipment and machinery underpinning the mechanization of agriculture from the second half of the twentieth century allowed for and favored the homogenization of agriculture [35]. In a reinforcement feedback loop, the homogenization of agriculture accentuated the generalization of mechanization. This homogenization combined with a cost-effective mechanization, input use, and improved genetics [36] allowed for the achievement of a significant increase in yields (per ha) and productivity (per person), as well as a return on energy investment [37].

Homogenization is intended here as the widening of the same farm management practices over increasingly large areas that follows an increase in average field surface. In addition, this homogenization also led to an increase in specialization at farm and regional levels, but the converse also holds true [38]. Regional specialization is defined as the distribution of the weight of a sector in the total economic activity of a pedoclimatic area [39]. Besides, the growing world population, which is mainly concentrated in urban areas, is increasing the demand for processed products that can be consumed immediately [40–43]. Seen at a wider level, the economic anchoring of the agricultural and agri-food sectors in the global economy is leading to an increased specialization and the search for competitiveness between agricultural sectors. According to this logic of production optimization, depending on optimal climatic conditions, regions of the world specialize in certain crops [44]. This creates de facto territorial food dependencies according to agricultural specializations [45].

For example, in France, the mixed farming underwent homogenization due to specialization. French farms have had a strong tendency to specialize since the 1940s [46,47]. On the one hand, some regions specialize in crop production without livestock on the farm. The farms in these regions are endowed with agronomic assets and, in their homogenization, specialized in cereals and cash crops. On the other hand, other regions are specialized in animal production (milk or meat) without crops on the farm [47–51]. The farms in these regions benefit from commercial and industrial situations allowing for breeding. They keep a goal of optimized production at lower cost, but their room for maneuvering is restricted and is shown by the cessation of animal production in a considerable proportion of them [52].

2.2. Agroecology and Agroecological Practices

Agroecology is a polysemic notion. A scientific definition was introduced by Altieri [12] as "natural resource management" for agriculture. Gliessman et al. [53] presented agroecology as "the application of ecology to the study, design and management of agro-systems". The goal is to promote the resilience of agricultural systems through the diversification of crops or cultivated varieties, autonomy, and resistance to climatic hazards. Agroecology was initially defined in terms of production and protection of the agroecosystem. The actors of agroecology were considered at the time to be farmers and scientists.

According to Wezel et al. [54], agroecology refers to "either a scientific discipline, an agricultural practice or a social or political movement". Thus, the definition of agroecology has evolved. The production and protection aspects of agroecosystems are integrated into more global aspects. Whether it is a scientific discipline, an agricultural practice or a social and political movement, agroecology today deals not only with agronomic and environmental aspects but also with social, economic, and development aspects. Through its different definitions in the scientific literature, agroecology is an effective solution to

the problems related to the homogenization of agriculture. In this study, the expansion of agroecology in France would implicitly allow a reintroduction of pulses. However, we note a divergence in the use of the concept of agroecology between the different actors depending on the sector (academic, institutional, technical, etc.).

2.3. Protein Autonomy and Pulses

Protein autonomy is currently at the heart of many debates in France. In a context of climate change directly affecting agriculture and thus the country's food sovereignty, it is becoming urgent to act on all possible axes [4]. The reintroduction of pulses could be a solution to the problems of protein autonomy thanks to their high protein content [55] but also of energy autonomy through their ability to fix nitrogen and to allow the reduction or independence from nitrogen fertilization [56].

Although the inclusion of pulses in cropping systems has agronomic, environmental, and economic interests [55], we note that legume acreage has declined significantly since the early 1960s. This decline is partly explained by the evolution of the seed industry in the world. The economy, including budgets for R&D in the seed industries, has focused on fewer crops [57]. Several crops including most pulses have not been the target of genetic innovations [58]. This increases the income gap for farmers between modern crops (such as soybeans) and crops that have not been the target of genetic innovation (such as other pulses) [57]. Pulses are thus "lost" crops in the process of agricultural homogenization. From an agronomic perspective, Voisin et al. [56] highlighted that "unsuitable mechanization, risks of leaf loss at heading, unpredictable qualities, and the impossibility of preserving them as fodder have favored the decline of legume areas" [56]. Stoate et al. [59], echoed by Magrini et al. [58,60], evoke the hypothesis of a technological lock-in of crop diversity, strongly impacting pulses and their reintroduction.

3. Material and Methods

This study focuses on the role of agri-equipment in the introduction of pulses in France because of the underpinning goal of protein autonomy from crops [61]. It is meant as an example to describe and understand the influence of agri-equipment availability and suitability in cropping system design starting from known crops, for which the evolution of the links between production practices and mechanization remains unclear. Namely, what is the availability and suitability of agri-equipment for pulse production using technical lock-ins specifically concerning pulses? The review of the literature presented in the previous section shows the multiplicity of actors involved in the topic. To achieve robust results, we posit the importance of a system perspective to include the different viewpoints. Indeed, the choice of a method to describe the sampling universe is needed to avoid bias of sectorial or partial survey samples. In this regard, we opted for the key informant approach. The following paragraphs address the background and validity of this approach, the deployment of semi-directive interviews, and the data treatment steps.

3.1. Analytical Approach: Key Informant Interviews and Sample Description

A key informant approach was chosen for this study. This approach has been used in formative research in various domains, e.g., for the description and understanding of agricultural practices and policies [62–64]. Marshall [65] defines a key informant as an expert source of information. Lokot [66] considers key informant interviews as "an in-depth discussion with persons who have special or expert knowledge". Key informant interviews conducted with experts allow researchers to obtain a broad perspective on a specific topic or process and allow for discovery and exploration when little is known about a topic of interest [67]. Key informant interviews involve interviewing people who can provide ideas and perspectives on a particular topic [68]. Some of the primary reasons for using key informant interviews are to obtain information that may not be captured by a survey or to better understand a system or a process [69]. Originally used in anthropological studies, key informants are now being used in other branches of social science investigation

and in agronomic studies, for example, to develop holistic descriptions of stakeholders' interlocks [70]. The concepts of key informants and key information belong to the field of human sciences, as they concern the analysis of the actors, their knowledge, and their know-how.

