Impact of value chain stakeholders on territorial integrated crop livestock systems. Summary of a participatory workshop

Florence Bonnet-Beaugrand, Théo Delord, Joseph Ory

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Florence BONNET-BEAUGRAND[1], Théo DELORD[2], Joseph ORY[1,2]

[1] Oniris, INRAE, BIOEPAR, 44300, Nantes, France

[2] ENSAT, 31326, Castanet-Tolosan, France

Corresponding author: florence.beaugrand@inrae.fr

In this workshop, we addressed the impact of value chain stakeholders on territorial integrated crop-livestock systems (TICLS). Three themes were suggested for this World Café workshop: the link to producers and advice, the link to markets, and the internal organisation of sector stakeholders. Scientific literature and workshop participants pointed out the strong dependence on investments and the standardisation of global markets as major obstacles. The levers could lie in regulatory, economic and organisational redesign that would take into account local specificities and coupling between producers and consumers of agricultural products and services at large. Redesigning however implies transition costs which require new financing and risk management.

Keywords: integrated crop-livestock system, value chain, vertical coordination, commons

1. Agricultural value chain stakeholders: between the path dependency to specialisation and the despecialisation of territories

In the second half of the 20th century, the agricultural sector in high-income countries underwent profound changes. Farms became larger and more specialised, and their numbers decreased; large farms now account for over 40% of the total. French regions have specialised either in plant production (in areas such as viticulture, market gardening and horticulture, or as part of the cereal-growing process in the Paris Basin and Aquitaine, for example), or in animal production (for example, mountain livestock farming, dairy cattle farming in the Western France, suckler cattle farming in the Massif Central and Pays de la Loire, or organised production in Brittany) (Hardelin and Schwoob, 2021). Specialisation takes place around pivotal crops, the choice of which is the result of a complex interweaving of soil and climate conditions, the history of the area and the socio-economic dynamics of the agricultural sector, the spatial organisation of the area, the link between agricultural activity and the local production market, and interdependencies with neighbouring areas (Herment and Mignemi, 2021) - for instance in cross-border areas (de la Haye Saint Hilaire et al., 2023); at present, only cereal crops are continuing to expand.

Indeed barriers to international trade have been lowered (transport costs have fallen and markets have been liberalised), and as a result, competitiveness targets have risen. Capital and labour yield better returns; techniques have evolved, notably through the increased use of varietal and genetic selection, irrigation, and the use of chemical and pharmaceutical inputs. Geographical agglomeration effects (on the labour, goods and knowledge markets), particularly for dairy farming, have combined with the search for economies of scale. Public agricultural policies have encouraged farmers to specialise, whether through the Common Agricultural Policy (CAP) or territorial development policies (Hardelin and Schwoob, 2021; Herment and Mignemi, 2021; Simboli et al. 2015).

However, specialisation is now reaching its limits. Crop yields are declining structurally, suggesting that crop rotation and crop synergy should be better applied, to benefit to biodiversity, fertility management

and protection against pests and diseases. Production and market risks are increasing as a result of climate change, calling for income diversification (Hardelin and Schwoob, 2021). What's more, specialised livestock farming uses up land, water and crop resources, destroys biodiversity and produces unsustainable levels of pollution (FAO, 2006). Nitrogen from effluent from pig and poultry farming in Brittany, for example, eutrophises the environment, while at the same time French agricultural production depends on imported fertilisers. Cattle produce greenhouse gases. In addition, French livestock farming lacks protein feed. Linking nutrient and fertiliser cycles and integrating crops and livestock are therefore crucial issues for the future of agriculture. Legume production, which enables both nitrogen fixation and the production of animal feed and human food is a key element, either at farm level or in the context of exchanges between farms (Jouan et al., 2020; Duru and Therond, 2021).

At farm level, some farmers are looking for autonomy and are strengthening their forage systems to lower inputs, simplifying farming techniques or diversifying crops and intercropping (Moraine et al., 2019). However, in the current model, mixed crop-livestock farms tend to specialise; conversely, reintroducing livestock into cereal farms is a challenge. The territorial scale therefore seems more likely to enable cycles to be completed, and new integrated crop-livestock systems have been re-emerging since the 1990s, promoted in particular by these 'low-input' farms and the incentives of the CAP (Garett et al., 2020). Different archetypes of exchanges between farms can be distinguished, requiring an increasing level of coordination (Moraine et al., 2017; Martin et al., 2016):

- Specialist farms exchange produce with each other (cereals, fodder, straw, manure, etc.);
- Specific products (concentrates for animal feed, straw, fodder, etc.) are exchanged throughout the region with the aim of complementing each other;
- Farming systems are redesigned to increase the ecosystem services provided (e.g. with grazing of intercropping wasteland, or the creation of methanation units, or the management of by-products and waste (Simboli et al., 2015));
- Complete new regional value chains are created, with specific marketing and the pooling of human and material resources.

