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An intensive and collective style of farm work that enables the agroecological transition: A case study of six French farm machinery cooperatives

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The higher intensity of labor observed in many agroecological farming systems has been little studied by the scientific community, especially in terms of work organization. Narrative interview research concerning 34 farmers in six French farm machinery cooperatives, on the basis of the farming styles framework, allows us to highlight a specific style of farm work conducive to the agroecological transition. Farmers members of these cooperatives have developed a long-standing reliance on peer-to-peer cooperation, gradually shaping a labor-intensive and collective style of farm work to make their conventional farming systems viable. They have then remobilized with relative ease the structuring basis of their initial organization of work, i.e., labor intensity and peer-to-peer cooperation, to develop agroecological practices.

KEYWORDS

farm work, farmers' collectives, agroecology, farming styles, farm machinery cooperative

Introduction

A growing body of research studies has highlighted the larger employment benefits of agroecological farming systems as compared to conventional ones, with higher requirements of labor per hectare or animal on agroecological farms (Midler et al., 2019; van der Ploeg et al., 2019). This greater intensity of labor needed for agroecology appears paradoxical. On the one hand, labor intensity is considered to be positive because of the larger employment generated by agroecological farms, allowing the counterbalancing of lower activity and employment generated in the upstream sector. The labor intensity results from the replacement of non-renewable resources by knowledge and labor time to better base the farming system on local ecological functionalities and resources. On the other hand, it is considered to be negative, since agriculture in developed countries is seeing a steady decline in the active agricultural population due to a substitution of labor by capital and the low attractiveness of agricultural jobs (Bertin et al., 2016; Devienne et al., 2016; Massis and Hild, 2016; Carlisle et al., 2019; van der Ploeg et al., 2019). This article does not discuss this paradox, but examines the fact that the details of the intensification of labor that takes place and evolves during the processes of agroecological

transition, as well as of the on-farm work organization that enables this labor intensity, has largely been ignored by the research efforts that have focused on these paths of change (Midler et al., 2019).

An analysis of the processes of agroecological improvement undertaken by French farmer members of machinery cooperatives has allowed us to study such processes (Lucas, 2018). French agricultural equipment cooperatives (known in French as CUMA, for *Coopérative d'Utilisation de Matériel Agricole*) are the most widespread network for inter-farm cooperation in France, with nearly 12,000 existing cooperatives, involving more than one third of all French farms (Jeanneaux et al., 2018; Lucas et al., 2019). A part of the French farmers who are undertaking a transition to agroecological practices relies on these cooperatives to do so (Lucas, 2021).

An action-research project undertaken in collaboration with the National CUMA Federation (or FNCUMA, for *Fédération Nationale des CUMA*) had the goal of examining the collective processes within the CUMAs that facilitate the development of agroecological practices. It aimed at addressing several questions, including: How was the on-farm work organization of the CUMAs' members before they changed their practices? How did the farm work organization change during the transition process? What are the new features of their agroecological farm work organization? Our study, based on the farming styles approach (van der Ploeg, 2003, 2012), of six cooperatives, whose members are developing agroecological practices widely adopted across the French CUMA network, namely conservation agriculture or legume cultivation, reveals a labor-intensive and collective style of farm work.

The article starts by summarizing the state of the art of the CUMA in the context of work issues, as well as of agroecological ones. It then explains the analytical and methodological framework, based on the farming styles approach. Then the research results are discussed in Parts 4 and 5. Part 4 examines the labor intensification approach adopted over many years by the interviewed farmers, and its collective nature, in the form of reliance on peer-to-peer cooperation. In Part 5 we analyze how the farmers have modified and repurposed this approach to develop new practices that contribute to agroecological improvements in their farming systems. Finally, the article concludes by considering how further research could help improve our understanding of this style of farm work.

The French farm machinery cooperatives: Between productivism and agroecology

The first CUMAs date back to 1945. They were created to facilitate the mechanization and modernization of French agriculture. These cooperatives are meant for the sharing not only of equipment and labor, but also of hired workers and buildings.

The CUMA constitutes a useful entry point for analyzing farmers' work, as it is based on the pooling and sharing of equipment and labor. Labor sharing is especially well-developed through the CUMAs, as working together is often the best way to share machinery and to avoid a competitive situation in which more than one farmer wishes to use the same piece of equipment at the same time. Various labor-sharing arrangements exist in CUMAs, such as the joint organization of tasks and mutual help. Another labor-sharing concept is the time bank, a system to better balance exchanges of labor among farmers by keeping record of each individual's contribution (labor given or received, machinery lent or borrowed, services given or received, driving and repairing of the common machinery, etc.). Delegation of work is also a characteristic in the CUMAs, as 15% of them employ hired workers (a total of 4,800) to maintain and/or drive the equipment (FNCUMA, 2019) (See Box 1 for more explanations about the structure and management of these cooperatives).

In developed countries, farming is mostly mechanized. Indeed, the substitution of human labor by mechanization was a strategic component of these countries' agricultural modernization processes. This reliance on labor-saving technologies has led to a scarcity in the agricultural workforce that is being felt now during the agroecological transition (Aubron et al., 2016; Carlisle et al., 2019). CUMAs have contributed to this situation, as many of their members rely mainly on it for economical access to high-capacity equipment to increase their farms' physical labor productivity (Harff and Lamarche, 1998; Jeanneaux et al., 2018).