Key informants are considered as "remarkable" compared to others in the community and may occupy positions of power [65]. They can be community leaders or experts on an issue and are "owners" of important contextual knowledge [71]. Therefore, engaging with key informants can lead to "insider" knowledge [72]. Key informants may enable researchers to obtain greater access to communities, helping to identify additional research participants [73].

Tremblay [74] suggests that key informants are likely to have ideas that investigators can solicit and that this would able us to represent a variety of viewpoints and stakeholders concerned with the research question. Tremblay [74] defines the "ideal" key informant with five characteristics: *"a role in the community, knowledge, willingness, communicability and impartiality, objective and without bias"*. Considering professional positions, key informants can be gatekeepers, research supervisors, field coordinators, or others in similar roles [66].

A key element in researcher methodologies is the interaction between participants and the interviewer or facilitator [75]. Typically, interviews are semi-structured and can appear to be a natural conversation [68].

The choice of material used (e.g., phone interviews, online platform interviews, or meetings) is influenced by the informant's location and availability [76]. Phone interviews are least restrictive because they save travel (for interviewer) and can be arranged at a convenient time, but they might restrain the personalized interaction with the key informant [66] and therefore restrain observations of "valuable nonverbal behavior" [77].

3.2. Choice of the Key Informants

The key informants were chosen to learn about the processes in cropping system design, with a focus on the junction between the introduction of pulses and agri-equipment availability. The respondents were positioned on network nodes: conservation agriculture, innovative farmers, French chambers of agriculture, research and technical transfer, and industrial agri-equipment networks. The list of contacts was fed upon previous works about the French agri-equipment sector [78,79]. We ensured that all interviewees met the definition of a key informant and had the characteristics defined by Tremblay [74]. As such, priority was given according to the interviewee's ability to communicate: community federators and communicators were considered as providers of a richer discourse. The initial sample consisted of 20 people, 10 of which were interviewed. The list was then fed by a respondent-driven non-probability sampling technique to identify further respondents that were hard to locate [80]. As a result, 21 people were interviewed.

In relation to the questions asked, the expertise of respondents covered two domains agri-equipment and agriculture:

In the field of agri-equipment, we interviewed a director, an economic director, a technical director of an agri-equipment manufacturers' union, a project manager, a general manager, and an agricultural work manager of a union of agricultural enterprises. These respondents allowed us to address viewpoints regarding the sector and target respondents with strategic and decision-making positions.

From the agronomy and agriculture fields, we interviewed three farmers, two agricultural advisors, four agronomic researchers, and an applied research team leader. These respondents allowed us to address technical jobs that were close to the field and directly related to agricultural and agroecological practices. In this regard, we considered that agriculture transformation would not only be done *with* farmers but also *by* them: agri-entrepreneurship appears as a new paradigm based on the implementation of deliberate strategies to respond to liberalization and sustainability [81]. Of note, agri-entrepreneurship highlights a new "agricultural technical culture" [82].

3.3. Deployment of the Semi-Structured Interviews

The interviews with key informants are qualitative and, more precisely, semi-qualitative, i.e., the information collected concerns the interviewee's point of view as well as his or her own practices [83]. They were conducted using interview guides listing the questions to be covered during the session. The atmosphere of these interviews was informal, resembling a conversation. Questions were asked, and detailed notes were taken as the conversation progressed.

The interviews were composed of four pre-determined questions to cover the themes of the study. The exploratory nature of the study oriented us for semi-structured interviews to ensure comparability among the different respondents, while keeping the freedom to develop any themes mentioned by each of them according to their specific perspective about the study topic [84]. The interview outline was built around four questions:

(1) Can you introduce yourself and your current missions?
(2) Do you think that the availability of agri-equipment influences the design of the cropping system?
(3) Do you think that pulses require specific agri-equipment?
(4) How would you define agroecology?

Each semi-structured interview followed the same routine. First, a presentation of the general context of the study, the global issues, and the progress made. Then the four pre-determined questions were used to structure the discussion. Interviewees were further guided through follow-up questions that allowed us to explore any of their ideas and concepts of interest for the study. Interviews were conducted by different means, depending on the interviewees' availability: (i) face-to-face meetings, (ii) video-conference platforms, or (iii) telephone calls. Interviews were systematically recorded for complete transcription purposes except for one interview conducted by telephone, for which very detailed notes were taken instead.

First contact was through an email, then a follow-up email and then by phone call. Interviews were conducted by the same person from mid-September 2021 to mid-December 2021; each interview lasted between 30 min and 2 h. All interviews were conducted in French, which was the language used daily by all respondents. We conducted 16 semi-structured interviews, out of which 13 were with individuals and 3 were with groups; group interviews included two double interviews when the targeted interviewee spontaneously invited a colleague considered relevant for the topic, and one interview with a group of three people from a team working on the same topic. In total, 21 people were interviewed.

3.4. Data Treatment and Analysis

The interviews generated three types of data: video, audio, and text. Non-text files were prepared for transcription in four steps (Figure 1):

1. Standardization of the recording formats, respectively, from .M4A (audio) and .MP4 (video) to .WAV standard audio format;
2. Automatic transcription of the .WAV files using a Python open-source script [85];
3. Transfer of the raw text obtained from the automatic transcription in a summary table to separate the text associated with each of the four questions;
4. A manual review of the text for corrections to produce a clean file for each interview and a complementary file to summarize the key ideas for each interview.

