



Research Paper

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Abstract

Diversified farming systems appear to be one means of meeting the sustainability challenges facing livestock farming systems and of facilitating the renewal of future generations of farmers in a context of climatic, economic and social change. However, although work seems to be an essential issue for livestock farms, few studies have explored the impact of on-farm diversity on work. This study aims to fill the gap in our understanding of the various ways in which on-farm diversity affects work. We applied a framework combining six dimensions of work with three forms of on-farm diversity (diversity of management entities, diversity of farming activities, diversity of workers) to six studies that had been conducted previously on livestock farms. Our results highlight a wide range of links between on-farm diversity and work. We show that on-farm diversity affects various dimensions of work in multiple ways, which can be both positive and negative. For example, while there may not be a strict and clear relation between on-farm diversity and workloads, diversity provides flexibility for organizing the distribution of working time. Moreover, on-farm diversity seems to more frequently reinforce the meaning of work for farmers. Our results also show that there are multiple interactions between the six dimensions of work studied. Our study points to the need for a comprehensive approach to understanding the multifaceted and interconnected nature of work dimensions in diversified farming systems. Further research is recommended to explore these relationships more deeply to support sustainable and attractive diversified farming systems.

Introduction

As the productivist model that led to the specialization of livestock farming is called into question, on-farm diversity may be a means to meet the sustainability challenges facing livestock farming systems in a context of climatic, economic (price volatility, for example) and social change, notably in OCDE countries (Magne et al., 2019; Dumont et al., 2020b; Martin et al., 2020; Aare et al., 2021).

This diversity within the farm also may help to ensure that a new generation of farmers will take up farming as older farmers retire, an issue that will be a major challenge for agriculture in the years ahead in Europe (Coopmans et al., 2021; HLPE, 2021; Dedieu et al., 2022). This is particularly true for livestock farming, which is going through an unprecedented crisis of legitimacy in the eyes of society (Delanoue et al., 2018). Newly installed livestock farmers consider diversified systems as being more resilient (Darnhofer et al., 2010; Magne et al., 2019; Dumont et al., 2020b; Dardonville et al., 2020; Aare et al., 2021), more environmentally friendly (Martin et al., 2020; Forteau et al., 2020; Dumont et al., 2022), better able to make use of local resources (López-í-Gelats, Milán and Bartolomé, 2011) and more apt to meet their expectations in terms of job satisfaction (Schanz et al., 2023).

However, while this on-farm diversity is attracting growing interest from value chain actors and researchers, it is often presented as having negative impacts on farmers' workloads in OCDE countries (Dumont et al., 2023). This is the case, for example, in mixed crop-livestock systems, where many authors have highlighted the workload and complex management involved (Lemaire et al., 2014; Ryschawy et al., 2017; Martin et al., 2020). Despite their agro-ecological virtues and resilience, these diversified systems may not offer optimal working conditions, and therefore may lose their appeal for new generations of farmers. However, this greater workload has often only been reported without being fully demonstrated. Furthermore, as Schanz et al. (2023) show, farmers' job satisfaction cannot be defined by workload alone. Working conditions are also determined by other dimensions (Dumont and Baret, 2017; Duval, Cournut and Hostiou, 2021b; Stratton, Whitman and Blesh, 2021), such as enjoyment of work, the distribution of work over time and between workers, health, work-life balance, and so on.

Few studies have explored the links between on-farm diversity and work. Those who tackle the subject often examine a single form of on-farm diversity, such as mixed crop-livestock farming or mixed-species livestock farming, and in most cases do so only in relation to the

impact in terms of workload (Ryschawy *et al.*, 2017; Benoit *et al.*, 2023). Yet the complexity of the links between on-farm diversity and work needs to be understood in order to identify the factors, particularly those related to work, that are hindering or facilitating the development of diversified systems.

This paper focuses on the complexity of links between diversity and work on livestock farms. It analyzes how different ways of managing diversity on farms can influence different dimensions of work. To conduct this analysis, we used a multidimensional framework to revisit six case studies that the authors had conducted previously. Each of these case studies examined at least one dimension of work and one form of diversity management at the farm level. Our objectives were to better understand the potential challenges that farmers face when implementing changes leading toward more diversified production systems, and to provide 'keys' to analyzing these challenges. In the first part, we present the framework used to analyze links between on-farm diversity and work. This is followed by the methodology, which details the main features of the case studies. We then present the main results for the various dimensions of work involved. In the fourth section, we discuss these results and conclude our analysis.

Framework

To analyze the links between on-farm diversity and work, we combined a six-dimensional framework for work with three major forms of diversity at the farm level.

A six-dimensional framework for the analysis of work

Our framework for analyzing work was inspired by the research undertaken by Duval, Blanchonnet and Hostiou (2021a, Duval, Cournut and Hostiou, 2021b) and Cournut and Balay (2021). The following six dimensions of work were selected: (1) duration and temporal distribution of work, (2) workforce organization, (3) work-life balance, (4) mental and physical health, (5) meaning of work and (6) skills.

In the first dimension (duration and temporal distribution of work), work is analyzed in terms of the time required to operate the livestock farming system. This makes it possible to link the technical organization of the system and the amount of work, and to identify peak work periods and tensions between different activities (Cournut *et al.*, 2018).

The second dimension (workforce organization) corresponds to the way in which the distribution of tasks and responsibilities is organized within the working group, and assesses the versatility of workers which can make it easier or harder to replace them (Malanski, Ingrand and Hostiou, 2019).

In the third dimension (work-life balance), work is considered in relation to the private sphere (Contzen and Forney, 2017, Hansen and Stræte, 2020; Janker, Vesala and Vesala, 2021). This refers to time off, the opportunity given to workers to take a breather and set aside time for family, friends and leisure activities.

In the fourth dimension (mental and physical health), we focus on the effects of work on workers' health (Duval, Blanchonnet and Hostiou, 2021a), which can be affected by physically demanding tasks, excessive workloads, and stress (Timmermann and Félix, 2015; Kallioniemi *et al.*, 2018).

In the fifth category (meaning of work), work is considered in terms of what reinforces or weakens livestock farmers' personal convictions and reasons for doing their jobs (Lusson and Coquil, 2016).

The last dimension (skills) reflects the fact that to be able to design or perform a task efficiently and effectively, skills must be acquired through trial and error, access to new knowledge, or training (Duval, Blanchonnet and Hostiou, 2021a; Toffolini and Jeuffroy, 2022).

Three major forms of on-farm diversity considered

In the literature, multiple forms of on-farm diversity are considered depending on the scale of analysis and the definition of the system studied (Magne *et al.*, 2019; Tacconi *et al.*, 2022; Dumont *et al.*, 2022). For our part, we consider livestock systems to be a combination of herd and land management, agricultural activities, and workers (Dedieu *et al.*, 2008). For our analysis of work, we therefore selected three main forms for the expression of on-farm diversity.