And yet, the network of CUMAs also forms the backdrop for a renewed interest on the part of farmers in developing ecological practices to improve their farming systems. Since the 1980s, some CUMAs have taken initiatives that pertain to agroecology: purchases of specialized harvesting equipment necessary for more diversified farming systems; setting up of facilities to transform wood waste from the maintenance of farmland hedges into wood chips for local heating systems; and shared facilities for composting or methane production from local biomass materials (Pierre, 2009; Meynard et al., 2018). CUMAs can also assist in the relocalization of strategic resources for agroecological adaptation, for instance by making shared investments in seed-cleaning or seed-sorting equipment or in collective kitchens for local food processing (Cholez and Magrini, 2014; Terrieux et al., 2021). More recently, new French public policy measures aimed at supporting the agroecological transition have imparted greater visibility to farmer-initiated collective projects within the CUMAs, with increased pooling of new productive resources (harvests, knowledge). These initiatives are leading to collective investments in specific new machinery for shared use (Lucas et al., 2019).

The development of agroecological practices through the CUMAs raises new questions: How do some farmers, members of CUMA, develop agroecological practices whilst increasing

their collective investments in machinery? What are the effects of these practices on work organization?

Research approach

This section explains the theoretical framework, the case-study approach and the methodology we have adopted.

The farming styles approach

The farming styles approach has been developed over the past three decades to understand the heterogeneity between farmers within homogeneous settings (van der Ploeg, 2003, 2012, 2018; Sturaro et al., 2009; O'Rourke et al., 2012). In this approach, scientists consider how farming processes and systems are linked to technology and markets, and thus to access to and use of resources (including land, labor, capital, water, and knowledge). This allows them to conceptualize the specific ways in which the labor process in farming is organized (i.e., how the process of production is organized as well as how the farm develops over time) (van der Ploeg, 2003). Thus, farming styles are patterns of selection of technologies and market relations that determine a specific structuring of the production process. The farming styles approach has been mobilized to characterize the features of some agroecological farming systems (van der Ploeg, 2000; Schmitzberger et al., 2005; DuPuis and Block, 2008). By focusing on technologies, this approach first addresses the issue of equipment, which is closely tied to issues of work. Second, by focusing on markets, this approach addresses the production process and the labor required for it, since it examines the use of external productive resources in comparison with internal resources, as well as the ways in which value is derived from products (recycled in the farm system, sold through long or short marketing channels, exchanged with colleagues, etc.).

As far as the issue of work is concerned, the farming styles approach then considers the two following dimensions:

- First, the farmers' relationship with technology, i.e., the way farmers mobilize the equipment and other technical devices, and their consequences on the work dimension in the farming system.
- Second, the farmers' relationship with the inputs and outputs markets, i.e., the way farmers mobilize their productive resources (such as seeds, fertilizers, organic matter, feed, etc.) and derive value from their products, and their consequences on the work dimension in the farming system.

Selection of case studies

This research project had the goal of understanding the CUMAs' contribution to the development of agroecological practices. Our research was based on the study of six CUMAs (see Table 1) and used an analytical framework constructed

TABLE 1 Characteristics of the CUMAs surveyed.

Geographical area	Farms surveyed in each CUMA	Main collective activities	Farm practices developed
French Basque Country Foothill pastures	Three farms: two dairy sheep farms, one dairy goat and sheep farm	Sharing of a collective hay dryer, training program for members	Development of forage legumes
Tarn Arable & crop-livestock farming	Six farms: two dairy farms with milking robot (one organic), four grain farms (one organic)	Sharing of direct seeding/minimum tillage equipment, mutual help, seed exchanges	Minimum tillage and direct seeding, winter cover crop, crop diversification
Ain Crop-livestock farming	Six farms: four dairy farms, one dairy goat farm, one grain farm	Sharing of a collective hay dryer, with a shared employee, mutual help	Development of forage legumes, crop diversification
Aube Arable farming	Five farms: two sheep-meat farms, one cattle-meat farm, two grain farms	Sharing of direct seeding/ minimum tillage equipment, mutual help through a time bank, seed exchanges, cross-farm grazing of cover crops	Minimum tillage and direct seeding, winter cover crop, crop diversification
Loire-Atlantique Crop-livestock farming	Four farms: three dairy farms, one grain farm	Sharing of tractor and no-till equipment, comparison of results and agronomic training	Development of no-till agriculture and winter cover crop
Touraine Crop-livestock farming	10 farms: two dairy goat farms, seven dairy farms (five with milking robots), one cattle-meat farm	Sharing of hay-making equipment adapted to legumes, collective experimentation program, arrangements between livestock farmers and grain farmers	Development of forage legumes and winter cover crop, crop diversification

according to an iterative process. Case studies were identified with the assistance of the National CUMA Federation, and were intentionally chosen to include a range both of geographies (different parts of France) and of farming systems. In addition, the six case-study CUMAs were selected because their cooperative activities supported two types of practices: (1) the introduction of forage legumes into the farming system; and/or (2) a shift toward conservation agriculture with reduced herbicide use (see Box 2). FNCUMA data show that shared investments in equipment specific to these two types of practices have increased in recent years.