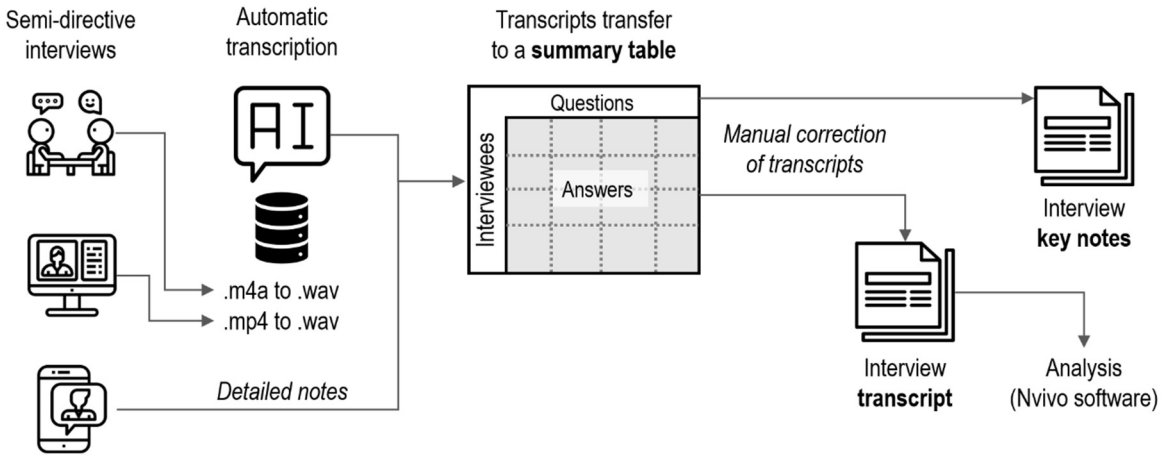

Figure 1. The four steps of the data treatment and analysis, from interviews to raw data preparation and final transcription with manual corrections and synthesis.

Altogether, the transcription phase was relatively time-consuming and took 6–7 h of work per interview.

Raw answers were coded based on the hypothesis that the respondents' views can be traced back to common ideas on the basis of an overall judgement of the researchers [84]. Coding was carried out on two levels (Table 1). First, coding matched the questions asked during the interviews. Two questions were added to account for the themes spontaneously mentioned by the respondents: the reintroduction of pulses into French cropping systems, mentioned by four respondents, and opinions on the agri-equipment market trends, mentioned by three respondents.

Table 1. Codes and sub-codes that were defined deductively to represent raw answers in the qualitative analysis.

ID	Question	Code	Sub-Code
	Explicit Questions		
E1	(1) Can you introduce yourself and your current missions?	Professional profile	Directly linked to farming No direct link to farming
E2	(2) Do you think that the availability of agri-equipment influences the design of the cropping system?	Equipment and cultural system	Illustration
E3	(3) Do you think that pulses require specific agri-equipment?	Pulses and specificity of equipment	Yes, requires specific equipment No, does not require specific equipment
E4	(4) How would you define agroecology?	Agroecology	Adapting practices to cope with changes Producing while respecting the environment
	Implicit questions		
I1	What do you think of reintroducing pulses in French cropping systems?	Reintroducing pulses	Positive opinion Negative opinion
I2	How is the agri-equipment market performing?	Agri-equipment market	Illustration

A sub-code was then defined to qualify the first code level deductively, according to the trends observed in the response patterns. We referred to opinions that could be negative or positive, and we referred to illustration for answers that did not have a positive or negative opinion by the respondents.

The coding was carried out with NVivo, a qualitative data analysis software, version release 1.3 (535). Encoding in NVivo allows for a quantitative visualization of the data and

responses according to the previously defined codes. For data description (determination of the most frequent words), a "word frequency" command is used in NVivo.

The first question concerned the respondents' background, areas of expertise, and current missions. Respondents were categorized into two groups to account for the diversity of professional profiles:

i. Directly linked to farming (N = 10): i.e., farmers, agronomy advisors, study engineers who work on plots lent by farmers, and farmers' group facilitators;
ii. No direct link to farming (N = 11): i.e., people with strategic jobs in agricultural macroeconomics and agri-equipment, politicians, and technicians. We based choices on the discourse of the respondents and the phrases used to describe their jobs; for example: "I am far from the field", "I do not work directly with farmers", and "this issue is very technical".

The diversity of the answers allowed us to have, through the opinions of the respondents, different illustrations. We will explain the answers according to the themes asked and the emerging themes (What do you think of reintroducing pulses in French cropping systems? and How is the agri-equipment market performing?).

The second question asked was about cropping system design and agri-equipment: "Do you think the available agri-equipment is related to the cropping system design?" The question was met with curiosity and misunderstanding. The definition of Sébillote [1] to explain the cropping system as *"a set of techniques implemented on plots treated in an identical manner"* was used. The cropping system and its design are defined by the crops chosen, the rotations, and the technical itineraries applied to these crops. We explained the available agri-equipment as being the agri-equipment already present in the fleet of equipment, on loan, rented, or purchased. Once the question was understood, answers were collected.

The third question dealing with the specificity of agri-equipment was defined for respondents as "characteristic equipment" that can be used or designed only for pulses.

The fourth question concerning the definition of agroecology is not only about defining agroecology; we also wanted to show the diversity of responses and therefore the diversity of understandings concerning the concept of agroecology.

4. Results

The first step was to extract the most frequent words. The occurrence of terms (Table 2) gives an overview of the content of the corpus. The term "soil" was clearly the most used. The second most frequent term, "farmer(s)", is probably related to the research target. On a first level, the following forms are nouns related to the world of the farmer: "practices", "culture", and "production" as well as "time" and "work" correspond to vocabulary related to the profession and to the field. Logically and on a second level, we found terms related to our main themes: "equipment", "pulses", "machines", and "technique" correspond to the first theme, as well as "agroecology", "change", "ecology", and "transition". The discussions were in line with the questions posed. Nevertheless, "share", "market", and "economic" conveyed the financial side of the farming profession: an economic connotation was strongly present in the different discourses without there being any direct questions related to the economy.

Table 2. Occurrences (frequency) per lexical field.