The first involves diversity related to herd and land management. We focus on the diversity of management entities (several batches of animals, several types of forage and crops) that a farmer must consider to organize the biological diversity of plants and animals (physiological stages, ages, breeds, varieties) in space and time (Martin and Magne, 2015), and what this implies for work.

The second form concerns the diversity of agricultural activities (several production units, including plant production, processing, and marketing through short supply chains, which may also be associated with long supply chains) (Duval, Blanchonnet and Hostiou, 2020a). We focus on interactions between the processes specific to each production unit, creating opportunities for competition or complementarity in terms of resources, including labor.

The last form concerns the diversity of workers (different statuses, different skills, different availabilities, etc.) (Cialdella, Dobremez and Madelrieux, 2009; Darnhofer *et al.*, 2010; Nettle *et al.*, 2018). The workers constitute both new management entities for farmers (Dedieu and Servière, 2012) and resources for carrying out work.

Materials and methods

To our knowledge, no study has been carried out covering all of the different forms of on-farm diversity and work dimensions. In addition, the analysis of the different dimensions of work included in our framework requires detailed and precise knowledge of the results of surveys carried out on farms and of the experiences expressed by the farmers. For these reasons, we decided to retain studies that we carried out ourselves. Six studies were chosen to illustrate the links between on-farm diversity management and work on family livestock farms in France. The studies were selected to meet the following criteria: (i) they were carried out by one of the authors of this article, and were published in a scientific journal (four studies) or a book (two studies); (ii) they were based on semi-qualitative surveys carried out on livestock farms, with information gathered on farmers' practices and work; (iii) they analyzed at least one form of on-farm diversity related to herd and area management, agricultural activities, or workers involved in farming activities; and (iv) they aimed to analyze work by considering several dimensions and not only one.

None of the studies individually covered all six dimensions of work or all three forms of diversity featured in our framework. However, when the studies are considered together, all of these elements are covered.

We refer to the six studies selected as case studies. They are presented in Table 1, with the forms of on-farm diversity

considered, the type of farming system surveyed, the objective of the study, and information about the study zone. Two case studies illustrate the links between work and the diversity that stems from land and herd management (Hostiou, 2013; Mugnier, Husson and Cournut, 2021), four studies illustrate the links between work and the diversity of agricultural activities (Fanchone, Alexandre and Hostiou, 2022; Hostiou, 2013; Mugnier, Husson and Cournut, 2021; Cournut, Millet and Dufour, 2013), and three studies illustrate the links between work and the diversity of workers (Béguin et al., 2021; Hostiou, Chauvat and Cournut, 2014; Mugnier, Husson and Cournut, 2021). The study conducted by Hostiou (2013) compared work times and the organization of the workforce on farms using different reproductive management methods (from a single parturition period to several), taking into account the impact on work of the diversity of on-farm activities (slaughter, direct selling). The study by Fanchone, Alexandre and Hostiou (2022) focused on mixed crop and livestock farming systems in Guadeloupe (French Caribbean). The aim was to analyze work for different levels of integration practices. The study by Mugnier, Husson and Cournut (2021) concerned mixed sheep and suckler or dairy cattle, and analyzed how combinations of the two species influence work, taking into account the impact of the composition of the workforce and of the diversity of land and herd management. The study by Cournut, Millet and

Dufour (2013) looked at cattle farms diversifying their activities by processing and marketing through short supply chains, leading to a reconfiguration of work. The study by Béguin et al. (2021) compared work in three different types of working groups distinguished by their size and composition on dairy farms. Finally, the study by Hostiou, Chauvat and Cournut (2014) analyzed the links between types of working groups and work through the implementation of work solutions (modification of the system to adapt it to the livestock farmers' expectations in terms of work).

In addition, for each case study, the data about the structure and the workgroup of the farms surveyed were collected during the surveys and are presented in Table 2. The farms surveyed in the study by Fanchone, Alexandre and Hostiou (2022) were smaller, and had a greater diversity of livestock and crops than the farms surveyed in the other case studies (Table 2). In contrast, the farms surveyed in the study by Béguin et al. (2021) were larger than the farms surveyed in the other case studies. The number of workers in the basic group is quite similar in five of the case studies (1–3 persons), and higher (4.1 on average) in Béguin et al. (2022). The working group is composed mainly of the farm managers (husband/wife) helped by other family members (parents, children). In four of the case studies some of the farm managers hired wage workers.

We analyzed these studies through the prism of our analytical framework to understand how on-farm diversity affects the work

Table 1. Presentation of the six case studies used for the analysis of work

Papers	Diversity studied	Type of system	Description of initial aims of published study	Study zone in France
Hostiou (2013)	Agricultural activities/ Land and herd management	Organic suckler sheep farms	14 organic sheep farms in the central region of France were surveyed to compare different reproduction management methods in terms of work (organization, duration), taking into account the impact on work of the diversification of activities (slaughter, direct selling)	Massif Central (highland region in south-central France)
Fanchone, Alexandre and Hostiou (2022)	Agricultural activities	Crop-livestock farms	14 mixed crop-livestock farms were surveyed to understand how the implementation of crop-livestock integration practices are affected by work characteristics (perception, organization, duration, drudgery).	Guadeloupe (French archipelago in the Caribbean)
Mugnier, Husson and Cournut (2021)	Agricultural activities/ workers/Land and herd management	Mixed-species livestock farms	37 farms combining meat sheep with beef or dairy cattle were surveyed to understand why and how two species are combined on the same farm and the impact on work, taking into account the impact of the composition of the workforce	Massif Central
Cournut, Millet and Dufour (2013)	Agricultural activities	Livestock system with processing unit and short distribution channel	16 cattle breeders processing and marketing all or part of their production in short distribution channels were surveyed to understand how the development of short channels affected the farm level (functioning and link to the territory) and work	Massif Central
Béguin et al. (2021)	Workers	Farms with large dairy herds	49 large dairy farms were surveyed on their working conditions and their level of satisfaction with these. The farms had three types of working groups: small working groups (T1), large working groups with salaried employees (T2), large working groups with several partners (T3).	West and East of France and Massif Central
Hostiou, Chauvat and Cournut (2014)	Workers	Dairy farms	458 dairy farms were surveyed to identify the combinations between work solutions, the relations with the management of the farm, the types of working groups and the expectations of the farmers.	Massif Central