Methodology

In line with the literature on the farming style approach, we examine the farming styles within the case studies at two levels. First, at the level of the production system composed of subsystems (livestock, crop and processing systems) (Cochet, 2015), which corresponds to the scale of elementary production and management units. Second, at the level of organizational arrangements between farms. We then focus on the surveyed farmers' individual and collective methods of mobilizing productive resources and of deriving value from their products. We also examine how farmers include technologies and equipment in their farming systems. To assess the change in labor intensity due to adoption of agroecological production, we also examine if and how each introduced agroecological practice raises new issues or workloads to manage. Finally, we examine the ways in which farmers address these induced constraints.

Thirty-four individual narrative interviews were conducted of farmers belonging to the six selected CUMAs in the autumn and winter of 2015–2016. Since not all members of the case-study CUMAs (with the exception of the CUMA in Ain region) shared equipment suitable for legume-based forage and/or conservation agriculture, only members using the common equipment needed for these practices were interviewed. The interviews were designed to ascertain the farmers' justification of the practices they developed on their farms in this regard, as well as their trajectories of involvement in their CUMAs. We analyzed the farmers' narratives to identify their justifications. These narratives were collected using the "guided autobiography" method (Olivier de Sardan, 1995). Each farmer was asked to recount all or part of his or her lived experience (Bertaux, 1997). We adopted an analytical posture that aimed to characterize the farmer's professional or social

BOX 1
How does a CUMA work?

Locally based and self-organized, each CUMA includes on average about 25 farms. A farmer can become a member by contributing to the CUMA's share capital. A member generally acquires shares at the time of a collective purchase, in proportion to the level of committed use planned at the farm level. This self-financing by farmers represents on average 20% of the total financing of the investments of a French CUMA, with the rest being financed by bank loans. Public subsidies are sometimes available, up to 10% on average of the CUMA's overall investments. Each year, members must pay the cost of using the equipment at the level of activity they have subscribed to. In addition to these basic principles, there are rules enacted by the members specifying the organization and distribution of responsibilities. The cooperatives are generally managed on a collegial and voluntary basis. In addition to the farmers on the CUMA's board, each piece of equipment is often supervised by a member who manages the reservation schedule, checks it after it has been used, and even maintains it. The regional federations of the CUMAs employ around 350 people, mainly to provide legal and accounting support and to advise on the suitability of agricultural machinery (Lucas, 2018; FNCUMA, 2019).

This cooperative development, specific to France, has historically resulted from the promotion by different socio-political actors, as well as facilitation through the federative network. A few other countries have developed farm machinery cooperatives (Canada, Benin, Spain, Belgium, etc.), but without creating significant networks (<100 units) (Lucas, 2018).

BOX 2
Conservation agriculture, legumes, and agroecology.

Conservation agriculture seeks to restore soil fertility and improve soil quality based on three principles: reduced tillage, diversification of crops and of crops rotations, and protection of soils through the use of cover crops. Studies have emphasized the environmental benefits of conservation agriculture (reduced consumption of fossil fuels, development of soil conditions more favorable to soil biota, reduced erosion, increased soil organic matter and soil carbon storage), but also some negative impacts associated with the use of herbicides to compensate for the weed control effects of soil tillage (Kassam et al., 2009). Landel (2015) found that CUMAs played a significant role among the minority of farmers who practice conservation agriculture with a reduced use of herbicides.

Because of their ability to transform atmospheric nitrogen into a plant-available form, forage legumes can help reduce pollutants associated with synthetic fertilizers while, at the same time, promoting agrobiodiversity, which in turn has the potential to reduce pesticide use. However, specialized equipment is required to make hay from leguminous species, which explains in part why legumes are not used more often for hay crops in France despite their agroecological benefits. Instead, livestock farmers frequently purchase supplemental protein for animal feed in the form of imported soybeans (Schneider and Huyghe, 2015). New strategies for cooperation and equipment sharing have emerged within CUMAs in recent years to address this problem, including investments in shared hay-drying barns to facilitate the integration of forage legumes into their members' farming systems (Valorge et al., 2021).

universe and to analyze the strategies of actors through their narratives, which revealed their motivations and the conditions of their practical realization. It was a matter of getting the individual to recount the different stages of his or her trajectory, as he or she remembers them or as he or she judges them, and to invite him or her to analyze them. After this, the discussion was refocused on the perceived bifurcations in the trajectory in order to get the interviewee to express the different alternatives he or she had, as well as the other scenarios considered. The farmer thus revealed his or her justifications, which we then correlated with the strategic choices made at the farm and CUMA levels. The surveys were audio recorded and transcribed in full. Color coding was used to identify the verbatim quotes, themes and justifications (Olivier de Sardan, 2008).

We carried out a group analysis at the level of each CUMA studied, by correlating the narratives of all the member farmers of each CUMA, in order to identify the specific aspects as well as those common to all farms. Our interpretations were submitted to each CUMA through collective feedback workshops (conducted between May and August 2017). This allowed us to complement and fine-tune our group analysis.

Finally, we identified the characteristics that were common across all these case studies, and we presented our global analysis to farmer leaders and staff of the national federation of the CUMAs. This allowed us to better assess the significance of our results beyond just our case studies by confirming that some of our results indicated more general trends among the network of these cooperatives.