Lexical Field	Frequency	Word in French (Raw Data)	Word in English
Sol	129	Sol, sols	Soil, soils
Agri	123	Agriculteur, agriculteurs	Farmer, farmers
Be	99	Beaucoup	
Cul	98	Culture, cultures	Culture, cultures
Agr	93	Agriculture	Agriculture
Pe	93	Pense, pensé, pensée, penser, penses, pensez	Think, thinking, thought
Qu	84	Question, questionnements, questions	Question, questionings, questions
co	82	Coupe, couper, coupes, coupé	Cut, cutting, cuts
par	78	Part, parti, partie, partir	
tra	78	Travail	Work
pro	74	Productif, productifs, production, productions, productivité	Productive, production, productions, productivity
pra	74	Pratique, pratiqué, pratiquer, pratiques	Practice, practices, practicing
Leg	73	Légumineuse, légumineuses	Legume, pulses
Sys	73	Systèmes, système, système	System, systems
eco	73	Economie, économique	Economy, economic

In the following paragraphs, we present the results of the three explicit questions about the topic target. We identified five illustrations (an illustration being a thorough explanation or an explanatory example) about the influence of agri-equipment on cropping system design, four opinions about the requirement of specific agri-equipment for pulses, and two main definitions of agroecology. We then present the results of the two implicit questions (i.e., those that emerged spontaneously), as these helped to clarify the context for the study topic. These show the opinions held about the reintroduction of pulses in French cropping systems and illustrations about the trends of the agri-equipment market (Table 1).

4.1. Links between Agri-Equipment and Farming System Design (Question E2)

All respondents agreed that the availability of agri-equipment is related to the design of the cropping system. Within the consensus, nine respondents explicated their answers. The variability responses come in the examples given to illustrate these links (Table 3).

Table 3. Multiple illustrations about the links between agri-equipment and farming system design.

Type of Answer	Respondent	Content
Illustration E2.1	Three respondents, directly linked to farming.	These respondents believe that it seems obvious that the design of the cropping system is linked to the availability of agri-equipment: *"The planting of crops will be linked to the available equipment."* When thinking about design, two factors need to be considered: (i) crop rotation and (ii) agri-equipment that is adequate for cultivation operation. As far as the agri-equipment is concerned, the farmer or the farm employee who handles the tool may encounter blockages. By "blockages", the respondents suggest *"an inability to perform a technical operation"*. In this case, the farmer calls upon a contractor/service provider for these specific operations. While meeting farmers, the respondents noted the lack of some agri-equipment. Such a lack mainly concerns specific mechanical weeding operations with the aim of reducing phytosanitary products or shallow tillage, or direct seeding equipment under plant cover *"that passes through cultural residues"*. One respondent said: *"Although solutions may exist, in most cases, the investment is not worth it because the average cost of the practice will be exceeded."*

Table 3. *Cont.*

Type of Answer	Respondent	Content
Illustration E2.2.	One respondent, no direct link to farming.	This respondent assumed that two levels for evaluating the links between cropping systems and agri-equipment exist. These two levels depend heavily on the farmer. (i) The farmer innovates in the conception of his farming system. Agri-equipment, its availability, and its specificity are linked here to the conception of the cropping system. In this context, technical exchange groups exist between farmers and manufacturers. These exchange groups allow the farmer to express himself on the mechanical blockages experienced, and the manufacturer can take them into consideration. This respondent also noted a very strong increase in requests for soil cultivation tools and mechanical weeding tools. (ii) The farmer maintains a classic pattern in the design of his cropping system and does not necessarily take steps to change it. Agri-equipment offers a conventional view and a sufficiently wide range of products.
Illustration E2.3.	Two respondents, no direct link to farming.	These respondents expressed the complexity of links between the farming system and agri-equipment and highlighted the dependency that now exists. *"So, it is the machine that initially created an agronomic practice and today, the agronomic practice [requires] that we continue to build seeders at 75 cm, because we start from the principle that a seed drill is 75 cm. The equipment is so homogenized that if we want to change something, we have to change everything"*. The respondents illustrated the links between agri-equipment and cropping practices by recalling that in certain regions of France, the cropping operation is called by the name of the associated machine. In French, "charruer" is associated with the tool "charrue", which means "plow" for "ploughing". Otherwise, the most common term is "labour", associated with the act of "ploughing".
Illustration E2.4.	One respondent, directly linked to farming.	This respondent said, "*Farmers buy the tool first. Many farmers buy the equipment and then think about their farming systems"*. Mainly, young, recently graduated farmers are pushed through commercial approaches in schools and universities. The best tool the farmer can have is the soil. *"Once we understand the functioning and mechanisms of the soil, the best tool we have will be the soil".*
Illustration E2.5.	Two respondents, directly linked to farming.	These respondents believe that in France and in Europe generally, the farmer is "*spoiled"* by assistance plans, bonuses, and the easy access to phytopharmaceutical products and mechanical tools, so they think less about chemical and mechanical optimization options. The openness to agricultural practices in the world is very important when practicing agriculture. *"In several countries, access to chemicals and agri-equipment is very imitated, and this is where we can see that productive agriculture is possible without necessarily a lot of inputs or tools that could be harmful to the soil. The main tool is the seeder, and sowing remains the most important act."* To disturb the soil as little as possible, it is necessary to have an objective of a *"minimum of passages"*. Our respondents explained the difficulties they faced finding a seeder on the market that could adapt to their soil conservation practices. After unsuccessful searches in Europe and meetings with different manufacturers, a manufacturer explained to one respondent that it is up to the farmer to adapt his practices to the existing equipment.

4.2. Pulses and Specific Agri-Equipment (Question E3)

Responses to the question "Do pulses require specific agri-equipment?" were mixed. We have distributed them in a table according to the respondents' professional profiles (Table 4).

Table 4. Distribution of opinions concerning the specificity of equipment according to professional profiles.

Profile	Requires Specific Equipment	Does Not Require Specific Equipment	No Answer
Directly linked to farming	5	7	0
No direct link to farming	1	1	7

As the question was considered technical, seven respondents with no direct connection to the farmer refrained from answering this question.

4.2.1. Pulses Do Not Require Specific Agri-Equipment

The seven respondents who think that the establishment of *a legume does not require specific agri-equipment* agree that (i) a conventional seeder or a drill for seeding under plant cover would be sufficient to establish the crop, and that (ii) harvesting is possible with a combine harvester or tedding equipment.

