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► To cite this version:

Marc Moraine, Ryschawy Julie, Grillot Myriam, Cassagnes Andrea, Stark Fabien. Collective action and participatory knowledge building for Crop-Livestock integration at territory level in Mediterranean areas. 15th IFSA Conference, Systemic Change For Sustainable Futures, Jun 2024, Trapani, Italy. 7p. hal-04644941

HAL Id: hal-04644941

<https://hal.science/hal-04644941v1>

Submitted on 11 Jul 2024

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Collective action and participatory knowledge building for Crop-Livestock integration at territory level in Mediterranean areas

Moraine Marc^a, Ryschawy Julie^b, Grillot Myriam^b, Cassagnes Andrea^c, Stark Fabien^d

^a UMR 0951 INNOVATION, INRAE, CIRAD, Institut Agro Montpellier, 2 Place Pierre Viala, 34060 MONTPELLIER - marc.moraine@inrae.fr

^b UMR 1248 AGIR, INPT ENSAT INRAE, Chemin de Borderouge F-31324 CASTANET-TOLOSAN - julie.ryschawy@inrae.fr ; myriam.grillot@inrae.fr

^c BIOCIVAM 11 - Association des producteurs bio de l'Aude, 11 rue de l'Industrie - 11 800 TREBES - andrea.cassagnes@bio-aude.com

^d UMR SELMET, CIRAD, INRAE, Institut Agro, 34000, Montpellier, France - fabien.stark@inrae.fr

Abstract: The South of France is exposed to severe climatic hazards and natural resources' depletion, for which farming systems need to innovate to make the best use of water and restore soils and habitats for the biodiversity. In the wine-producing Minervois region, crop-livestock integration at farm and territory level appears to be a model for sustainable farming, allowing agroecological practices and circularity between crops, vineyards and semi-natural areas. We elaborated on the concept of agroecological territory to define under which sociotechnical conditions could crop-livestock integration be developed and reinforced. For this we studied the practices and collective organization of innovative farmers of the territory, and conducted interviews and workshops with farmers and local stakeholders to identify the suitable options for reintroduction of livestock in the territory. On this basis we designed scenarios of change in farming practices and the strategies to secure feed resources for livestock. Landscape mosaics including grazed vineyards, temporary grasslands, cereal cropping and semi-natural areas are desirable and feasible on the territory but require a reinforcement of collective action to support and facilitate the presence and circulation of grazing herds, and the development of shared knowledge and adequate practices.

1. Purpose

In Mediterranean areas, farming systems are facing multiple sustainability issues including soil erosion, water scarcity and pest invasions, which threaten on the short run the viability of farms, and on the long run the actual possibility to produce agricultural goods in following decades. In the same time, agriculture is more often expected to contribute to the global or local sustainability issues: carbon sequestration in soils and trees, management of habitats for biodiversity, fire risk mitigation. Consequently, building and developing innovative farming systems able to cope with these multiple challenges appears crucial and urgent. *Integrated Crop-Livestock Systems* (ICLS) are promising options for the agroecological transition of farming systems, allowing to increase farm self-sufficiency and nutrient cycling, and to shape diversified landscape patterns. Crop-livestock integration at territory level can address the challenge of specialized systems by opening diversification options, but it faces strong transaction costs and requires adequate combination of knowledge, know-how and cooperation between various stakeholders (Asai et al., 2018).

This article presents an attempt to co-design agroecological farming systems in Mediterranean areas of South-West of France, together with innovative farmers and local stakeholders, within the participatory research project SagiTerres (2021-2025). We studied the Minervois region, a wine-growing area facing numerous sustainability issues, where the reintroduction of livestock systems integrated in vineyards and cereal farming is progressively reconsidered since more than 10 years. We tried to understand the conditions of emergence of ICLS, their potential of development outside of the more innovative actors, and their contribution to local and global challenges.

2. Methodology

The approach developed in the SagiTerres project consists in 5 methodological steps inspired from Descheemaeker et al. (2019) and presented in Fig. 1. The objective is to integrate the knowledge and priorities of local stakeholders (managers of natural resources, agents of the Natural Regional Park, local authorities, animators of the Territorial Food Project, advisors of the Chamber of Agriculture, local government agents) and innovative farmers to design relevant scenarios for the territory and their conditions of implementation.