The despecialisation of territories requires constant trade-offs between individual and collective interests (Catarino et al, 2021). In these integrated crop-livestock systems, exchanges go beyond material exchanges and involve significant transaction costs. Exchanges involve cognitive resources, for the production, evaluation and transfer of new knowledge. Labour is shared. Capital is pooled for investment in collection, storage and processing (Madelrieux et al., 2017) and risk management. Production sequences and land allocation need to be planned collectively. New marketing methods are being explored. Ultimately, it is a matter of redesigning circular value chains (Moraine et al., 2016), characterised by their anchorage to local resources and other activities, their dependence on the area and their ecological footprint (Madelrieux et al., 2017).

Complex interactions take place at the territorial level, defined as both a geographical and socio-economic space in which stakeholders collectively manage common resources (Moraine et al., 2016). Coordination can take place bilaterally between livestock and crop farmers, which develops partnerships, via economic intermediaries, or through institutional stakeholders if higher interests are at stake (Moraine et al., 2017). Decision-support tools are sometimes used to promote coordination (Martin et al., 2016). Value chain stakeholders, such as producer organisations, cooperatives and industries, could orchestrate new forms of coordination in this territorial system and contribute to reduce transaction costs, linked to logistics, marketing, investment, particularly in livestock farming where the workload is high (Moraine et al., 2017), or take part to risk management. For example, Moraine et al (2016) cite a cooperative that takes charge of harvesting alfalfa and drying it to ensure the quality of the finished product. But this role of coordination between livestock and crop farmers, or of support for minor crops, is controversial with the dominant regime of agriculture. Peyraud et al (2014) indeed

attribute the disappearance of historical crop-livestock integrated systems precisely to the paradigm of specialisation in value chains.

In this participatory workshop, we questioned these contradictions and tried to identify with the participants the levers for greater value chain stakeholders' involvement in recoupling crop and livestock systems at territorial scale.

2. Framing the workshop

2.1. Three World Café themes linked to the strategy of value chain stakeholders

We conducted a World Café workshop. Three sub-groups brainstormed on three chosen themes. The sub-groups worked for around twenty minutes on a given theme and then continued the previous sub-group's reflection on another theme, by successive permutations. The three theme leaders built mind maps to enable the sub-groups to deepen the brainstorming as the permutations progressed.

We chose the three themes accordingly with the literature review and a number of targeted interviews (See Fig.1). We completed this review with a targeted search for resources on the website of the SPICEE joint technology network (Structuring and producing innovation in systems where crops and livestock are grown together).

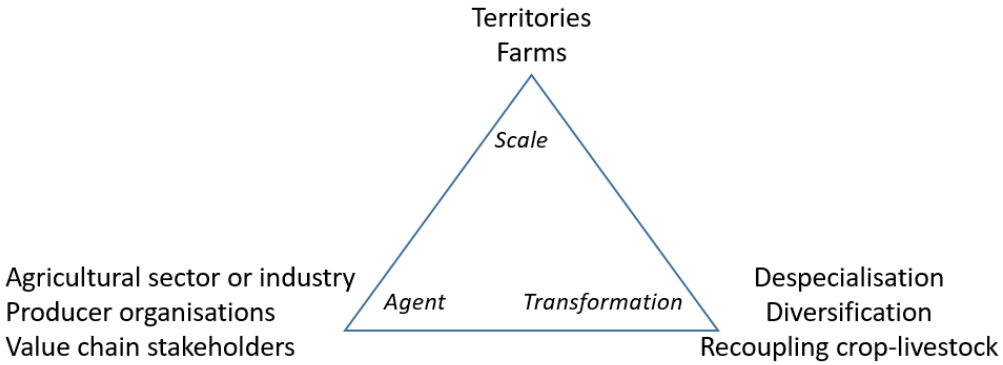

Figure 1: Framework and keywords of the literature review

The three themes are as follows

- Obstacles and levers upstream: links with farms and farm advisory services
- Obstacles and levers downstream: links to national and international markets
- Internal obstacles and levers: value chain stakeholders' organisation and skills

The facilitators (two agricultural engineering students and a lecturer) prepared questions to be asked at the start of the World Café for each theme, as well as specific follow-up questions. Around forty people took part in the workshop, mainly students from agricultural engineering schools and technical institutes, representatives from the agricultural sector and scientists. A introducing presentation about a large agricultural cooperative, Cooperl, set the context for value chain stakeholders to foster discussion.