4.2.2. Pulses Require Specific Agri-Equipment

While discussing agri-equipment for pulses, respondents tended to shift focus toward soil management (Table 5).

Table 5. Respondents' opinions concerning pulses requiring specific equipment. Quotes from the respondents are reported in italic.

ID	Respondent	Content
Opinion E3.1.	One respondent.	There are multiple ways of improving agri-equipment when it comes to soil conservation agriculture. Farmers engaged in soil conservation practices are "experimenters". The goal of these farmers is to minimize soil disturbance. Thus, the three pillars of conservation agriculture are (i) direct seeding, (ii) permanent soil cover, and (iii) crop diversification. Among the most common soil conservation practices are developing associated or double crops and implanting pulses for soil coverage. Therefore, sowing is the most important practice. There are areas of improvement for seed drills on two levels: (i) the distribution of varietal mixes and (ii) the seed drill as it is marketed today, which does not consider soil types or sowing conditions. Moreover, *"there are no tools that allow fertilizer to be applied at the same time as sowing or tools that allow one to bury fertilizer without disturbing the soil"*. This facilitator also said: *"There are also no seeders equipped with mowers capable of homogenizing crop residues on [the] surface at the same time as sowing, and at the same time [limiting] pest damage and the risks of competition with the main crop"*.
Opinion E3.2.	One respondent.	Regarding harvesting, the harvesting tool could adapt to the spacing when a spring crop is to be planted at narrower spacings. Similarly, the harvesting tool could be designed so as not to interfere with the crop canopy. *"It is even possible to imagine a harvesting tool capable of sorting two or more associated crops"*. Another respondent has the following, seemingly relevant idea: *"Machines related to the harvesting of pulses are often marketed by importers, who historically went abroad to find technical solutions for crops that were not very developed in France at the time"*. These are often small companies where the manager is also in charge of the commercial part. Therefore, these manufacturers keep a close link with the end user of the machines and must have the technical bases related to the target crops. This respondent notes that the risk for these small businesses would be phagocytosis by larger companies once purchasing trends are verified.
Opinion E3.3.	Two respondents.	*"We are farmers to produce, to earn a living, and to be economically and ecologically sustainable in our production act. The adaptations we make are the adaptations we make to this act of production."* One respondent explains that the reality of the farmer's job is to produce with different challenges implemented in the act of production: economic, climatic, social, and territorial changes. The agricultural enterprise must anticipate or undergo external constraints and impose the necessary adaptations. Soil conservation agriculture would make it possible to adapt to local territorial constraints. The changes we make are not constraints coming from the outside but internal choices that respond to external issues. The most solid choice should not be made at the material or machine level but rather at the human level. Farmer's job should be to be able to transform external agropedoclimatic constraints into advantages for the farm. In France, a farmer is not recognized as a change maker. On the one hand, the actor does not participate in the decisive governmental or industrial reflections. On the other hand, agriculture is subjected to external decisions and lives them as additional constraints. The respondent presumed that farmers are not autonomous in any of their choices. Although being the most important link in the production chain, the farmer is positioned at the bottom of the decision pyramid and, in most cases, "*is pushed to buy equipment, fertilizers, or phytopharmaceutical products or seeds"*. One respondent told us that the implementation can have an impact, but it is not enough. His experience began with a reflection on how to perpetuate the farm while producing and preserving the environment. This was completed over several years and required reading, exchanges, and adaptations of the equipment. The respondent stated that conservation agriculture with its three pillars (no tillage, permanent soil cover, and the diversification of species) corresponds to his vision of the farming profession. According to the respondent, the practice of soil conservation allows for the resilience of the farm to territorial conditions and allows for the reduction in mechanical costs by reducing the amount of equipment but also and most importantly allows for the reduction in carbon emissions.

Table 5. *Cont.*

ID	Respondent	Content
Opinion E3.4.	One respondent.	For one of the farmers we interviewed, the reflection concerning installing culture should not start with choosing the agri-equipment but rather with the conditions necessary for the ideal development of the crop. For a perfect legume crop, it is necessary to have successful sowing and harvesting. For successful sowing, the soil must be aerated and warmed. There is no real need to plow, but if there is a need, the soil must be dried. For harvesting, a combine harvester will be needed. *"It is not necessary to have specific agri-equipment. The most important thing is preparing the soil."*

In conclusion, there are development paths in the design of tools that combine agronomic practice (fertilization, homogenizing crop residues, the destruction of a cover crop, etc.) with seeding. This would have two main results: (i) minimizing soil disturbance, which will have an agronomic positive effect: organic matter improves structural stability [86], and (ii) the increased presence of plant residues on the surface protects the soil surface from erosion and acts as shelter and food for living organisms, minimizing fuel [87–89] use, which will have economic and environmental advantages: the reduction in mechanical costs and GHG emissions, and therefore decarbonation [90,91].

4.3. The Diversity of Definitions of the Concept of Agroecology (Question E4)

For all interviewees, agroecology maintains production as the major objective of agriculture. We can group them according to two opposite visions, which are defined as follows:

Definition E4.1. The first one is clearly politically oriented and comes from people with little or indirect contact with daily agricultural practices: no direct link to farming. This vision links agroecology to environmental labels (high environmental value, organic agriculture, sustainable agriculture, etc.). The labels will promote and valorize agroecology. The farmer must follow a set of specifications, guaranteeing his or her good practices. The farmer should follow a set of specifications that guarantee good practices with the risk of standardization and institutionalization of agriculture [92] less adapted to specific agro-pedo-climatic conditions.

In this vision, agroecology is a clear concept juridically defined as "the ambition of a transition of the agricultural sector towards systems which, by relying on the valorization of natural processes, simultaneously combine economic performance, environmental and sanitary performance, and social performance".