- Step 0 is the initial description and diagnosis of current farming systems, and the associated sustainability challenges regarding natural resources, biodiversity, landscape management. This has been done through analysis of existing reports and surveys on the territory, and gathering the visions of local stakeholders through semi-directive interviews at the beginning of the project.

- Step 1 is the characterization of the innovative farming systems already developing crop-livestock integration practices, through farmers' interviews and questionnaires. Farmers were voluntary for participating in this step, and contacted through the organic farmers' association Biocivam 11 in partnership with INRAE for the SagiTerres project.

- Step 2 is the modelling of current feed resources on the territory, based on a Geographical Information System derived from land use map and CAP statement and representing the spatial distribution and surfaces for legume fodder crops, cereals, vineyards, grasslands, fallows, rangelands and woods. An estimation of the potential of feed production through grazing or mowing is done using local data and expertise (technical advisors from Agricultural Chamber and Biocivam 11).

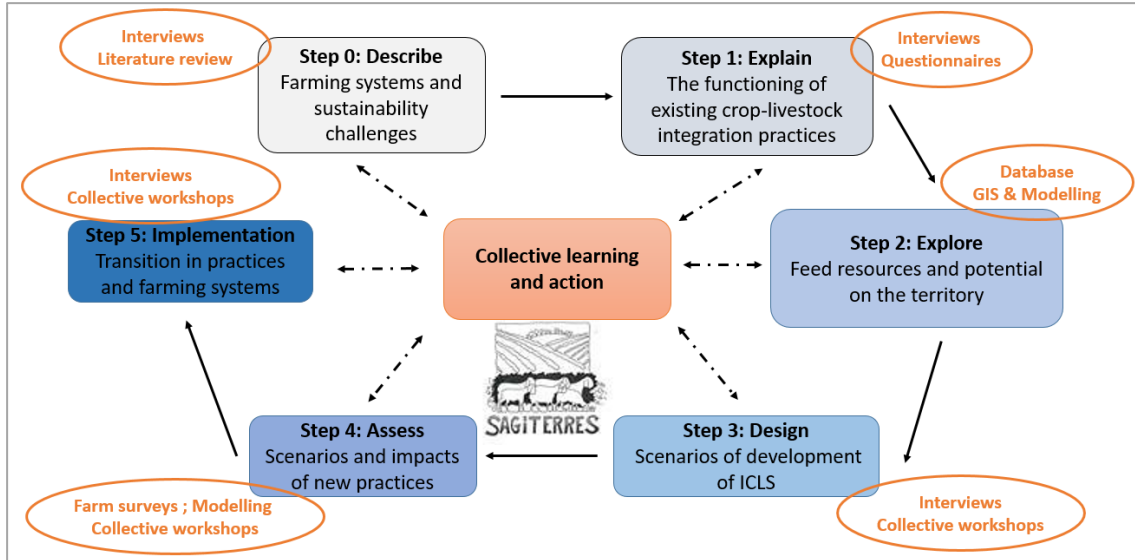
- Step 3 is a participatory step aiming to co-design options for the development of ICLS on the territory. Local stakeholders and voluntary farmers have been interviewed and associated to workshops during which the local knowledge about relevant practices, obstacles and levers to crop-livestock integration in the territory has been shared and discussed.

- Step 4 is a two-level assessment of the potential of ICLS. At farm level we assessed the performances, benefits and impacts of crop-livestock integration practices, through annual farm surveys to collect data, and farmers' interviews to identify their degree of satisfaction regarding the practices and their expectations for following years. At territory level we estimated the potential of production of crops, fodder and animal products under several hypotheses: i) the impact of climate variations on pastoral resources (dry or humid years), (ii) the increase of the herds' size, (iii) the maximization of the use of biomass for feeding grazing animals. We conducted collective workshops to gather the ideas and visions of local stakeholders on how could the ICLS contribute to other territory issues: fire risk mitigation, water resources protection, biodiversity conservation.

- Step 5 is an investigation of economic, social and political conditions of emergence and development of ICLS practices. Interviews with farmers and local stakeholders and collective

workshops have been carried out to identify the relevant animation device, financial support, collective organization and governance rules to frame ICLS and reduce the risk of disengagement.