Characterizing a style of work adopted by farmers for several years and supported by the CUMAs and other collectives

Our analysis of the style of farm work of the surveyed CUMA farmer members that existed before they started legume cultivation or conservation agriculture reveals its labor-intensive and collective nature, which they have materialized through cooperation.

Diversifying output markets, mainly through farm level actions

The surveyed farms tend to specialize in either livestock or grain production: eight are grain farms, 26 are livestock farms. Most farmers in the sample (24/34) engage in a secondary activity such as livestock fattening, seed production, or the sale of breeding animals (for five of the livestock farms pursuing a genetic improvement of their herds). Four farms engage in pluriactivity, including two that undertake agricultural work as contractors for other farms. Three livestock farms process and sell most of their animal products directly to consumers, while the remainder rely on indirect marketing channels, in some cases using quality labeling schemes (12/34), in other cases engaging in some minor direct sales as well by selling mainly within their family and friends networks (10/34).

Technical orientations and inputs managed at the farm and groups levels

In addition to their membership in the CUMAs, the majority of the farmers (21/34) have been involved for a long time in formal, peer-to-peer information exchanges *via* discussion groups that are supported and moderated by professional facilitators. These groups' purpose is to allow farmers to share experiences and compare results from year to year, as well as to organize participation in group training programs. As a result, the farms have achieved high levels of technical performance. For example, the dairy farms with Holstein cows have achieved levels of individual production per cow higher than the French average (from 9,000 to 11,000 L/year/ cow[1]). However, farmers emphasize the need to manage a balance between production, animal health, economic performance, and the farm's fodder potential. As a Basque dairy sheep farmer notes: "[The goal is] is to achieve a good economic result per ewe. My average is 240 L/ewe[2]. The progress in genetics now allows a gain of 3 L/year but the error would be to give more feed to achieve it. The right path is to keep the amount of feed equal to what I have given for the past 2 or 3 years, and to ensure that this feed is used to the best potential of my ewes." To this end, this farmer is attempting to improve the quality of the fodder produced on the farm by improving the monitoring and observation of the herd and fields, thanks to the knowledge gained through the sharing of experiences and group trainings with peers.

As far as the input markets are concerned, the high level of technical performance has compelled the farmers to rely on inputs such as feed (imported soybeans, for example), seeds, pesticides, fuel, fertilizers, etc. The farmers have attempted to limit intermediate consumption or its costs through, for instance, a strategy of self-provisioning, allowing them to partially produce themselves the resources needed. Twenty of the 26 livestock farmers produce a part of the feed supplement from their own grown grains, while the practice of producing farm seeds is, on the whole, widespread amongst farmers growing wheat. Twelve of the 34 interviewed farmers

1 The average individual production per Holstein cow in France was about 9,000 L/year in 2015 (CNIEL, 2016).

2 This Basque sheep farmer grows ewes of a regional breed, called "Manech Tête Rousse," whose average individual production in French Basque Country is about 200 L/year (Boiron, 2017).

belong to buying clubs, which help them limit costs of inputs such as fuel and fertilizers through lower negotiated prices. And to better determine which remaining inputs to purchase individually, technical advice received from input vendors is compared with information from disinterested actors, such as technicians of public extension organizations, as well as from peers participating in the discussion groups or/and in the buying club. Finally, farmers have also entered into a variety of arrangements for sharing and exchanging resources such as equipment acquired individually or in co-ownership, material (for example, the exchange of livestock manure for straw from grain farms) and services. Many of these arrangements are informal and are based on mutual trust between members resulting, among others, from cooperative CUMA activities.

Improved management of equipment and work at the group level (CUMA)

Most of the interviewees have been involved in their CUMA for a long time. Indeed, parents of some of them were members of the local CUMA and even founder members. Over time, the CUMA has become an important component of their farming strategy, allowing them to invest more in other gainful activities (herds, facilities for diversifying outlets, etc.). This increased room for maneuver is why the interviewees have tended to deepen pooling processes through the cooperative. One of them, from Touraine, described the CUMA as an essential tool: "It would be stupid to use this tool [the CUMA] only occasionally. It is a tool that can allow me to provide income, to buy my buildings, to build a goat pen, to develop goat rearing activity on my farm, to improve my working conditions [...]. So, I use this tool, it has become essential."

However, the strategies of diversifying production, outputs or outlets, of achieving both high performance and technical efficiency, and of limiting input costs are expensive in terms of labor and equipment. For example, self-provisioning requires specific tools, such as storage and drying facilities, on-farm milling or grinding machines, as well as time available to manage these tasks. Peer-to-peer cooperation through the farmers' memberships in their CUMA has helped them deal with the additional generated workload. First, by sharing machinery costs to access the very latest technologies and large-scale equipment, farmers achieve a high physical labor productivity. Second, labor-sharing arrangements have also allowed the physical labor productivity of certain tasks to be improved by optimizing the work organization. For instance, a joint operation involves mobilizing much labor and equipment at the same time. Farmers organize a common management of specific operations (such as harvesting, seeding or haymaking) through their CUMA so that the work is done in a timely fashion on all the members' fields. Third, half of the surveyed CUMA have employed hired workers to maintain and/or drive the common equipment, which has allowed members to outsource field operations.