2.2. Introductory purpose by an animal production consultant

"Cooperl is a cooperative of livestock and crop farmers in the Western France, with 3,000 members and 8,000 employees. It supplies 13 million consumers every day. It is structured as a supply chain, integrating all the levels in the value chain, from genetics and feed to outlets for supermarkets. For the past twenty years, Cooperl has based its strategy on social and environmental responsibility. The

cooperative uses livestock effluents as organic fertiliser, promotes animal welfare and complies with specific labels: pigs raised without antibiotics, pigs fed without GMOs, uncastrated pigs, and so on.

The synergy within the value chain induce greater average revenue for its members compared to other cooperatives.

Confronting the challenges faced by society and the environment, Cooperl is continually investing to develop its production systems in line with the transitions to food (greening food), energy (decarbonisation), agro-ecology (reducing pesticides, controlling pollution, saving resources, new farming techniques) and digital technology (smart farming). This research effort takes the form of partnerships with technical institutes, research centres and partner companies (open innovation).

This transformation dynamic is crucial to the survival of the company and its economic environment (members, employees, regions), but it faces lock-ins in historical production systems, price competitiveness in a global competitive environment exacerbated by numerous competitive distortions, and a significant need for investment. Responsible French cooperatives therefore need greater support from the public authorities for transition".

3. Contributions from World Café participants

In the outcomes of the World Café themes, we highlight both the initial framework provided by the literature and the contributions made by the participants.

3.1. Value chain stakeholderds capabilities: innovation and support for transition on farms

3.1.1. Outcomes from the literature review

Integrated crop-livestock systems are less profitable and more labour-intensive than other production systems, yet their return on investment is faster and more substantial for farms (Garett et al., 2020). However, the transition phase at farm level raises issues linked to a lack of knowledge and risk management (Meynard et al., 2013).

Technical references of all kinds lack, if only historical data on technical trials. There are few crop protection solutions, due to the low economic interest in R&D and/or registration for minor crops. Approaches to genetic progress are slower (Meynard et al., 2013). Peer groups are less active in these areas (Garett et al., 2020). Meynard et al (2013) advocate a policy of support for R&D and the knowledge capitalisation, in particular via the CAP, while Moraine et al (2016) call for an assessment of profitability for producer organisations and workload.

Value chain stakeholders can contribute to disseminating technologies through the production of knowledge *per se* in R&D and consultancy, but they can also help to set standards, in line with market demand, or to create attractive value chains for new technologies (Labarthe et al., 2018). Establishing long-term contracts with producers would also help to guarantee a secure environment for investment and the co-construction of knowledge, and to better manage risks (Meynard et al, 2013).

3.1.2. Questions raised by the participants

Participants in the workshop on the theme of "Links with farms and farm advisory services" focused on the support needs of farmers, outlining a possible role for value chain stakeholders in this support. The question of knowledge was addressed, at farm level and in relation to the way current advice is structured. Participants also discussed risk management at farm level.

The participants identified the need for farmers to develop their skills in completely new areas as the first obstacle to the development of agro-ecological practices. They therefore stressed the need for

support tailored to each situation when farmers want to diversify their operations. They felt that farmers needed revised advisory methods to adopt a more systemic approach to their farms, with personalised technical advice tailored to the characteristics of the region, in contrast to the standardisation of advisory bodies in numerous sectors. The participants identified levers such as peer knowledge exchange, in particular through collective meetings, the training of agricultural advisers and strategic advice guidelines that are better adapted to the issues encountered. Funding (particularly from the regions) would be a key factor in the development of advice tailored to agricultural diversification.

The workshop participants then addressed the issue of risk management at three levels for farmers. They mentioned the market risk, in particular in the case where farmers choose a direct sales method that guarantees good value for the products resulting from despecialisation. In this case, the workshop participants mentioned that the time and marketing costs involved in developing their marketing network and customer base would be better shared through collective approaches. They felt that this was an interesting option in areas not currently covered by value chain stakeholders, but that its organisational, economic and financial feasibility had yet to be demonstrated. In connection with this theme, participants raised the issue of the region's demographics, which they see as a potential barrier both in terms of the customer base and the labour pool.