Table 2. Description of the surveyed farms for each case study

Case studies	Nb. of farms surveyed	UAA (ha)	Type of crops	Type of livestock farming	Nb. of animals/farm	Nb. of workers in the workgroup/farm	Type of workgroup
Hostiou (2013)	14	84	Cereals mainly	Ewes	43 ewes	1.6 person on BG	Family (farm manager) + family help
Fanchone, Alexandre and Hostiou (2022)	14	12	Sugar cane, market gardening, food crops, arboriculture	Ruminants (cattle, sheep, goat), Monogastrics (pigs, poultry, donkey, rabbits)	17 Tropical livestock units	1 person on BG	Family (farm manager) + family help
Mugnier, Husson and Cournut (2021)	37	164	Cereals mainly	cattle and sheep	72 cows 296 ewes	1.9 persons on BG	Family (farm manager) + family help and volunteers, employees in some farms
Cournut, Millet and Dufour (2013)	16	108	Cereals mainly	Dairy and beef cattle	25 to 90 cows	1 to 3 persons BG	7 individual farms, 6 family association, 3 non-family associations; family help, volunteers, employees in some farms
Béguin et al. (2021)	49	208	Cereals mainly	Dairy cows	133 dairy cows	4.1 total labor unit (2.5 labor unit farmers; 1.2 labor unit wage workers; 0.4 labor unit volunteers)	T1 (16 farms): small working groups with 1 or 2 farmers + volunteers T2 (11 farms): large working groups with salaried employees T3 (22 farms): large working groups with several partners
Hostiou, Chauvat and Cournut (2014)	458	57	Cereals mainly	Dairy cows	36 dairy cows	2 persons on BG	41% individual farms; 57% family association; 2% non-family association; family help; employees in some farm

BG, The basic group comprised the workers for whom the agricultural work was their main activity in terms of working time and income and who organized all the work on the farm (farmer, couple, associates); Nb., Number; UAA, Utilized Agricultural Area; ha, hectare.

of livestock farmers. In a first step, for each case study, the work dimensions analyzed were identified and listed in a table (Table 3). In a second step, for each of the six work dimensions, a comparative analysis between the concerned case studies was conducted. We then synthesized the results by dimension.

Results

The application of our framework to the six case studies highlighted a wide range of links between on-farm diversity and work. We will first present these links dimension by dimension before providing a more systemic view.

Duration and temporal distribution of work

To consider the duration and temporal distribution of work in diversified systems, we must first examine workloads, and then how farmers distribute the tasks over the year.

Although workloads are often declared heavy, the reality is more complex

Fanchone, Alexandre and Hostiou (2022) found that the management of synergies between animal and plant production units seems to negatively impact workloads. These authors show that the day-to-day workload is high with time-consuming integration practices in mixed crop-livestock systems which are little mechanized (use of crop by-products for animal feed and organic manure to fertilize crops). In the study by Mugnier, Husson and Cournut (2021), workload was cited as the primary constraint by 82% of the mixed sheep-cattle farmers surveyed. These farmers viewed their workload as being heavy due to the need to supervise two herds and to install and maintain two types of fencing. Yet in the same study, the quantification of time spent working using the Work Assessment Method (Cournut et al., 2018) did not reveal any effect of species diversity (sheep-cattle) on workloads. Workloads can vary greatly due to many influential factors, such as the type and size of livestock units, choice of management and equipment, and so on. Moreover, the way in which diversity

Table 3. Application of the framework to the six case studies analyzed: forms of on-farm diversity and dimensions of work

Reference of the studies analyzed	Forms of diversity analyzed	Dimensions of work analyzed					
		Duration and temporal distribution of work	Workforce organization	Work-life balance	Mental and physical health	Meaning of work	Skills
Hostiou (2013)	Agricultural activities/ Land and herd management	X	X	X			X
Fanchone, Alexandre and Hostiou (2022)	Agricultural activities	X	X		X	X	
Mugnier, Husson and Cournut (2021)	Agricultural activities/ workers/Land and herd management	X	X	X		X	X
Cournut, Millet and Dufour (2013)	Agricultural activities	X	X	X		X	X
Béguin et al. (2021)	Workers	X	X	X	X		X
Hostiou, Chauvat and Cournut (2014)	Workers	X		X	X	X	

is organized has an impact on workload. Mugnier, Husson and Cournut (2021) highlight the savings in working time made possible by sharing the same resources (feed, equipment, workforce) in the case of farms combining suckling sheep with suckling cattle. The beef cattle and sheep farming units share similarities in terms of feeding practices, enabling the same person to feed both herds in the same work sequence. In her study of organic suckler systems, Hostiou (2013) compares the organization of work on organic sheep farms that have different reproduction arrangements, and notes that the number of breeding periods has no influence on workload. The influence of diversity of activities on workloads therefore does not seem easy to demonstrate.

The study by Béguin et al. (2021) provides insight into the links between worker diversity and workload. The authors show that in working groups where diversity is relatively low in terms of workers' statuses and the size of the workforce (one or two family members and volunteers; 16 farms surveyed), the workload is the highest (3041 h yr⁻¹ labor unit⁻¹). In contrast, in large working groups where diversity is relatively high (two or more associate with permanent employees; 11 farms surveyed), the workload is relatively light (2249 h yr⁻¹ labor unit⁻¹). The size of herd per labor unit could explain this difference of workload between working groups. In the less diversified working groups, routine work is the most efficient (37 h dairy cow⁻¹ yr⁻¹, and 60 cows⁻¹ labor unit⁻¹), perhaps because the shortage of workers requires it to be so. On farms with the most diverse working groups (several statuses with family labor and salaried employees), the opposite is true: routine work is the least efficient (51 h dairy cow⁻¹ yr⁻¹, and only 45 cows⁻¹ labor unit⁻¹). Yet while the quantity of work is reduced by the increase in the number of workers, the share of work carried out by the farm heads is not reduced in the same proportions. The organization of work within a group with wage workers is marked by the difference in status between the wage workers and the farmers, requiring the latter to extend their working days to compensate for the shorter working day

of their employees, and/or to act as a 'buffer' in the event of their employees' absence (leave, illness, etc.). The diversity of the workforce also has an impact on farmers' work expectations, influencing the choices they make in terms of work organization. In working groups composed of associates where the question of weekends or holidays is resolved by the possibility of rotating duties between them, a willingness to work faster can lead farmers to invest in livestock equipment and in making buildings more functional, which improves the efficiency of work (Hostiou, Chauvat and Cournut, 2014).