A labor-intensive and collective style of agriculture

Cooperation between peers has helped the interviewed farmers minimize the cost of inputs and equipment in their farming systems and to improve the performance of their farm practices. Farmers have dedicated a part of their labor time to improve their skills and knowledge, especially in the form of discussions with peers. They have continuously sought to derive better value from their resources through observations and experimentations, which are labor and knowledge intensive. The distribution of the work among diverse spheres (at the farm level and through several collectives and arrangements) has contributed to improvements of their farm systems, and increases in the value-added from the set of internal resources and purchased inputs and equipment. All of this has thus shaped a labor-intensive farming style.

Recomposing the farm work style for the agroecological adaptation

Over the last 15 years, the interviewed farmers have encountered a combination of various problems and issues that have made them more vulnerable. These issues are behind their decision to grow legumes or to develop conservation agriculture on their farms. In this way, they have relied on the ecological functioning of the agroecosystem, and sought further reduction in the use of external inputs. As these new practices have also led to additional workloads or new constraints, they have remobilized, recomposed and deepened the intensive and collective farm work style.

Conservation agriculture and cultivation of legumes to respond to new challenges

Farmers are turning to conservation agriculture to deal with soil degradation and/or to reduce costs and workloads. They take recourse to winter cover crop to improve soil fertility, while also complying with the growing number of regulatory injunctions against bare soils in winter. Most livestock farmers use this practice to produce additional fodder. Other new crops, such as alfalfa, are sometimes cultivated for self-provisioning or for agronomic improvement through crop diversification.

Legume cultivation allows for more protein production from pastures and winter cover crops, leading to an improvement in the quality of fodder production and thus of animal nutrition. For some dairy farmers in Ain, French Basque Country

and Touraine who are involved in direct sales or in quality labeling schemes, this practice aims to reduce purchases of feed supplements, whose use is increasingly being limited by scheme requirements since the 2000s, especially after public campaigns against the imports of transgenic soybeans by European livestock farmers (Escobar, 2014).

Conservation agriculture and the cultivation of legumes are also perceived by some producers as a mean of adapting to climate change. For instance, a winter cover crop, as a basis of conservation agriculture, provides an opportunity to produce additional fodder to complement the feed stocks threatened nowadays by the more frequent extreme climate events (such as droughts). In this context, price volatility, especially exacerbated since 2007, has turned out to be the "straw that breaks the camel's back" for farmers. This factor has only led to a greater desire to become more autonomous by reducing the purchase of external inputs, as farmers explained:

> "We had two spikes in [milk] prices [...]. Funny how the price of inputs often went up too...! So [...] the benefits we could get in the market for finished products, we often saw them disappear in expenses...." (Farmer in Loire-Atlantique)
>
> "What we have been trying to do for the past several years is just to get by, to avoid going under and going under again, that's it." (Farmer in the Tarn)
>
> "What also got things moving in my opinion were the economic crises... 2009,[3] that reset everyone's clocks, because if you want to survive, you have no choice, you lay everything out and you say, what am I going to do? [...] That's the beginning of it... that changed everything [...] we had to start again almost from nothing." (Farmer in Touraine).

Cooperating to tackle the obstacles encountered

Cultivating legumes or developing conservation agriculture to address agronomic, work, regulatory, economic and/or climate issues leads to new constraints, additional workloads, and problems in obtaining the necessary resources. Most farmers have difficulty sourcing certain seeds, especially for legumes and cover crops. Their usual suppliers do not always offer the diversity of the desired species at the right time and at affordable prices. This has led most of the farmers to self-produce farm-saved seeds, which leads to new operations or even the need for equipment (for seed sorting, storage and drying, for example). Farmers wanting to enrich their pastures with legumes also have difficulty obtaining adequate information on their management from their usual suppliers, who have been known to provide incorrect information in Ain and French Basque Country. New self-provisioning strategies require additional farm operations, such as the management and harvesting of winter cover crops. Producers adopting conservation agriculture have had to increase their use of herbicides to deal with weed growth, though some of them have managed to reduce this reliance on herbicides over time. Indeed, on two farms in Tarn that have switched to organic farming, conservation agriculture is being practiced today without any use of herbicides (see Box 3).

As a result, in order to implement new practices and to cope with the constraints and the issues raised, these farmers are remobilizing and deepening the three forms of cooperation they were already participating in. First, farmers are entering into new exchange and resource-sharing arrangements, such as the exchange of farm-saved seeds, especially for cover crops. This allows farmers to obtain the diversity of desired species without having to produce the full range of necessary seeds themselves. Second, to address the paucity of references and knowledge about conservation agriculture and legume cultivation, farmers are relying on or creating new spaces for sharing experiences and collective training through their discussion groups. In the absence of such local groups working on these issues, the CUMAs of French Basque Country, Loire-Atlantique and Touraine organized discussion and training mechanisms by enlisting the help of external experts and facilitators. Third, farmers rely on their CUMAs to invest in tools for conservation agriculture and haymaking equipment suitable for forage legumes, sometimes by purchasing high-capacity machinery to increase physical labor productivity and even storage and processing equipment needed by new self-provisioning strategies. To this end, new sharing processes are emerging within CUMAs, such as the pooling of members' hay in collective artificial dryers, the employment of workers, and the organization of new joint harvesting operations, and even collective training processes. For example, in Tarn, due to the development of winter cover crops mainly based on legumes, four farmers decided to produce silage-based fodder (three to feed cows, and one to power a biogas production unit). But silage is a task that requires the mobilization of many workers and much equipment at the same time, especially as these four farmers own about 400 ha between them. Winter crops need to be silaged in spring, a time of unpredictable weather conditions, and also of high labor demand as the main crops also need to be sown at this time. This situation has led the farmers to work together to optimize their silage-making and seeding operations, even collectively negotiating with the contractor who owns the silage machinery, so as to organize the work across the four farms in an optimal manner.