The second risk addressed in the workshop is a production risk related to climate change. Faced with climatic events that reduce crop yields and force farmers to rethink their production methods, diversification seems *a priori* to be an alternative likely to limit production and economic losses. However, diversification also represents a significant risk because of the yield uncertainties when new crops are introduced. The workshop participants felt that an insurance-based approach would be likely to support this type of approach and reassure farmers making the transition, but expressed doubts about the willingness of private insurance companies to commit to this approach.

Finally, the participants mentioned the entrepreneurial risk. When production facilities change, the existing infrastructure on a farm needs to be resized and/or combined with new storage or livestock buildings. The question of return on investment raised more general issues of transfer and access to agricultural land.

3.2. International standardisation versus territorial heritage: a commercial dilemma

3.2.1. Outcomes from the literature review

Despite the complexity of the factors involved, market demand is the main driving force behind the intensification and specialisation of farms and regions. Agricultural products have commercial outlets as foodstuffs, particularly for urban areas; as industrial raw materials; or as luxury goods. From a historical situation of tension between self-consumption by farmers and local markets, we have progressively moved away from areas of production and areas of consumption, on national or international markets. Farming systems are adapting to the prices of different products on world markets (Herment and Mignemi, 2021).

Usually, companies express their attachment to the territory through several dimensions: their location, the way they add value to their products and the way they link production and consumption (Madelrieux et al., 2017). Competition on international markets creates emulation for value chain stakeholders, which encourages the emergence of new technologies, rationalisation methods and commercial practices, all targeted at the dominant products. Value chain stakeholders help to shape a normative commercial universe: the quality criteria set downstream in the value chain standardise the choices and production methods upstream (Herment and Mignemi, 2021). New products create new competition with existing, standardised products, both on the market and within the value chain organisations (Meynard et al., 2013; Madelrieux et al., 2017).

The sectors therefore differentiate their production and promote their local heritage through quality labels (official quality signs or brands and appellations) (Herment and Mignemi, 2021). This is a lever for diversifying production, particularly when it involves alternative production (Meynard et al., 2013; Madelrieux et al., 2017). As well as adding value to products, internalising ecosystem services in the price of products could lead industries to relocate their workshops and redesign a denser network across the country (Meynard et al., 2013). However, Madelrieux et al. (2017) note that an excessive focus on quality signs could be an organisational dead end. De La Haye Saint Hilaire et al (2023) open up another perspective through their work on the dairy sector: dairies exchange milk collections for rationalisation purposes. They demonstrate that milk is a relatively standardised product, whatever the production method, and that processing and marketing can be partly decoupled from production.

3.2.2. Questions raised by participants

The debate on "the link to national and international markets" focused on two main issues: consumers' willingness to pay and the quest for international competitiveness. The whole debate was based on an unexplained premise: diversification would lead to better quality products, at least for ecological impact, and a subsequent increase in consumer prices. A number of participants also defended a necessary level of specialisation, although the threshold level was not discussed.

A number of participants deplored, the low share of food in household expenditure, consumers' disconnection from the food production constraints, and their low willingness to pay. The participants mentioned consumer education, and broadly called for a change of mentality or collective food culture, as a potential lever and a major area to work on. However, they also raised questions about how this education could be achieved and its impact in terms of changing purchasing practices. Labels have been suggested as a major way of providing a solution. However, their limitations have also been highlighted, mainly due to their lack of legibility and reliability, competition between them and label fatigue. Another mentioned approach was to enhance the value of the regions themselves (for instance through regional natural parks or certifications, etc.).

The participants were also interested in imported products. International competition was judged unequal, due to a lack of ecological requirements for imports, and, according to the participants, constitutes an incentive for specialised productivist agriculture. Globalisation was seen as imposed and irremovable and the participants barely called free trade agreements into question.

3.3. The inner organisation of value chain stakeholders: between path dependency and redesign

3.3.1. Outcomes from the literature review

Value chain stakeholders are concentrated at national or international reach, and take little account of diversification initiatives in the external environment (de la Haye Saint Hilaire et al., 2023). They offer standardised services to their members, based on the dominant crops, ranging from inputs to marketing. These 'technical packages', which are homogeneous from one region to another, tend to distance decision-making centres from production areas and from opportunities for innovation (Madelrieux et al., 2017). In fact, there are systemic obstacles, for example when it comes to investing in large cereal silos in specialised areas, which would not be profitable if they handled a multitude of low-volume species (Meynard et al., 2013). Specialisation choices are thus made on the basis of access to irrigation, transport or processing infrastructures, which value chain stakeholders help to structure (Herment and Mignemi, 2021).