However, this supports the intensification of plant cover, hedges, and the use of soil conservation methods, thanks to the integration of farmers reflecting the agro-ecological transition, the valorization of products, and the support of several aids. In this political vision, the technical and research institutes and the chambers of agriculture are the interlocutors for implementing projects and providing feedback from the field throughout the territory. *"The whole complexity of support is that there are contradictory objectives. There are injunctions, and the role of the decision-maker, legislative or executive, will be to arbitrate and intervene in case of conflict".*

Definition E4.2. The respondents who are closest to the agricultural activity basically associate agroecology with agroecological practices, with some reticence concerning the term "agroecology". They express the will to practice agroecology while ensuring the economic, environmental and sociological viability of the farm. To succeed in the agroecological transition of the farm, these farmers stress the importance of (i) scientific documentation and the international openness of practices and agronomic alternatives concerning the use of inputs, tillage, or the reduction in farm expenses, (ii) understanding the elements that make up the farm and mainly the soil, and (iii) choosing, or even modifying, the necessary agri-equipment in order to disturb the soil as little as possible.

4.4. Reintroduction of Pulses into the French Cropping Systems (Question I1)

In this emerging question, one respondent had a positive opinion, and four respondents had a negative opinion (Table 6).

Table 6. Opinions concerning reintroducing pulses into the French cropping systems.

Positive Opinion		
Opinion I1.1.	One respondent, no direct link to farming.	One respondent mentioned the political and governmental network that supports agroecology through support and financing and on several axes, including the multiplication of cover crops and the reintroduction of pulses. In this context, we mentioned the "France Relance" plan and its "plant protein strategies" section. France Relance is a national strategy for the development of plant proteins, launched in December 2020 and endowed with more than 120 million euros. The aim of this strategy was to reduce France's dependence on plant protein imports by promoting forage autonomy on livestock farms, and by developing a supply of local pulses products (lentils, chickpeas, beans, etc.)
Negative Opinions		
Opinion I1.2.	One respondent, no direct link to farming.	One respondent thinks that reintroducing pulses and, more broadly, the protein autonomy quest in France requires a step backwards in thinking. Pulses have long been a subject of debate. Legume acreage fluctuates depending on several policy factors. An initial stimulus plan for protein autonomy launched in the 1980s would have allowed for a jump in legume acreage. Pulses were easy to plant and were what could be called "virgin crops". The respondent explained that a "virgin crop" is a crop that is outside the usual rotation pattern in the regions concerned. This makes it less disease-prone and a more resistant crop. There are different concomitant reasons for the difficulty of inserting pulses: Agriculture in France has undergone an evolution by the shortening of rotations, strong competition, and the opening of international markets concerning vegetal proteins. Pulses have become much less attractive.
Opinion I1.3.	One respondent, directly linked to farming.	One respondent mentioned the importance of the sector and the food chain organization in the development of pulses. It would seem that "*Pulses are not a crop "by default". The sector is poorly organized; the markets are very specific and small, and there is no real desire to organize*". Indeed, by naming pulses as a "default crop", the respondent is emphasizing the idea that the legume does not fit into a conventional rotation pattern. The production of food pulses in France is organized in production niches and depends on the species cultivated. For example, the production of green beans and peas depends strongly on the industrialist concerned and is implanted in the region.
Opinion I1.4.	One respondent, no direct link to farming.	*"It's easy to talk about awareness when it comes to the revival of pulses."* Several personalities in France call for the revival of pulses to *"loosen the constraint of vegetable protein production"*, which will encourage French food sovereignty. One respondent evoked a historical dimension to the non-development of pulses despite the various European and governmental stimulus plans. The current operation is based on a free trade agreement established in the 1960s. This agreement defines American countries as producers of vegetable proteins and European countries as producers of starch. This is what creates the dependence on foreign plant proteins experienced in France today. The dependency rate is calculable: "*I do not know if we can reach this level of disaggregation of nomenclatures, but the input/output database makes it possible to measure the dependency rate even abroad, and the dependency rate has increased between 2000 and 2015.*" The respondent believes that to reintroduce pulses, it will be necessary to break a habit and is skeptical of the real will of the authorities to modify the existing agreements.

4.5. The Agri-Equipment Market: Towards an Agroecological Shift? (Question I2)

The three respondents that mentioned spontaneously their views on the agri-equipment markets in France simply provided illustrations, with no positive or negative opinions. All of them were not directly linked to farming (Table 7).

Table 7. Opinions concerning the agri-equipment market.

ID	Respondent	Content
Illustration I2.1.	Two respondents.	One respondent explained that as far as the specificity of agri-equipment is concerned, the industries build machines that the market "expects" but not the machines that the market "could expect". It is very rare that industries take risks on very specific tools. There are innovative farmers in France who have become agri-equipment manufacturers. These equipment manufacturers remain close to the field and to the farmer's job. They have the capacity to create new machines that meet emerging needs in the field. The originality of these manufacturers does not only come from the fact that they are from the farming profession. It also comes from the fact that the equipment they propose is more modular and concerns simplified cultivation techniques and soil conservation.
Illustration I2.2.	One respondent.	One respondent said that the French agri-equipment market is very dynamic and healthy with a growth rate of 1% to 2% per year. It is also cyclical and characterized by oscillating cycles that last two to three years. The oscillation and dynamism of the agri-equipment market can be explained by a period of non-investment in the past followed by a period of catch-up and reinvestment. In terms of investment by farmers and local authorities, the tractor remains the leading item purchased on the market, followed by equipment for green spaces, wine-making equipment, and agri-equipment. For a long time, the agri-equipment market remained within the paradigm of engine power, but it is now beginning to evolve by adopting robotics, for example, and by taking an interest in agroecology. However, for manufacturers, agroecology remains a trend today. "*Industries are [. . .] followers as far as the agroecological transition is concerned. It has to be done in the agricultural world, and then it will be followed by industries*".

5. Discussion

This study allowed for the identification of close links between agri-equipment and pulse production. We examine below distinct levels of these locks to finally discuss some perspectives.

5.1. Study Limits

Respondents included many farmers committed to practices corresponding to their ideologies. During the first contact, we presented the main project from which this study derives. As we explained the funding that we were granted, we discovered difficulties convincing some of these farmers to talk to us, as they had doubts about such a project partly granted by manufacturers. This confirms the early observation of a lack of dialogue and trust between farmers and manufacturers, which has been regularly confirmed by both some manufacturers [29] and some farmers [27]. In summary, we highlight a partial bias in the interviewed farmers through the selection of those who finally accepted the interview.