Diversity provides flexibility for organizing the distribution of working time

One of the reasons given by farmers for diversifying their production or marketing channels is the possibility of staggering their workload more evenly over the year and being able to adapt the workload in case of unforeseen events. This is the case, for example, in the farms combining sheep and cattle in the study by Mugnier, Husson and Cournut (2021), where differences in the duration and production cycles of the two species make it possible to manage the distribution of workloads over the year by adjusting the calving and lambing periods. Three types of organization were identified among the 37 mixed livestock farms studied, corresponding to different ways of thinking about calving and lambing, in relation to the available workforce (Fig. 1). In the first type, farmers aim to limit the overlap between calving and lambing and between birthing and harvesting periods. This makes it possible for farmers who are often alone to manage their farms. In the second type, the quest to use grass better means that calving and lambing overlap in early spring, necessitating the temporary use of extra pairs of hands, often on a voluntary basis (mainly family members). In the third type, which is specific to dairy production systems, the birthing of both species is spread out over the year to guarantee both regular milk production and staggered workloads. This possibility of mobilizing diversity to manage the

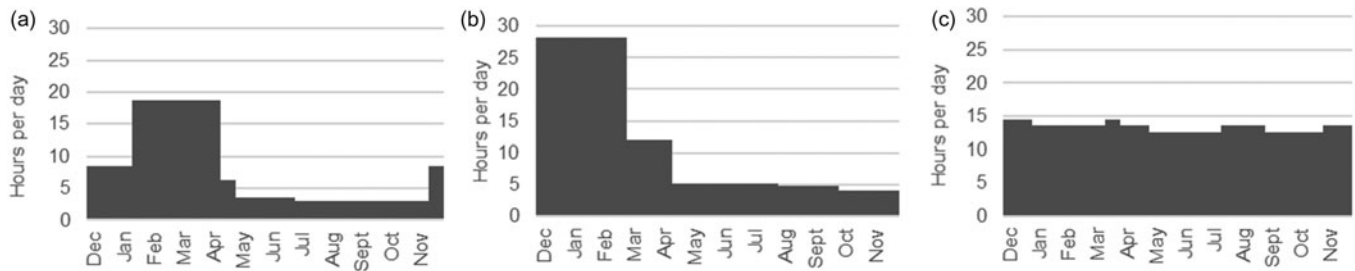


Figure 1. Three modes of distribution of routine work over the agricultural year (hours per day) in mixed cattle-sheep farming system: (a) no overlaps between birthing periods or even between birthing periods and harvests, (b) grouping of calving and lambing, with a certain level of overlap, (c) spreading of calving and lambing over the year (Mugnier, Husson and Cournut, 2021).

temporal distribution of work is found in the study by Hostiou (2013), where farmers can play on the diversity of suckling sheep batches and the articulation of their lambing periods. The author clearly shows that the diversity of lambing periods has consequences for the distribution of the workload over the course of the year.

We note that, as in the case of mixed sheep and cattle farming, diversity management can also be guided by other motivations than the staggering of work, such as making better use of resources and products over time. This is what we find in the study by Cournut, Millet and Dufour (2013), where livestock farmers who process and market their products through local supply chains have designed their systems to make the best use of diverse resources and spread out their production to guarantee supply year-round. In all cases, however, these changes have an impact on the temporal distribution of work.

The links between management of the temporal distribution of work and the diversity of workers evoked in the study by Mugnier, Husson and Cournut (2021) also are illustrated in that of Hostiou, Chauvat and Cournut (2014), where farmers managing their farms alone seek to spread out their work and adapt their systems accordingly.

Workforce organization

To consider the organization of the workforce in diversified systems, we must examine the versatility of workers, and the way in which tasks and responsibilities are distributed within the work collective, bearing in mind that the number and nature of tasks involved expands with on-farm diversity.

In the case of mixed sheep and cattle systems (Mugnier, Husson and Cournut, 2021), the similarities between the husbandry practices used for the two animal species facilitate the versatility of workers, which is more frequent on suckler sheep and cattle farms, where both species are raised for meat, than on farms combining dairy cattle and suckler sheep. The all-versatile configuration dominated on beef cattle-meat sheep farms (85%) but was rare on dairy cattle—meat sheep farms, where specialized workers dominated: only 47% of dairy cattle—meat sheep farms had a versatile worker. Versatility also depends on the diversity observed within the working group, and therefore on the types of workers. In the working groups with low diversity studied by Béguin *et al.* (2021), versatility is often a necessity. But the search for, and implementation of, versatility and equality in the distribution of tasks (everyone carries out all tasks with regular rotations) can be observed in farms where the diversity of status in working groups is low and in those where it is high (Béguin

et al., 2021). The same is not true for the distribution of responsibilities, which proves unequal in the most diversified working groups with wage workers, as farmers very rarely delegate responsibility for a production unit to an employee (Béguin *et al.*, 2021).

Delegating tasks to non-farmer labor is a way of avoiding peak workloads when one activity competes with another, as we saw earlier in the case of mixed sheep and cattle systems, where calving and lambing overlap (Case b in Fig. 1), necessitating the use of extra labor, often on a voluntary basis (Mugnier, Husson and Cournut, 2021). It also can be a way of compensating for a shortage of skills arising from diversification, as in the case of the addition of a meat cutting unit (Hostiou, 2013; Cournut, Millet and Dufour, 2013). However, delegation to manage diversity is not always possible when no additional labor is available (Hostiou, 2013), nor is it always desired when livestock farmers reserve for themselves certain tasks that are important to them. On the mixed crop-livestock farms studied by Fanchone, Alexandre and Hostiou (2022), the integration practices needed to optimize synergies between crops and livestock (use of crop by-products for animal feed, use of organic manure on plantations) are implemented by farmers who do not delegate work with the animals. In fact, the qualitative investigation of motivations revealed that farmers with integrated farming practices had a stronger bond with their animals. Farmers do not delegate work with animals because they enjoy doing it themselves and distrust non-family labor.

Finally, diversifying activities can lead to the creation of jobs. This is the case in the study by Mugnier, Husson and Cournut (2021), where some farmers claim to have added a livestock unit to enable a new partner to settle in, and in the study by Cournut, Millet and Dufour (2013), where farmers claim that the on-farm processing and sales unit has enabled a family member (often a spouse) to find a place on the farm. When a processing unit is added and the skills are not available within the working group, hiring an employee also is possible (Cournut, Millet and Dufour, 2013; Hostiou, 2013).

Work-life balance

To consider the work-life balance in diversified systems, we must examine the articulation between work and free time, as it is organized and as it is experienced by farmers.

Mugnier, Husson and Cournut (2021) highlighted the advantages of managing two animal species in order to distribute work more evenly over time, but also pointed out the disadvantage, namely the absence of lulls in the work. Some livestock farmers shared their negative feelings about not being able to rest. The

diversity of marketing channels also is often accompanied by difficulties in coping with routine work. When the working group cannot pick up the slack (not enough workers or unable to find employees), this leads to imbalances between personal and professional life that are often difficult to cope with (Cournut, Millet and Dufour, 2013). Hostiou (2013), in her study of organic sheep farming, highlighted a group of farmers who organized animal management to allow time off in summer (i.e., from late August to early September, flocks are put out to pasture and no lambing took place).

