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Clémentine Meunier[a], Guillaume Martin[a], Cécile Barnaud[b] and Julie Ryschawy[c]

[a] *AGIR, Univ Toulouse, INRAE, 31326 Castanet-Tolosan, France*
[b] *UMR Dynafor, Univ Toulouse, INRAE, 31326 Castanet-Tolosan, France*
[c] *AGIR, Univ Toulouse, INPT, INRAE, 31320 Auzeville, France*

Abstract:

Bucking the trend of specialisation, a few pioneering farmers have reintegrated livestock onto crop farms. These systems have been neglected by research to date. We identified French farmers' motivations for reintegrating livestock into specialised crop farms and crop-producing regions. Following innovation-tracking principles, we interviewed 18 crop farmers having reintegrated livestock in various systems in two regions dominated by crop farming. The semi-directed interviews focused on farmers' motivations for reintegrating livestock and were completed by farmers' ranking of 10/36 cards representing their main agronomic, economic, social and environmental motivations for crop-livestock farming. Seven categories of motivations for reintegrating livestock emerged from inductive content analysis: following personal ethical and moral values, increasing and stabilising income, promoting ecosystem services, increasing self-sufficiency and traceability, connecting to the local community, decreasing pollution and keeping the landscape open. Agricultural motivations, particularly related to soil quality, dominated both discourse analysis and motivation card rankings. Economic and social motivations were closely ranked, with income stability and social connections being primary drivers. Environmental motivation cards were less selected. This study is the first to provide a ranked summary of crop farmers' motivations for reintegrating livestock. Understanding this diversity is an initial step in supporting the development of this practice.

Keywords: Crop-livestock integration, Mixed systems, Sustainability, Farmers' motivations, Innovation tracking, Inductive content analysis

1. Purpose

Over the past few decades, the trend towards agricultural specialisation has spatially disconnected crop and livestock farming systems in Europe, and in France in particular, contributing to generate environmental externalities (Garrett et al., 2020). Specialised crop regions, while productive, heavily rely on nutrient inputs and consume substantial energy (Harchaoui and Chatzimpiros, 2018). Conversely, specialised livestock regions face challenges such as dependence on external animal feed and the generation of excess manure, leading to storage, disposal, and pollution issues (Lassaletta et al., 2009; Peterson et al., 2020). In spite of these acknowledged impacts, input-intensive segregated crop and livestock systems go on being developed.

Bucking this trend, a few pioneering farmers in France are reintegrating (i.e. intentionally organising the return of) livestock onto crop farms and into crop regions. These systems can contribute to decreasing environmental externalities thanks to crop and livestock reconnection at the farm (e.g. rearing livestock on the farm) or regional level (e.g. partnership between a crop farmer and livestock farmer, with the former hosting the latter's livestock for a specific period, for example to graze a winter cover crop). In spite of the potential advantages of these systems for transition towards sustainable farming, livestock reintegration is rare and understudied to date. Few studies have focused on the conditions that support or impede persistence of mixed systems or reconnection of crops and livestock due to farmer cooperation beyond the farm level in regions where both types of farms still exist (Martin et al., 2016). To date, no study has specifically sought in-depth understanding of the motivation toward reintegrating livestock onto specialised crop farms and into crop-producing regions.

The objective of this study was to identify and analyse French farmers' motivations for reintegrating livestock onto crop farms and into regions. Understanding the motivations that drive farmers to reintegrate livestock in such a challenging context is a necessary first step to assess performances of these systems in light of farmers' objectives and to incentivise, promote and/or support transition pathways towards sustainability through adoption of this sustainable practice (Paut et al., 2021; Ryschawy et al., 2021).

2. Methodology

We conducted 18 semi-directed interviews with crop farmers who had reintegrated livestock in order to analyse their motivations for having done so.

Case-study regions and farmers

We selected two regions where crops currently predominate but which differed in their history of livestock production: Occitanie (where traditional livestock and crop-livestock farms have strongly declined to be replaced with specialised grain crop farms, and where services such as slaughterhouses or technical advisors have remained but have been reduced greatly) ; and the Parisian Basin (where specialised cash crop farms have dominated for decades).

Following innovation tracking principles (Salembier et al., 2021), we aimed at identifying a wide variety of crop farmers' motivations for reintegrating livestock, rather than at obtaining statistical representativeness. As reintegrating livestock is uncommon, we included all crop farmers we could identify in the two regions, i.e. organic or conventional farmers who produced any type of crop and had reintegrated any type of livestock at the farm or regional level. We relied on farm advisors from our network to identify farmers who had reintegrated livestock onto crop farms and into regions, and increased the sample size using the snowball approach.