Automatic transcription via a script available in open source allowed for time optimization. However, transferring the speeches into a summary table was required to standardize the responses and silo reading.

The distribution of the respondents into two categories according to a direct or absent link to farming allowed us to have results on two themes: (i) the specificity of agri-equipment for pulses and (ii) the definition of agroecology. This distribution did not yield significant results for the other themes.

A strong movement in the agri-equipment sectors and among farmers can be described. This movement concerns the ecological and energy transition. The interviews with key informants confirmed the limited timely relevance of their answers because of the rapid evolution of this sector. Any advice, proposals, or speculations were typically dated.

5.2. Farmers Involved in a Soil Conservation Design Cropping System around Farming Practices

One respondent (E2.1.) was consistent with the literature regarding crop rotation. The practice of crop rotation has existed since the first century BC [93] and is still used today. It can therefore be said that crop rotation is an integral part of a farmer's thinking. Agri-equipment is a necessary condition for agriculture [94], since agricultural activity consists of a series of technical acts in succession. These all require specific equipment. Agricultural equipment is designed for productivity and efficiency [35]. The use of agri-equipment is therefore also an integral part of a farmer's thinking. In the French context, there is little

literature about agri-equipment availability and the shortcomings of agri-equipment for specific agronomic acts. However, Bournigal et al. and Imbert, Petit, and Siben [95,96] note the necessity of adapting agri-equipment to current challenges, be they agronomic, environmental, social, or economic. This has been also demonstrated by the DiverIMPACTS project, whose working package 5 highlighted the interdependency between the availability of suitable equipment and its high capital investment [26].

As mentioned by (E2.2), it is a fact that farmers innovate in cultural system conceptions. Goulet et al. [97] states: *"Farmers are not only producers: they constantly adjust their actions and their knowledge, they adapt to changes, and sometimes they create technical and organizational novelties that can then be taken over by others to become market products or standard."* They are supported by Salembier et al., Magrini et al., and Vall et al. [98–100]. Such technical creation and organizational novelties could be completed individually but are mostly achieved in a group context [97,98,101].

Some respondents (E2.4, E2.5, E3.1, E3.3 and E3.4) engaging in soil conservation practices explained the importance of cropping systems, understanding the soil and its structure, and preserving it. Agronomic information concerning conservation agriculture given by respondents match the literature. In conservation agriculture practices, soil preservation is a fundamental axis [102,103]. Conservation agriculture concepts include minimum soil disturbance, permanent soil cover, crop rotation diversification, and integrated weed management [102–106]. As mentioned by these respondents, permanent soil coverage enhances soil biological activity and biodiversity, soil quality and soil carbon sequestration [23,102,104,107,108], and water quality [109]. An ongoing European research project also found the need for "more suitable mechanization in the context of crop diversification for strip cropping, mechanical weeding and no-tillage practices" [26].

Some respondents emphasized the importance of thinking about farming practices before thinking about agri-equipment: agriculture practices are at the center of their reflection [110]. Reflection concerning agri-equipment comes afterwards. Farmers in soil conservation practices would look for suitable agri-equipment abroad, look for small manufacturers, or adapt their equipment themselves. The farmers that responded to the interview demonstrated a high degree of autonomy and were mostly engaged in conservation agriculture and/or moving toward very low-input agriculture. They showed an ecosystem approach to agriculture that is sustainable. Today, the terms used are relay cropping, double cropping, soil conservation, direct sowing in live and plant cover, living agriculture, and regenerative agriculture. The selection of such farmers as key informants, having leadership and being specifically innovative in the agroecological sense, was made according to their roles in the agricultural structures and by searching in agricultural networks on the Internet.

We have noted that soil conservation farmers accept a continuous learning disposition. Each farmer we met asserted the importance of exploration in the farming profession. This exploration is done through (i) experimenting with practices in the field, (ii) tinkering with agri-equipment to adapt it to their own practices, and (iii) sharing experiments and failures with other farmers. The farmer in soil conservation thus assumes the position of an entrepreneur and sometimes that of an inventor.

5.3. Discussion on the Specificity of Agri-Equipment

For the question regarding *"specific equipment for pulses"*, it was difficult to remain focused on agri-equipment. In fact, almost systematically, the reflection was diverted toward agricultural practices and soil.

Bournigal et al. [95] mentioned that room for improvement in agri-equipment is consistent with conservation agricultural concepts, such as reducing soil disturbance. Conservation agriculture needs better access to suited machinery [110] to be practiced in larger scales [111]. Pulses are used in soil conservation practices to cover the soil. Nevertheless, pulses related to soil conservation practices call for the development of specific agri-equipment according to respondents.

5.4. Agroecology Is Production-Oriented but Key Informants' Views Diverge

In the first definition, the respondents without a direct link to farm activities associated agroecology with regulation by labeling. One respondent emphasized the importance of integrating the farmer with the global reflection concerning agroecology by emphasizing farmer's capacity to valorize his products. In this instance, the farmer is not systematically involved in decision making. This centralizing vision might be insufficient for an effective agroecological transition.

In the second definition, which was given by the respondents from the group linked to farmers, agroecology is associated with learning, curiosity, and open-mindedness about practices in the world. For respondents, it is important that a farmer freely chooses to practice his job and to adapt his cultural choices and practices to the specific characteristics of his farm. It is possible to associate this definition to an entrepreneurial approach, as the farmer is a "risk-taker". Ahmad and Seymour [112] citing Knight et al. [113] consider the entrepreneur as a risk-taker, or a bearer of uncertainty, although this uncertainty is difficult to measure. Entrepreneurship is about identifying and acting on opportunities that create value (be it economic, cultural, or social). In general, entrepreneurial activities require leveraging resources and capabilities through innovation [112]. The value created by these farmers can be economic, environmental, agronomic, and social. This refers to entrepreneurial activity that creates value through innovative processes or new markets and reflects on the importance of the creation of new markets through business births, i.e., value creation (e.g., high-growth companies). Through the prism of agri-equipment, the definition of agroecology associated with an entrepreneurial approach could confirm trends in agri-equipment innovation, in this case for soil conservation practices. Researchers consider the position of the farmer as a carrier of knowledge. Farmers' innovations track methods [114] considering agri-equipment could help move one step further in effective agroecological transition.