Hostiou, Chauvat and Cournut (2014) showed that expectations in terms of work differ according to the diversity of workers and therefore the work solutions implemented. While in working groups composed of several farmers (with or without wage workers), the problem of weekends and vacations is solved by the possibility of rotation between partners, this remains an issue in groups composed of single farmers or couples with volunteers or non-regular workers who implement solutions to allow themselves time off. The study by Béguin et al. (2021) confirms that working groups with a low diversity of workers (composed of single farmers) have more difficulty taking off days or weekends than working groups with a higher diversity of workers (composed of several farmers with or without wage workers). This ability to take time off is facilitated by the size of the working group and the presence of wage earners (80% of employers take more than seven weekends a year compared to 66% of non-employers), but it also depends on the versatility of the members and the overall workload (Béguin et al., 2021).

Mental and physical health

To consider mental and physical health, we must examine the effects of physically demanding tasks, excessive workloads, and stress on workers' health.

In the study by Fanchone, Alexandre and Hostiou (2022), Guadeloupe's mixed crop and livestock farmers noted that integrating crop and livestock farming practices is physically demanding. According to farmers interviewed in this study, collecting crop products and animal excreta is an arduous task that takes an excessive amount of time. For this reason, non-integrated farms used to buy concentrated feed and fertilizers. The study by Béguin et al. (2021) shows that physical hardship is felt more keenly by working groups that are less diverse in terms of types of workers and size. In the case of working groups composed of single farmers, the workload is a major risk factor. To better manage risks, farmers cited facilities and equipment designed to reduce manual labor and, consequently, the physical workload. In the study by Hostiou, Chauvat and Cournut (2014), solutions for limiting the physical drudgery of work are often related to equipment and buildings and are implemented in working groups consisting of relatively young partners.

The study by Béguin et al. (2021) is the only one of our six studies to examine the mental health dimension of work. This study shows that the feelings expressed by livestock farmers about their mental health vary according to the diversity of workers within the working group (alone, family association, wage workers). In groups with a variety of worker statuses (farmers and wage workers), the livestock farmers experience a higher level of mental fatigue. This may be explained by less shared responsibility and the complexity of managing employees. On the other hand, groups also based on a large number of workers but with more homogeneous statuses (farmers working as

partners) say that they experience less mental hardship because they share responsibilities and decision-making.

Meaning of work

To consider the meaning of work, we must examine the livestock farmers' perceptions of their profession and the diversity within their farms.

Mixed sheep-cattle farmers say they enjoy managing two species, the complexity of the task gives meaning to their work: 'juggling the two helps break the monotony'; 'I like both species; I like raising two different species' (Mugnier, Husson and Cournut, 2021). In the case of livestock farmers who diversify their marketing channels, the direct feedback they receive from consumers on their production and processing activities provides them with recognition for their work, reinforcing their meaning of work (Cournut, Millet and Dufour, 2013).

In Guadeloupe's mixed crop-livestock systems, the different levels of integration between the two production units are associated with different perceptions of their profession (Fanchone, Alexandre and Hostiou, 2022). On farms where the crop-livestock units are the least integrated, farmers define themselves as producers, and the livestock and crop activities are more intensive and industrial. Their focus on productivity is also reflected in their references to economic and identity-driven rationales, meaning the need for personal and professional fulfillment with targets for success in terms of productivity. On farms with a moderate level of crop-livestock integration, livestock farmers often refer to the economic benefits of their work, of crop-livestock integration and of keeping animals. For them, animals supply technical services, particularly organic matter, and mixed crop-livestock systems save on inputs and money. In contrast, the livestock farmers who seek to maximize the synergies between livestock and crop production through their practices define themselves as enjoying animal husbandry and the contact they have with animals. Their profession brings them personal fulfillment and well-being. The meaning of work also differs according to the composition of the working group and the diversity of the workers. The study by Hostiou, Chauvat and Cournut (2014) shows that working with a partner or family is one of the reasons why farmers are motivated by their profession.

Skills

To consider the skills in diversified systems, we must examine the need expressed by farmers for diverse knowledge and training to manage diversity.

The mixed livestock farmers in the study by Mugnier, Husson and Cournut (2021) explained that managing two different species requires technical knowledge about both species. This need for new skills can be perceived by livestock farmers as a negative point ('It is difficult to be technically good in both species'), or a positive one (the pleasure of learning, of acquiring new skills) (Mugnier, Husson and Cournut, 2021). This also applies to the development of processing, which requires skills that are far removed from those associated with animal husbandry (Hostiou, 2013), and to short supply chains, which require know-how that extends beyond technical aspects (Cournut, Millet and Dufour, 2013). If these new skills are not available within the working group, a new member may need to be integrated (Cournut, Millet and Dufour, 2013; Hostiou, 2013). In the case of the livestock farmers employing salaried workers studied by Béguin et al. (2021), the acquisition of managerial skills appears fundamental.

The multiple interactions between dimensions of work and diversity on livestock farms

Applying our framework to the six studies shows that all types of on-farm diversity can influence all dimensions of work (Table 4), with the exception of diversity linked to the management of land and livestock, for which no results were identified with the last three dimensions (meaning of work, health, and skills). These links express different types of influence depending on the form of on-farm diversity. In the case of the diversity of agricultural activities, for example, farmers feel that the workload was high. This is sometimes confirmed by the quantification of working times (Fanchone, Alexandre and Hostiou, 2022), and sometimes not (Mugnier, Husson and Cournut, 2021). The influence of the diversity associated with herd and land management on the distribution of work over time varies according to the way in which this diversity is organized, leading to different forms of distribution (regular or contrasting, Hostiou 2013). Another example concerns the diversity of the workforce, which can have a positive or negative impact on mental workloads depending on the composition of the working groups (Béguin *et al.*, 2021). It is therefore impossible to characterize clearly and unquestionably the effect of one type of diversity on one dimension of work. This was not the aim of this article, which was rather to show the complexity of the links between diversity and work, and to provide keys to understanding what happens when diversity is introduced into a farming system.

In addition to the complexity of the links between diversity and dimensions of work, our article highlights the multiple interactions between dimensions of work. We illustrate this with elements from our case studies (Fig. 2). For example, farmers' workloads, which depend on the organization of their workforce (link 4), will be experienced differently by farmers depending on the meaning each one finds in their work (link 7), and may also have consequences for work-life balance (link 2) and mental and physical health (link 5). This clearly demonstrates the value of our systemic and comprehensive approach.