According to Duru and Therond (2021), despecialisation requires a complete redesign of the system, which has an impact on the internal and external organisation of value chain stakeholders. This rethinking may involve hybrid marketing methods between long distribution channels and local

marketing, to make the most of co-productions (Chazoule et al., 2018). For example, the GIS *Relance Agronomique* cites an integrated Italian company that markets cattle and six co-productions in both short circuits in southern Italy and long circuits in France (Georget and Manbrini-Doudet, 2020). They can also involve new institutional partnerships, inspired for example by competitiveness clusters or European innovation partnerships, which help to support transition periods (Meynard et al., 2013).

3.3.2. Questions raised by participants

The participants first addressed the regulatory and technical-economic obstacles, then explored risk management for value chain stakeholders, and finally discussed the need to strengthen skills and governance - without going into detail on these last two points.

The participants addressed the issue of regulatory obstacles, which are widely cited in the literature on transitions, using concrete examples and including energy production in the discussion. They cited regulations on the reuse of wastewater, exchanges between cereal growers and livestock farmers, and methanation as potential obstacles to diversification of production. In peculiar, the regulation of energy production by monopolies, including for methanation plants, was seen as undermining the autonomy of economic stakeholders. They called for an appropriate coordination of national and European regulations to free up room for manoeuvre for local stakeholders.

Investment in collection and processing equipment was also widely discussed. This seems to be the main technical and economic dependence factor. The equipment size raises a question, whatever it may be. In the case of the largest facilities (silos, for example), there is no question of easily managing diversified production, or even quality variability within the same production. What is more, the structure of the regional network determines transport, which is a key impact factor in costs and greenhouse gases. Reconfigurations are therefore potentially costly, or require coordination between different economic stakeholders, such as different value chain operators. In the case of smaller units, participants cited an example where diversified production has occurred, but has required greater collective coordination of production, collection and processing schedules (in the case cited, by an autonomous group of farmers).

The participants referred to market risks and to economic and financial risks, rather than production risks. They identified two levers to deal with them: company financing on the one hand, and commercial and institutional partnerships on the other. They outlined a financing portfolio that would combine targeted bank loans, subsidies from public bodies (in particular ADEME for energy production) and innovative fund-raising, for example via crowdfunding or green finance. They also referred to a typical contract farming model that would encourage collective action either in the value chain (contracts with supermarkets) or in the regions (contracts with local authorities).

4. Concluding discussion

In this workshop, we looked at the role and impact of value chain stakeholders on the despecialisation of regions. Discussions focused on the link to farmers, markets and the very organisation of value chain stakeholders. The participants in this World Café initially focused on a linear vision of the value chain, from production to the food consumer. They pointed to the shift in the food paradigm and the promotion of products to end consumers as major levers for diversification. However, they had more difficulty integrating into their reasoning the multiple loops and hybridities of industrial ecology in the despecialisation of territories: exchange between farmers, coupling plant production and animal feed, valorisation of co-products, energy production, hybrid marketing.... This point calls for clarification of the terms and concepts used, particularly in agricultural education (Madelrieux et al., 2017b).

On the other hand, the need for organisational redesign of the agricultural sectors have been clearly identified. These needs relate to knowledge, logistics, manpower, investment and partnerships. Value chain stakeholders, which could play a major role here, are subject to path dependency in their sunk

investments or the quest for competitiveness on world markets. The participants in this workshop explored the regulatory obstacles linked to the constraints of this dominant regime, whether in terms of sectoral regulation for energy production or market agreements. They also detailed the levers in terms of financing, calling for increased public support via subsidies, but also for more participative private financing. In their view, risks should be managed more through long-term industry contracts, but also through insurance mechanisms.

While value chain stakeholders were at the heart of the debate, the World Café highlighted the importance of coordinating different scales and a variety of partnerships. It confronted a logic of standardisation and a logic of fine-tuning to local situations, whether at farm level, in terms of knowledge sharing and advice, or in terms of sectors and territories.

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Author ORCIDs
Florence Bonnet-Beaugrand: https://orcid.org/0000-0002-3860-3873

Authors' contributions
Florence Bonnet-Beaugrand structured and led the workshop and wrote the article. Théo Delord and Joseph Ory carried out part of the literature review, helped run the World Café and summarised the participants' interactions, as part of the 'ProCom' training module in the 3rd year engineering major 'Agroecology: from production system to territory' at ENSAT.

Declaration of interest
The authors declare that they do not work for, advise, own shares in, or receive funds from any organisation that could benefit from this article, and declare no affiliation other than those listed at the beginning of the article.

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