We interviewed 10 farmers in Occitanie and 8 farmers in the Parisian Basin (total: 18), who had diverse profiles in production mode (15 in organic farming or in conversion, 3 conventional), utilized agricultural area (5-2000 ha), crop production (grain crops, vegetables, orchard, vineyard), livestock production (meat sheep, meat cattle, laying hens, broilers, pigs), number of animals (e.g. from 200 laying hens to 1200 ewes plus 15 000 fattening lambs), as well as the type (farm level, regional level or both) and duration of livestock reintegration (1-24 years, but most farmers had reintegrated livestock recently (mean of 5.6 years and median of 4 years)).

Data collection

Following Ajzen's Theory of Planned Behaviour (1991), the interview guide included questions targeting all the factors that may have motivated crop farmers to reintegrate livestock, such as i) beliefs about livestock reintegration, ii) overall objectives for the farm, iii) values and their influence on livestock reintegration, iv) perception of the risks involved in reintegrating livestock and v) internalised subjective norms. We also mentioned other topics to understand the overall functioning of the farm and identify some motivations for reintegrating livestock the farmer might have omitted when asked specifically.

At the end of the interview, to confirm whether we had identified all the motivations for livestock reintegration and to establish their priority, we provided farmers with 36 cards, encompassing the primary benefits of mixed farming and livestock reintegration as identified in existing literature, supplemented by us with additional advantages associated with farmers adopting sustainable practices. The cards were categorised into four categories: agronomic (13 cards, including 5 for soil-related benefits such as improving soil fertility and 8 for other aspects), environmental (4 cards), economic (12 cards), and social (7 cards). We asked farmers to choose and rank approximately 10

cards, irrespective of the category, that resonated with their own motivations for reintegrating livestock into their crop farms. Farmers were also given the option to add cards if they felt that a significant motivation was missing. We engaged in a brief discussion to explore their rankings, align them with the motivations identified during the interview, and incorporated any overlooked points.

Data analysis

To identify farmers' motivations for reintegrating livestock, we transcribed the 18 interviews completely and performed inductive content analysis. To rank crop farmers' motivations, we analysed their 18 rankings of the motivation cards, using the number of times each card had been selected, and the weighted sum of points attributed to each card (from 10 points for rank 1 to 1 point for rank 10). We triangulated the results obtained through qualitative and quantitative data analysis to increase their robustness. For each farmer, we compared the motivations identified through discourse analysis to the ranking of each motivation card and classified the comparison into four classes: i) the same ; ii) nearly the same (he card could be easily associated with something the farmer mentioned, albeit expressed in different term.); iii) ambiguous or unclear (e.g. the motivation was mentioned by the farmer only after seeing it on the card, or was not specific to livestock reintegration) ; iv) different (the motivation was identified in only one of the methods). We computed the percentage of motivations within each category by aggregating responses from all 18 farmers. We also performed multivariate analysis to characterize the differences in farmers' motivations rankings according to characteristics of the farming system (i.e. Region, Crops, Livestock reintegrated, Level of reintegration, Years reintegrated, farm size, type of housing) and farmer's profile (Age and Prior connection to livestock farming).

3. Findings

Discourse analysis

Seven categories of motivations for reintegrating livestock emerged from the inductive analysis of the interviews: following personal ethical and moral values, increasing and stabilising income, promoting ecosystem services, connecting to the local community, increasing self-sufficiency and traceability, decreasing pollution and keeping the landscape open.

Almost all farmers (17) identified livestock reintegration as a means to follow their diverse personal ethical and moral values, either to i) respond to their desire to have a meaningful job (as animals helped derive value from crops that were difficult to sell) (3 farmers) ; ii) matching their value of environmental stewardship (10); iii) undertaking a technical challenge through implementing a not well-known agricultural practice (8) ; iv) connecting to family or regional heritage of mixed farming (6) ; v) insuring the transmission of the farm by increasing its financial value (6); vi) improving the balance between personal and personal life by reducing workload (e.g. mechanization avoided through grazing) (5) and vii) improving their satisfaction at work thanks to animals' presence (11).

Fourteen farmers reintegrated livestock to *increase their income* through i) selling new products (6 farmers) ; ii) using "lost" crops or land, such as between orchard or vineyard rows or growing pasture where crop production was costly (7) ; iii) decreasing production costs by promoting ecosystem services and increasing self-sufficiency (6). Another motivation was to stabilise income (10), by i) increasing farm self-sufficiency and diversifying production to lessen dependence on market prices and climate events (10) and ii) using livestock to derive value from crops that did not grow well (1).

Another motivation for reintegrating livestock was to *promote ecosystem services* (16 farmers), especially regarding soils (life, fertility, structure, and carbon storage thanks to substituting mechanization with grazing thereby reducing greenhouse gas emissions). Five farmers mentioned

grazing (sometimes associated with introducing pasture in the crop rotation) as a way to manage weeds and cover crops. Three farmers identified livestock as helping increase fields biodiversity.