Discussion

In our study, we examined the impact of managing on-farm diversity on work, and revealed the complexity of the links between the different dimensions of work and on-farm diversity. We will discuss our results in several stages. First, we will look at the dimensions linked to the organization of work at the farm level (duration and distribution of work, organization of the workforce and work-life balance), then we will examine those more linked to the individual (health, meaning of work and

skills). This will be followed by a discussion of the interactions between the different work dimensions and forms of on-farm diversity, and finally of the method of analysis and avenues for support and research.

Relationship between work organization and on-farm diversity

Through our case studies, we have demonstrated that there is no strict or clear relation between on-farm diversity and workloads. Our results do not confirm what is often claimed in the literature, namely that workload increases as diversity in the system increases (Kingwell, 2011; Pissonnier, Dufils and Le Gal, 2019; Dumont *et al.*, 2020a; Petersen-Rockney *et al.*, 2021; Schanz *et al.*, 2023). We have shown that some forms of on-farm diversity lead to increased workloads, but others do not. Some specific forms of on-farm diversity can lead to higher workloads, such as a diversity of marketing channels (Azima and Mundler, 2022) and of animal species on a farm. Farmers also can find solutions and reorganize their systems to reduce the effects of on-farm diversity on workloads, for example by sharing the same resources (feed, equipment, workforce) between two different animal species.

However, in line with the study of Moraine *et al.* (2014), we also found that farmers perceived their workloads as being higher due to on-farm diversity. We identified several factors that could explain this perception. These include difficulties in finding time to rest and for family, an imbalance between their personal and professional lives, more limited possibilities for mechanization, and an increase in the complexity of their work (increase in the number of tasks) (Galt, 2013; Dumont and Baret, 2017; Martin *et al.*, 2020).

Our findings highlighted the flexibility offered by diversity for organizing work, particularly for staggering work and better distributing the workload over the year. Our findings concur with those of other authors (Martin *et al.*, 2020; Petersen-Rockney *et al.*, 2021; Dumont *et al.*, 2022). For example, a simulation study by Mosnier *et al.* (2021) showed that compared with specialized cattle or sheep farming, managing a diversity of sheep and cattle species does not increase the workload, but spreads it out differently over the year. Spreading work over the year makes better use of the workforce available, but this constant demand on the workforce can be detrimental to farmers' feelings about their work and their ability to take time off, and thus may not favor system resilience. One of the consequences of staggered working hours is the disappearance of free time (evenings, week-ends, vacations), which farmers often find hard to cope with (Schanz *et al.*, 2023). Staggered working hours can also reduce a system's buffer capacity, which is needed to manage unforeseen events (Darnhofer *et al.*, 2010).

Table 4. Links between the forms of on-farm diversity and dimensions of work identified in the six case studies

		Forms of diversity		
		Land and herd management	Agricultural activities	Workers
Dimensions of work	Duration and temporal distribution of work	X	X	X
	Workforce organization	X	X	X
	Work-life balance	X	X	X
	Mental and physical health		X	X
	Meaning of work		X	X
	Skills		X	X

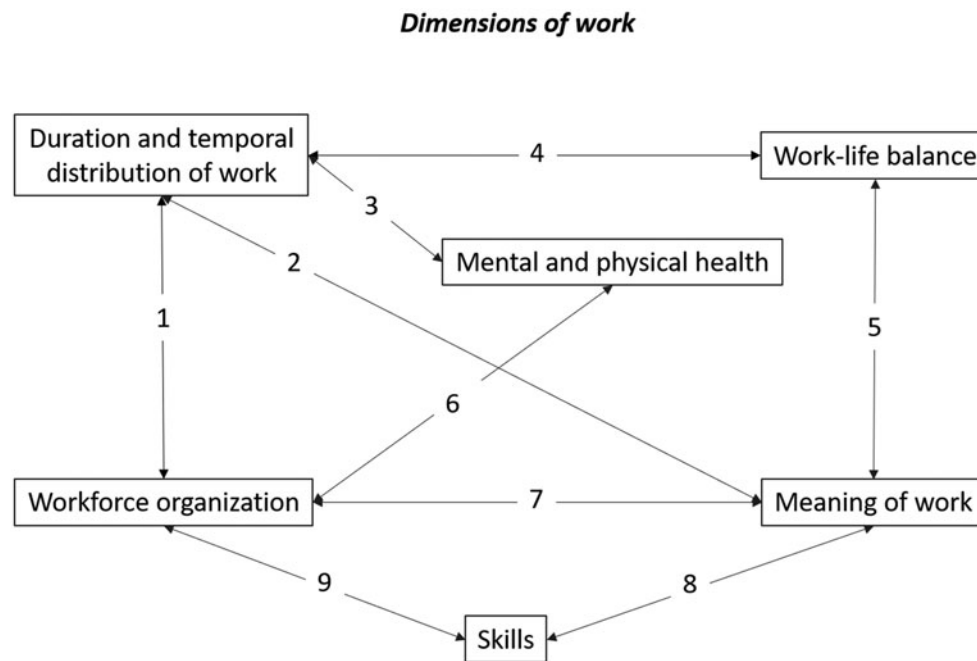


Figure 2. Interactions between the dimensions of work: some examples from the six case studies. Legend: (1) To manage the workload and its temporal distribution, the farmer can adapt the organization of the workforce (Mugnier, Husson and Cournut, 2021); (2) The meaning farmers give to their work determines their appreciation of working time, and their assessment of their workload (Cournut, Millet and Dufour, 2013); (3) Managing diversity can make workloads more arduous (Fanchone, Alexandre and Hostiou, 2022); (4) When diversity (of activities or linked to the management of land and herds) leads to staggered working hours, the periods when farmers can take a breather are reduced, and work-life balance is threatened (Mugnier, Husson and Cournut, 2021; Cournut, Millet and Dufour, 2013); (5) The chosen work-life balance depends on the meaning farmers give to their work (Hostiou, Chauvat and Cournut, 2014); (6) Organizational problems of the workforce can lead to stress (Béguin et al., 2021); (7) Depending on what makes sense for the farmers, the organization of work within the working groups will differ (delegate or not, working with others ...) (Hostiou, 2013; Hostiou, Chauvat and Cournut, 2014); (8) Developing and diversifying skills can help to reinforce the meaning of work (Béguin et al., 2021); (9) The diversification of activities requires new skills (e.g., direct sales) (Cournut, Millet and Dufour, 2013; Hostiou, 2013), which will undoubtedly call for a rethinking of the organization of the workforce.