Increased cooperation allows the farmers to develop legumes and conservation agriculture. Through collective investments and joint field operations, they can exceed their farms' existing

3 There was a significant fall in milk prices in 2009.

BOX 3
Multiple cooperative arrangements to support conservation agriculture without herbicides.

Seven farms belonging to the CUMA in Tarn have acquired specialized equipment for conservation agriculture since 2013. Two of these farms are organic (designated here as Farm A and Farm B).

Six of these farms also belong to a local peer-to-peer discussion group for comparing technical and economic results and participating in training sessions, as well as to another local group for sharing experiences in the practice of conservation agriculture. Both of these groups receive technical support from trained agronomists employed by an organization that includes ∼50 such local discussion groups and also helps buying clubs coordinate amongst themselves to purchase inputs. This organization is mainly funded by fees paid by the farmers, with additional support from public mechanisms. Finally, five of these CUMA farms also participate in a national network for peer-to-peer discussion of conservation agriculture, with whose assistance they organize an annual study trip to visit farms elsewhere in France or in other countries.

For all of these farms, increased participation within the CUMA has led to new types of sharing and exchange. While earlier these arrangements included, for example, mutual help during the harvest period and co-ownership of equipment, they now also include the exchange of farm seeds and the collective organization of silage cutting, a new task that has become necessary after the introduction of cover crops and which entails significant labor requirements at an already busy time in the agricultural calendar.

The two organic farms, which have practiced no-till without herbicides since 2016, have joined a distributed group active across southwestern France that works with a private consultant to assist in the development and discussion of this technique. These two farms have also worked together with a local fabricator to design an implement to kill cover crops mechanically (instead of with herbicides). Farm A, which has a robotic milking system and keeps its cows on pastures, has also formed a regional discussion group for rotational grazing. These two organic farms thus participate in a total of five peer-to-peer discussion groups, some at the supra-regional level, to support their practice of conservation agriculture without herbicides. In our interviews, the farmers managing these farms emphasized the significant amount of time they invest in these groups as well as the technical complexity of their new farming practices, which they were still working to perfect.

These organic farmers, relying intensively on inter-farm cooperation through the CUMA and other collectives and arrangements, had professional responsibilities in the past, at the regional federation of the CUMA and in a young farmers' union.

organizational limits. Seed exchanges as well as discussion groups help them cope with the lack of suitable resources. Labor and resource sharing help to mitigate induced workloads, as shown by the CUMA of Aube: two of its members decided to jointly employ a worker to work on both of their farms to free up their time, allowing one of them to spend more time developing his new practices and to participate in discussion groups. The other, a sheep farmer, had the idea of grazing his herd on the winter cover crops. He now moves his herd each winter to five other grain farms for the grazing of their winter cover crops, which has the benefit of reducing the quantity of herbicides used to terminate them.

Deepening the labor-intensive and collective work style

The development of agroecological practices has led the interviewed farmers to deepen the labor-intensive farming style. Thanks to the improvement of the farmers' skills, these new practices have improved their self-provisioning strategies and optimized some internal resources, until then barely leveraged (activating the biological life in the soil by practicing conservation agriculture, stimulating the symbiotic biological nitrogen fixation with the introduction of legumes).

Moreover, there is greater distribution of work between the farm system and the collective arrangements. Farmers enrich their skills by participating in discussion groups, and the increased workload is minimized by several collective processes: delegation of work to hired workers, and increased physical labor productivity through collective investments in high-capacity machinery, and/or through new forms of joint operation (for the silage of the cover crops, for the mixing of the seeds to sow the cover crops). And finally, self-provisioning is helped by new sharing arrangements between farmers.

However, the level of adoption of new practices and of the reduction in inputs differ from farm to farm, within each CUMA and between the CUMAs surveyed. Some farmers have been able to significantly reduce their purchases of feed supplements and fodder, sometimes even beyond their own expectations. This has allowed a few of them to become part of more remunerative supply chains which stipulate lower dependence on feed. For example, a producer in Tarn has converted to organic farming, and a dairy farmer from Touraine has enrolled in a geographical indication label which forbids the purchase of transgenic soybeans. Many farmers consider themselves as being in a phase of transition and expect to further reduce their use of external inputs, while for others, these decreases are still minimal. We explain the differences of agroecological improvement among the interviewed farmers by the fact that each farmer relies differently on peer-to-peer cooperation (see Table 2), which requires available time, cooperative skills and enlarged social capital. The farmers do not all equally have these resources necessary to collaborate between peers. Farmers endowed with these social resources are better able to activate the diverse modes of peer-to-peer cooperation and are thus able to develop agroecological practices more in depth, as we discuss in the following section.

TABLE 2 Number of farmers involved in discussion groups and sharing arrangements in the case studies.