Twelve farmers reintegrated livestock as a way to *strengthen their connections to the local community*, either within the agricultural sector (e.g. having someone working on the farm yearlong to tend the livestock, partnering with a livestock farmer) or outside (e.g. improving the image of the system towards customers (5 farmers) or citizens (3)).

Eight farmers also identified reintegrating livestock as a way to improve *farm self-sufficiency*, especially regarding nitrogen thanks to high-quality livestock manure. Fours farmers mentioned an increased traceability of farm products thanks to direct selling initiated with livestock reintegration.

In fewer cases, farmers mentioned reintegrating livestock to *decrease pollution* (through promotion of ecosystem services, decrease of input and energy use) (3 farmers) or to *maintain the landscape* (e.g. renovating an abandoned orchard) (3).

Motivation card rankings analysis and triangulation of the results

Through the analysis of farmers' ranking of motivation cards, we showed that farmers' main category of motivations for reintegrating livestock was agronomy (43% of the points), especially regarding soils (25% of the points) and biodiversity, consistently with the high number of farmers mentioning ecosystem services promotion in their discourse.

Cards from economic and social categories were selected nearly as much by farmers (25% and 22% of the points respectively). The highest-ranked economic motivations were increasing and stabilising income, and increasing self-sufficiency, also identified as important motivations in farmers' discourse. Social motivations included creating social connections as mentioned by 17 farmers in their discourse, then responding to a desire/preference/belief, that could be linked to the motivation to follow personal moral and ethical values. Farmers attribute few points to the pollution cards in the environmental category (9% of the points in total). The most selected card was environmental stewardship, consistently with farmers' motivation to follow ethical values identified in their discourse.

Overall, results from the discourse analysis and motivation cards analysis were similar, with 82% of motivations that were the same or nearly the same, and mismatches appearing low in farmers' rankings. The motivations classified as different were mainly those identified through discourse analysis but not selected in the cards.

Main difference between farmers' motivations to reintegrate livestock regarding farming systems' characteristics was linked to the type of housing, as farmers reintegrating livestock in fully outdoor systems tended to favour agronomic motivations whereas farmers with at least partly indoor systems (e.g. free-range poultry, mixed indoors/outdoors for other livestock) tended to select more economic motivations.

4. Practical implications

In the current climate of escalating energy, feed, and nitrogen fertilizer prices, livestock reintegration seems to be a promising lifeline for crop farmers. Understanding the diversity of crop farmers' motivations for reintegrating livestock is the first step in sustaining the development of this innovative practice under favourable conditions and farmers' transition towards more sustainable farming systems. Building on the motivations for reintegrating livestock identified among crop farmers, decision-makers could align their communication on the benefits of these systems accordingly. They could also promote the development of this practice by developing payments for the ecosystem services provided.

5. Theoretical implications

Motivations for reintegrating livestock identified in this study are consistent with the benefits of crop-livestock integration documented in the literature, especially regarding promotion of ecosystem services through livestock manure and diversification of the crop rotation (Brewer and Gaudin, 2020) and income stabilisation through increased resilience regarding climate and market events (Bell and Moore, 2012). Social motivations highlighted in our study have not been reported as an advantage of crop-livestock integration so far. Benefits of crop-livestock integrated systems in pollution reduction have been widely documented, especially regarding closing carbon and nitrogen cycles (Ryschawy et al., 2021), but have not stood out as a major motivation in our sample.

Farmers' motivations for reintegrating livestock were consistent with those mentioned in other studies for engaging in sustainable transition pathways. Ecosystem services promotion was identified as a motivation for adopting conservation agricultural practices (Casagrande et al., 2016). Increasing income was also identified in studies on adoption of conservation practices in organic farming, reducing pesticide use or grazing orchards (Casagrande et al., 2016; Paut et al., 2021; Pergner and Lippert, 2023). Social motivations identified in our study, such as the desire to undertake a technical challenge and to strengthen connections to the local community, were mentioned as triggering conversion to organic farming (Bouttes et al., 2019). Similarly, increased work satisfaction and caring about future generations were other motivations for adopting sustainable practices other than reintegrating livestock.

Our study focused on identifying a wide variety of crop farmers' motivations for reintegrating livestock. Following Lalani et al. (2021), future studies may focus on the interlinkages between those motivations, and how those motivations may vary according to farmers' profiles and farm characteristics. Similarly, motivations are one of the many factors triggering farmers' adoption of a sustainable practice or transition pathway. If the development of this practice is to be sustained, other elements should be in-depth studied such as the conditions that facilitate or hinder livestock reintegration, the trajectories followed by crop farmers to reintegrate livestock, or the impacts of reintegrating livestock on the sustainability of crop farms.

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