As we highlighted in our results, diversity can lead to different workforce organization strategies regarding levels of versatility and specialization, and delegation to non-farmer labor (salaried employees, volunteers). Studies confirming or complementing our results include, for example, Martin et al. (2020), who point out that on multi-species farms, versatility within a working group can help avoid work peaks and distribute work more evenly. It also makes it easier to replace staff, thereby managing risk, and encourages collective decision-making. However, as we have seen in our studies, this versatility does not always go hand in hand with on-farm diversity. Paranthoën and Wavresky (2021), looking at farms that diversify their marketing channels, identify the specialization of partners in the management of different channels, with, for example, one partner handling production destined for national and international markets and the other for more local supply chains. Authors interested in diversity within farm also cite the use of non-farmer labor as a means to cope with an overload of work or competition between tasks (Pissonnier, Dufils and Le Gal, 2019; Martin et al., 2020). Managing diversity can have an impact on the work-life balance, but it is not independent of the composition and organization of the workforce.

Relationship between health, meaning of work, skills and on-farm diversity

Physical health, addressed in our studies through farmers' feelings about their work, can be impacted differently by on-farm diversity. The physical drudgery of the tasks required for mixed

crop-livestock integration can be high due to a lack of mechanization, among other factors. Other studies note physical health risks linked to an overload of work and/or lack of mechanization in the case of diversified systems (Dumont and Baret, 2017; Stratton, Whitman and Blesh, 2021). As in our studies (Hostiou, Chauvat and Cournut, 2014; Fanchone, Alexandre and Hostiou, 2022) and that of Mosnier et al. (2021), the use of mechanization is cited as a solution for reducing physical drudgery. However, Petersen-Rockney et al. (2021) pointed out that mechanization and automation may also lead to agricultural work being devalued and to a simplification of systems, which disadvantages diversified systems and favors specialization.

The physical drudgery experienced by the farmers also is higher when the working group is small and less diversified. While diversifying the workforce by engaging wage workers can reduce the physical drudgery of work for farmers, the same effect is not always achieved when other kinds of workers (with other statuses) are involved. Our finding was confirmed by Schanz et al. (2023), who showed that a high percentage of unpaid workers was associated with more physically severe work for farmers. Unpaid workers perform specific tasks which are often not the most physically demanding, leaving the most onerous ones to the farmers themselves.

However, on-farm diversity also can have a positive impact on physical health. Stratton, Whitman and Blesh (2021) state that the desire of farmers to improve their physical health motivates them to move toward diversified agroecological systems. Like Petersen-Rockney et al. (2021), these authors claimed that

diversified systems are beneficial to health because they reduce exposure to chemicals.

Our research did not enable us to determine the effect of diversity on mental workloads. We found this same ambivalence in the literature. Like Steinmetz *et al.* (2021), we did not observe any increase in the mental load of livestock farmers managing several animal species because the farmers viewed the management of this diversity as an enjoyable challenge rather than a mental burden. In contrast, our results, alongside those of the Béguin *et al.*, study (2021), showed that livestock farmers experience a high level of mental stress in response to the complexity of managing employees. This also was highlighted in other studies arguing that the complexity of diversified systems can increase the mental workload (Kingwell, 2011; Petersen-Rockney *et al.*, 2021; Azima and Mundler, 2022; Dumont *et al.*, 2023; Schanz *et al.*, 2023).

The analysis of our studies has shown that diversified production systems can reinforce the meaning of work for farmers. First and foremost, managing diversity can be enjoyable. This is the case, for example, of farmers who manage several species of livestock, or of mixed crop-livestock farmers who claim to thrive on implementing practices that make the most of the synergies between animal and plant production. Several studies confirm our results concerning the pleasure experienced by livestock farmers in managing complexity. Petersen-Rockney *et al.* (2021) and Schanz *et al.* (2023) noted greater mental stimulation leading to increased job satisfaction. The diversified farmers in the study by Stratton, Whitman and Blesh (2021) often said the work is more meaningful, enables self-determination, and is appealing to younger generations. The second point highlighted in our work and found in the literature (Dupré, Lamine and Navarrete, 2017; Azima and Mundler, 2022) concerns the recognition that diversified farmers can feel in their work when they process and market all or part of their production. They derive this recognition from their exchanges with consumers, which helps to give meaning to their profession.

Our studies have highlighted the need for farmers managing diversity within their systems to acquire multiple skills, which can be seen as a drawback or an advantage depending on the individual. Several authors confirm our results specifying the nature of the multiple skills required, which are not only technical but also financial (Kingwell, 2011; Aare *et al.*, 2021; Petersen-Rockney *et al.*, 2021) and managerial (Malanski, Ingrand and Hostiou, 2019). Aare *et al.* (2021) also note that this wearing of multiple hats can be perceived as diluting the competences of each profession, which can act as a brake on diversification or lead to specialization.

The complexity of the links between on-farm diversity and work

We have shown that focusing on workloads alone is not enough to understand how work may hinder or encourage the development of diversified systems, and that other dimensions of work need to be considered (Fig. 2). We also have highlighted that for each dimension studied, the conclusions were not clear-cut one way or the other, except possibly for the fact that on-farm diversity frequently seems to make work more meaningful for farmers. This analysis of the links between work and diversity highlights the need to consider the complexity of situations.

As shown in our analysis, work is not just the sum of its dimensions. Studying the links between diversity and work cannot be done on a dimension by dimension basis, as these

dimensions intersect with positive and negative interactions (Cournut *et al.*, 2018; Duval, Blanchonnet and Hostiou, 2021a; Duval, Cournut and Hostiou, 2021b). Our results have shown the complexity of these interactions, which is rarely highlighted in studies. Due to this complexity, it is impossible to characterize clearly and unquestionably the effect of one type of diversity on one dimension of work. This was not the aim of this article, which was rather to show the complexity of the links between diversity and work, and to provide keys to understanding what happens when diversity is introduced into a farming system.

Moreover, as we observed in our case studies, different forms of diversity can be associated on farms. Consequently, when considering the links between the diversity of animal species and work, one should also consider the possible diversity of marketing channels and diversity within the workforce. These links between forms of diversity have also been highlighted in other studies. For example, Boncinelli, Bartolini and Casini (2018) and Tacconi *et al.* (2022) showed that farms with a larger workforce have a greater probability of diversifying and of having a larger amount of farm resources dedicated to diversification activities.

Our results have shown that changes in work induced by diversity on livestock farms also depend on the scale of analysis, for example, that of the farmer when considering health, that of the farm when considering the temporal distribution of work, and that of the territory when considering impacts in terms of employment (Cournut and Balay, 2021). While diversity can lead to some constraints on workers' work at the farm level, it also can create jobs at the territorial level (region, etc.). We have shown that diversification can lead to job creation when it allows a partner or employee to become established, as confirmed by several authors (Barbieri and Mahoney, 2009; Azima and Mundler, 2022). Paranthoën and Wavresky (2021) have shown that farms that use several marketing channels have more workers. For Petersen-Rockney *et al.* (2021), crop diversification, by staggering the demand for labor, facilitates the employment of year-round workers. However, several authors have pointed out the difficulty of finding and paying labor, which can hinder diversification (Pissonnier, Dufils and Le Gal, 2019; Petersen-Rockney *et al.*, 2021; Bowman and Zilberman, 2013).