CUMA & number of farms studied ➔ *Collectives* & *Sharing arrangements* ➘	CUMA *French Basque C.* Three farms studied	CUMA *Tarn* Six farms studied	CUMA *Ain* Six farms studied	CUMA *Aube* Five farms studied	CUMA *Loire-Atlantique* Four farms studied	CUMA *Touraine* 10 farms studied
Peer-to-peer discussion groups	2	5	3	All	2	All
Machinery-sharing arrangements						
Co-ownership	2	5	4	4	3	8
Equipment lending and exchange		5	2	All	1	All
Combined labor and machinery-sharing arrangements						
Mutual help for harvest tasks		All	All	2	3	9
Services exchanges		5	1	All	1	8
Joint organization of tasks		3	1	All	1	
Labor-sharing arrangements						
Pool of employers				2		2
Other resource-sharing arrangements						
Buying clubs	2	4	3	3	1	3
Crop-livestock partnership		3	2	4		7
Seed sharing		All	2	All		4
Manure partnership		3	2		1	
Common fodder drying and storage	All		All			
Feed exchange or partnership		2	1			
Collective preparation of seed mix		3		2		
Grazing by neighbor's animals				4		
Collective irrigation system		3				
Common grain drying and storage		4				
Renewable energy production pool		2				
Delegation of heifer rearing						3
Embryonic transplant pool			3			

Time, social skill and capital needed to develop a collective work style

The level of adoption of new practices and of the reduction in inputs depends in particular on the farmer's intensity of involvement in peer-to-peer cooperation, described in Table 2. This cooperation has three specific prerequisites: time, skill, and social capital. However, individual farmers possess these three requirements in varying degrees.

First, a farmer's individual workloads, and thus available time, is a determining factor for the involvement in cooperative activities. For instance, a farmer involved in off-farm work or one with several tasks to perform on a fixed schedule (including on-farm processing or direct sales) have greater time constraints, limiting their possibilities to take part in collective activities, such as meetings of peer-to-peer discussion groups.

Second, cooperative skills are crucial to be able to adequately rely on local inter-farm cooperation and arrangements. For instance, some farmers have expressed frustration about failing to convince their CUMA fellow members to invest collectively in new equipment they needed. In contrast, the narratives of interviewed farmers who have successfully persuaded their colleagues to invest reveal the strategic skills they mobilize to interest their peers and then to coordinate the subsequent investment in and sharing of the concerned equipment. For instance, in the Aube CUMA, a farmer, who was practicing conservation agriculture, personally owned a direct seeding machine but wanted to invest in a better, more sophisticated and much more expensive one. He made his seeder available to others to try out direct seeding for sowing wheat after the hemp harvest, which occurs during a very busy period. This increased the interest of some farmers of the group, who trusted this pioneer farmer, in no-till agriculture. Over time, this led to the collective acquisition of specific conservation agriculture equipment by the CUMA. This example shows that a farmer wanting the CUMA to make a new collective

investment had to develop a strategy to interest and persuade his peers by identifying a tactical operation that could be a convincing experience for them. Another illustration of the soft skills required was revealed when some farmers admitted that they benefit from the CUMA thanks to the involvement of other farmers, generally the cooperative's leaders, who possess the requisite skills to coordinate the collective processes and activities. The following statement of a farmer from the Basque CUMA, little involved in the management of its collective hay dryer, illustrates this point: "I think it is also a little bit a matter of aptitudes. Perhaps I do not have the correct personality for... I think also that... people are made differently, there are some people who are capable in this regard, some others very little...."

Third, a farmer's ability to benefit from local inter-farm cooperation depends on his or her social capital,[4] which gives him/her the ability to identify and encourage strategic cooperation with farms with complementary needs. We observed that farmers who initiate new activities in a CUMA or new sharing arrangements often had or have professional responsibilities in agricultural organizations, which gives them favorable social position, standing and capital.

Generally speaking, the more farmers are able to draw on multiple forms of peer-to-peer cooperation, the greater their chances of success in reducing external inputs and benefiting from the ecological functionalities of their farming systems. The example of the CUMA in the Tarn, described in Box 2, illustrates how the dynamics of the farmers' cooperative efforts enable them to co-produce knowledge, optimize the synergies among their farms, and maximize the efficient use of shared resources.

Discussion

The results we discuss in detail in the two preceding parts have been confirmed and refined through discussion with officials of the National CUMA Federation. The simultaneous involvement of CUMA members in multiple kinds of collectives and arrangements is a common situation (also confirmed by other research, see for instance Compagnone and Hellec, 2015; Slimi et al., 2021), hence the widespread collective style of farm work that we observed among these farmers. In addition, the approach of internalizing the discussion group and training function within CUMAs, observed in three of the surveyed CUMA, is an emerging trend in the CUMA network. This is aimed at compensating for the currently low investment in agroecological topics such as conservation agriculture and fodder legumes by existing public research and extension organizations (Landel, 2015; Valorge et al., 2021). The CUMAs are thus increasingly being mobilized for multiple aims, inducing a diversification of their functions, beyond their basic equipment- and labor-sharing purpose. At the same time, this increased mobilization of the cooperative strengthens and makes possible the labor intensity associated with the agroecological transition.