Today's ambitions for agriculture, with agroecology in the lead, require devising farming systems adaptable to social and ecological uncertainties and recognizing and embracing the diversity of situations in which farming is practiced.

5.5. The Agri-Equipment Market

The French agri-equipment market is summed up by the yearly economic report of the professional association of the sector called AXEMA. The total turnover for the sector ranged from 11.4 to 12.7 million euros between 2017 and 2020, with a reduction of 4% between 2019 and 2020. Therefore, the turnover appears to be slightly growing across time [115]. A focus on the market value including only the machinery production shows alternating growth trends and stable periods in the last 10 years, especially with the increase in production export [115]. This convergence was affirmed by one of the respondents, even though the cyclicity appears to be over a period of three to four years (Illustration I2.2). Nonetheless, the trade balance shows a constant negative trend, with a coverage rate (expressed as the ratio between exports and import) of more than 70% after 2019 [115]. The greatest part of the turnover was achieved in France by local subsidiaries of foreign manufacturers. The French producers are mainly specialized in viticulture and crop protection, but new players have emerged in the robotic and automation sector [116].

Based on the observation of a farmers' group supporting agri-equipment design adapted to agroecological practices, i.e., the "Atelier Paysan", Salembier and colleagues [117] stressed the feedback from farmers regarding a mismatch between the agri-equipment designers and the evolution of farming needs [114]. Beyond this single case study, the development of agricultural robotics is expected to reinvigorate the combined design between machines and farming systems [118]. At the world level, agri-equipment manufacturers show two main trends. On the one hand, those based in China and India pursue an increase in sales volumes through low-cost (and low-tech) machinery [119]; this accounts for the complete lack of mechanization packages for most crops, which eventually leads to an abandonment of farming [120] or a move toward agricultural modernization [121]. On the

other hand, the major players based in developed countries continue to focus on precision farming as an innovation trajectory [119,122].

In this vein, the design of agri-equipment is expected to be innovative either by theoretical expectations for better agroecological performances [122,123] or by a system- and sustainability-oriented perspective that should be able to account for agri-equipment that is appropriate for farmers [120], especially small farmers [114,124]. These examples highlight the contrast between the homogenization trends in the European equipment pool determined by the small number of major players that increasingly focus on the technological sophistication of agri-equipment [119] and the expectation for appropriate agri-equipment for specific practices (cf. Opinion E3.2).

5.6. On Pulse Reintroduction

Another reason for the non-development of pulses areas was mentioned by one respondent (I.1.4). In fact, free trade historic agreements in favor of vegetal protein and more specifically soybean imports were mentioned as an explanation for the lack of increase in legume areas in France [58,125,126]. In this same context, another respondent (I.1.1.) mentioned the France Relance recovery plan [127] for the reintroduction of protein cultures, particularly pulses, into French farming systems. It is possible to note an inconsistency between the prevailing free trade dogma and the recovery plan.

6. Conclusion and Perspectives

This study addressed the role of agri-equipment in the cropping system design, with a focus on pulses as an example of crops using both generic and specialized machinery. We opted for a key informant approach as a first step in the description of the complex agri-equipment sector within a system perspective. The results proved to be robust as they confirmed the trends already observed by partial market analyses, while they highlighted some specific issues to be considered in future surveys and sample selection. It appears, from all interviews, that agroecology or even agronomy are rarely, if at all, thought of as being in connection with agri-equipment. It was stated in these interviews that most farmers choose their practices according to the equipment they have, though not all of them. Nonetheless, further research is needed to identify the modifications of the agri-equipment, which are carried out in farms and by farmers, the new types of equipment, and the specific use of available equipment, according to entrepreneurial capabilities and bricolage [128]. We noted from our discussions with farmers that soil conservation in crops might be economically tenable while being agroecological. We note that the reduction in land area is not necessary to achieve agroecological objectives. On the contrary, increasing land area allows for greater flexibility in innovation and economic ease. We will focus on a larger sample of farmers using soil conservation practices and on ways to improve agri-equipment.

Initially, we associated a potential blockage to the development of pulses with agri-equipment. With this study, we found that blockages associated with agri-equipment are more related to pulses used for soil coverage in conservation practices than to pulses as crops.

This research opens up new perspectives. First, although soil conservation agriculture has been researched for almost a century, its aim is consistent with anthropologist Philippe Descola's analysis of "Beyond Nature and Culture" [129] and seeks a new mythical alliance between humans and nature. The new term "regenerative agriculture" may be more representative of its goals and is already used by some SCA farmers. This new approach may foreshadow the complex future of agriculture.

A second perspective is that this agroecological agriculture that places farmers at the heart of agricultural change accepts the need for interdisciplinarity in agricultural research and thus recognizes both adaptation to local conditions and complexity together [130,131].

A third perspective is that agronomy, at all scales of analysis, cannot exclude the human and social sciences. Indeed, the new approach to agronomic sciences will have

every interest in accepting that agronomy is a human science, because farmers and human society are now considered as part of the entire agricultural system.

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Institutional Review Board Statement: Not applicable as this is a non-interventional study on humans. Prior to the interviews, interviewees were informed of their rights according to the Regulation (EU) 2016/679 (General Data Protection Regulation) and given their informed consent to treat and publish interviews content in a pseudonymized way.

Informed Consent Statement: We obtained verbal consent from all respondents before recording. We also informed them that we would process the data anonymously and that the purpose of the interview would be the publication of an article. We are also committed to sharing the final results with them.

Data Availability Statement: The summary table of the interviews is available upon request and will be made available on an open repository after anonymization.

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