Discussion of the method and avenues for support and research

The approaches to work used in our study, derived from farming system approaches (Gibon *et al.*, 1999; Darnhofer, Gibbon and Dedieu, 2012), have focused the analysis of work by using a framework combining technical management and work organization (Dedieu and Schiavi, 2019), considering the farmer as the driver of the system and the organizer of work (Dedieu and Servière, 2012; Cournut *et al.*, 2018). This is why the analysis of the links between work organization and diversity at the farm level is given greater weight in the studies presented in this article. We applied our framework to our own studies, analyzing work in relation to one or two forms of on-farm diversity. Of course, these studies were not all designed to explicitly analyze the links between diversity and work, and only explored certain aspects of each form of on-farm diversity. It would have been interesting to consider, for example, the gender and age of workers in terms of worker diversity as suggested by the study of Tacconi *et al.* (2022). However, the analysis of these studies has produced a wealth of findings. We have shown that managing diversity in a livestock system has various implications in terms of work.

These concern different dimensions of work and are difficult to characterize in a generic way because they depend on many factors and are interconnected. Above all, our study has highlighted the complexity of these situations. For example, diversity of marketing methods, which is often associated with diversified agricultural production and sometimes diversified livestock production, leads to several compromises and tensions over work. The diversity of production methods within a farm means that work is spread out over the year, with fewer opportunities to take a breather, thus jeopardizing work-life balance. The recruitment of an employee to compensate for a farmer's lack of marketing or processing skills requires the farmer to acquire skills in human resources management and to rethink the distribution of tasks. Finally, direct sales to consumers can reinforce the meaning of work for a farmer, but also can cause stress.

These examples highlight that the development of a farm towards greater diversity needs to be considered in the light of the impact on work in all of its dimensions. On-farm diversity provides farmers with several potential strategies for responding to uncertainties (Darnhofer et al., 2010; Martin et al., 2020; Mugnier, Husson and Cournut, 2021), but the question of work is a significant consideration as it can jeopardize the sustainability of diversified farms. Our study shows that the impact of diversity on work is complex, and that while diversity may lead to heavier workloads, a point that has yet to be proven, it brings other work benefits that are just as important in keeping farmers on their farm. This study does not examine economic and environmental aspects (e.g., productivity, antibiotic use, greenhouse gas emissions), but these are naturally elements that must be considered in relation to the sustainability of a system and its ability to cope with climatic and economic changes (Mosnier et al., 2021; Benoit et al., 2023).

Our case studies concern French family farms, although some are larger than the national average noted in the study by Béguin et al. (2021), with characteristics less similar to many family farms in the country. The case study in Guadeloupe (Fanchone, Alexandre and Hostiou, 2022) highlights diversified systems that are smaller compared to farms in France (Stark et al., 2016) with lower levels of mechanization (e.g., no agricultural robotics, lower tractor power levels, etc.). The farms studied in Guadeloupe are closer to the situation observed in developing countries, although the configurations are not entirely identical. In developing countries, diversified farms employ numerous temporary workers, rely on manual work, and are sometimes even smaller in size (Daum et al., 2023). However, the results of this study (i.e., the different dimensions of work to be analyzed and the complexity of their links) are not called into question. The farms included in our five case studies, with the exception of the one in Guadeloupe (Fanchone, Alexandre and Hostiou, 2022), are similar in size to average livestock farms in France. They employ a similar number of workers, who are primarily family members, although some farms also employ salaried workers. The equipment used on these farms is also relatively standard. During the course of the case studies, no data were collected on the forms of mechanization and their impact on work. Consequently, an analysis of this aspect was not possible. However, this does not affect the validity of the analytical framework or the conclusions drawn. The case study in Guadeloupe (Fanchone, Alexandre and Hostiou, 2022) clearly demonstrates that a low level of mechanization will accentuate the impact of diversity on work, particularly in terms of workload and arduousness. Therefore, mechanization should be taken into account in analyses of work in diversified systems, with the aim of proposing avenues for more sustainable systems.

Our proposal for further research is to examine more deeply the interactions and compromises between the different dimensions of work and the various forms of on-farm diversity. The framework we have proposed seems appropriate for carrying out such research. It can also serve as a basis for the development of tools to support diversified livestock farmers, or those planning to become so. The framework can be particularly useful for examining and analyzing work in these systems, enabling a better understanding of the implications of managing diversity, and thus better support for farmers. A tool could be developed for advisers to ensure that the different dimensions of work are taken into account, and not just the workload, which is often the main focus. This could be used by advisers when farmers are considering introducing or increasing their on-farm diversity, as well as when farmers are facing difficulties related to their working conditions in diversified farming systems. Our framework reveals what is happening, or could happen, from a work point of view as farms move towards greater diversity. It therefore highlights the tensions and weaknesses, as well as the strengths, of these systems, which need to be taken into account if this evolution is to lead to greater sustainability. The framework could be enriched to consider what happens at the interface between farms and territories, with the possibility of sharing work at the level of farmers' collectives (Lucas and Gasselín, 2022).

Conclusion

Our study focuses on promising livestock systems, specifically those that are managing on-farm diversity. These systems are attracting growing interest for their agroecological virtues and resilience, but are often presented as having negative impacts on farmers' workloads.

The originality of our paper is that we consider these diversified systems from a perspective of work in an integrative way. We applied a framework combining six dimensions of work with three forms of diversity to six case studies focusing on French family livestock farms. We were thus able to cover a wide range of situations and highlight the complexity of the links between work and on-farm diversity.

For those interested in the working conditions of farmers in diversified systems, the workload is far from being the only dimension of work that should be considered. We have shown that introducing and managing diversity in a livestock farming system has various work-related implications, affecting the duration and distribution of work over time, workforce organization, work-life balance, health, the meaning of work and skills. These implications can be favorable or unfavorable depending on the situation and the form of diversity involved, but also on the way in which farmers think about the balances and compromises between dimensions of work. Moreover, on-farm diversity seems to more frequently reinforce the meaning of work for farmers. This picture of the complexity of situations leads us to encourage further research that would examine the interactions between dimensions of work according to forms of on-farm diversity. These studies should make it possible to better anticipate the consequences of introducing or increasing on-farm diversity in an uncertain context marked by climate changes and price volatility. We need to understand the various facets of these interactions to promote the development of resilient, sustainable, and attractive livestock farming systems through suitable support services and public policies. Although our study focused on diversified livestock production systems in France, and therefore did not cover

every situation that may be encountered, particularly in non-OECD countries, the proposed analytical framework remains relevant and can be adapted to other contexts (low level of mechanization, etc.).

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