The farming style we reveal is novel when compared to others discussed in studies based on this concept, especially those highlighting farming styles conducive to the agroecological transition. For instance, van der Ploeg emphasized the style of "farming economically" as a proto-agroecological way of farming, found in the Netherlands, France and Ireland, with cost-reduction as the primary farm development strategy (van der Ploeg et al., 2019). Farms practicing this style tend to be small-scale,[5] which allows a high intensity of labor per animal or hectare that is associated with a high use-efficiency of internal resources and with reduced equipment needs. Van der Ploeg contrasts this farming style with that of large scale-farms needing big equipment and restricted to lower use-efficiency of internal and external inputs (as also demonstrated by Veysset et al., 2015; Garambois et al., 2020). As mid-scale farms form the core of the CUMAs (Harff and Lamarche, 1998; Mundler et al., 2010; Jeanneaux et al., 2018), our results, in contrast, suggest the hypothesis that the collective style of farm work is an intermediate farming style. This intermediate style thus allows mid-scale farms to achieve high physical labor productivity thanks to the common high-capacity equipment of the CUMA in order to almost reach the labor intensity of the small-scale producers engaged in farming economically. Furthermore, French CUMAs also employ more qualified hired workers, as they are paid higher wages and enjoy better working conditions than other categories of hired workers in French agriculture (Forget et al., 2019). This tends to confirm our hypothesis that a higher quality of work is required by the members of the employing CUMA.

Conclusion

In the CUMAs we surveyed, farmer members have developed and are using a labor-intensive farming style for a long time, thanks to their participation in collectives and sharing arrangements. In this way, they have adopted a conventional agricultural model using external inputs and powerful agricultural equipment. They have made this model viable by a strong reliance on inter-farm cooperation, which leads to a distributed work organization. Their peer-to-peer cooperation has allowed them to achieve economies of scale

4 The concept of social capital is used here according to the approach of Lin (2001), interpreting social capital as in individual endowment, resulting from personal involvement in social ties, communities, and groups.

5 Small-scale here means a small surface area of land or small number of animal heads per unit of work (one farmer or worker). Similarly, large-scale means a large surface area of land or large number of animal heads per unit of work.

and scope. This cooperation takes the form of buying clubs to purchase inputs at lower prices, discussion groups to achieve technical efficiency by comparisons of their individual technical results, and experience sharing. In addition, their CUMAs have allowed them to share their investment in high-capacity machinery to increase their physical labor productivity, especially for field operations.

This long-standing reliance on peer-to-peer cooperation, especially to manage resources (mainly labor, equipment, and knowledge), has shaped an initial style of work organization that has facilitated the process of change toward the development of agroecological practices. Indeed, farmer members have recently developed new practices to tackle various kinds of issues (technical, regulatory, economic, climatic, etc.) and to reduce their use of external inputs, which has exposed them to new constraints and challenges. They have recently mobilized the structuring basis of this long-standing style of farm work and modified their peer-to-peer cooperation in pursuit of an ecological adaptation of their farming systems. The CUMAs have also been recently used to be able to access a wide range of necessary machinery. Farmer members have created new discussion groups to collectively produce new site-specific knowledge by pooling their observations and by sharing the results of their individual experiments and their on-farm experiences. Finally, they have put new sharing arrangements in place to access strategic resources, such as seed sharing, necessary to grow a larger range of species to diversify their crops. Thus, they have easily remobilized the structuring basis of their initial farm work style, i.e., labor intensity and peer-to-peer cooperation, by reorienting it to develop agroecological practices.

Finally, our research, based on the farming styles approach (van der Ploeg, 2010), had the aim of studying practices, especially organizational ones, as well as the viewpoints of the farmers themselves (discourses and representations) from a perspective of actor-oriented research (Long, 2001). This approach has the advantage of revealing processes that cannot be detected by standardized measurement of practices through objectively verifiable indicators. As van der Ploeg (2012) has already shown, thinking on the basis of farming styles has made it possible to shed light on the transformation of agrarian realities by discerning processes that go beyond average situations and are not discernible by normative studies. These benefits of the farm work style are barely visible through the available data and surveys concerning agriculture, which are mainly focused on the farm level (thus masking collective processes) and reliant on monetary aspects (thus masking labor processes) (Altukhova-Nys et al., 2017; Lucas et al., 2020). New research is therefore required to better highlight the nature and recomposition of the labor processes that take place during the agroecological transition and to better design and target policy instruments to support this much needed transition. Such research could also examine the economic and social dimensions of this work model within agroecological farm systems, and could thus propose to complement the variables of study of agricultural practices in census surveys, in particular concerning organizational arrangements and labor processes. Our research covers a wide diversity of forms of agriculture in France thanks to a sample that represents contrasting agrarian systems, many different types of production, a wide range of technical systems and various marketing methods. Even though it is thus indicative of a wide range of agricultural situations that can be observed in France, we cannot claim to have covered all the situations existing in the country. We thus invite the scientific community to extend this research to other regions and situations.

Data availability statement

The datasets presented in this article are not readily available because they are verbatim of interviews. Given the monographic nature of the research, the interviews cannot be anonymized and are not available.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

VL designed the methodology and carried out the field surveys during her PhD thesis, and then planned the paper's contents and structure. PG co-supervised VL's PhD thesis and contributed to the revision of the article. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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