Figure 1. Synthesis of the methodology of participatory design



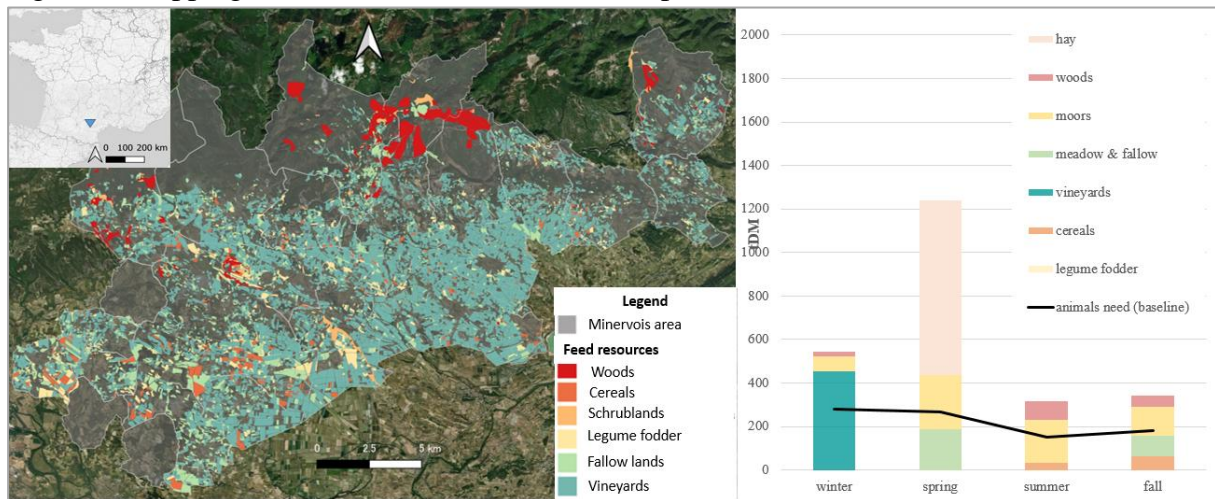
3. Findings

The *initial step* of diagnosis has stated the importance of restoring a diversity of land use and practices in the Minervois. Wastelands inherited from vineyards grubbing-up should be managed to maintain an open landscape for fauna and flora, and reduce the risk of fire. The use of herbicides and the ploughing of vineyards need to be reduced to preserve the quality of groundwater, to limit soil erosion and restore the soil fertility. The agricultural productions on the territory has to be diversified to contribute to the food production, and to offer more diverse habitats for the biodiversity. Organic diversified cropping systems appears to be good alternatives to the current specialized wine production, but require a coordination with livestock systems to make use of temporary grasslands and supply organic matter.

The *characterization of innovative ICLS* in the Minervois has enlighten the diversity of practices. Cereal farmers and winegrowers collaborate either with livestock breeders from outside the territory or with shepherds grazing across the area. The *Mowing-ICLS* is based on breeders who mow legume fodder crop planted by cereal growers. Organic cereal growers implement legume fodder in their crop rotation in order to improve soil quality and to break the cycles of weeds, diseases and pests. As the first cut of alfalfa and sainfoin cannot be processed into seed because it contains too many impurities, mowing agreements are set up with breeders in order to valorize this biomass. This collaboration give access to a premium on CAP subsidies for cereal farmers, and in return livestock farmers get free hay. The *Grazing-ICLS* is based on sheep herds which graze on vineyards and cereals plots. Shepherds benefit from a good quality and cheap grazing resource, while cereal farmers and winegrowers improve soil quality through animal manure and control their weed without chemical or mechanical intervention. The inter-rows of the vineyards can be sown or covered with spontaneous vegetation and are generally grazed between October after the harvest and March before the vines start to bud. Beyond the agronomic benefits, grazing in vineyards represents an added value in terms of the territory's image.

The *mapping and estimation* of available feed and grazing resources in the Minervois has shown that the availability of such resources is spatially and temporally distributed among the year, with strategic resources that are crucial for some seasons and other more or less plentiful on a very short temporal window (Fig. 2). Feed resources in vineyards, crop residues, temporary grasslands and semi-natural areas could be sufficient to increase the number of animals grazing on the territory, but transhumance may remain necessary in case of long summer droughts.

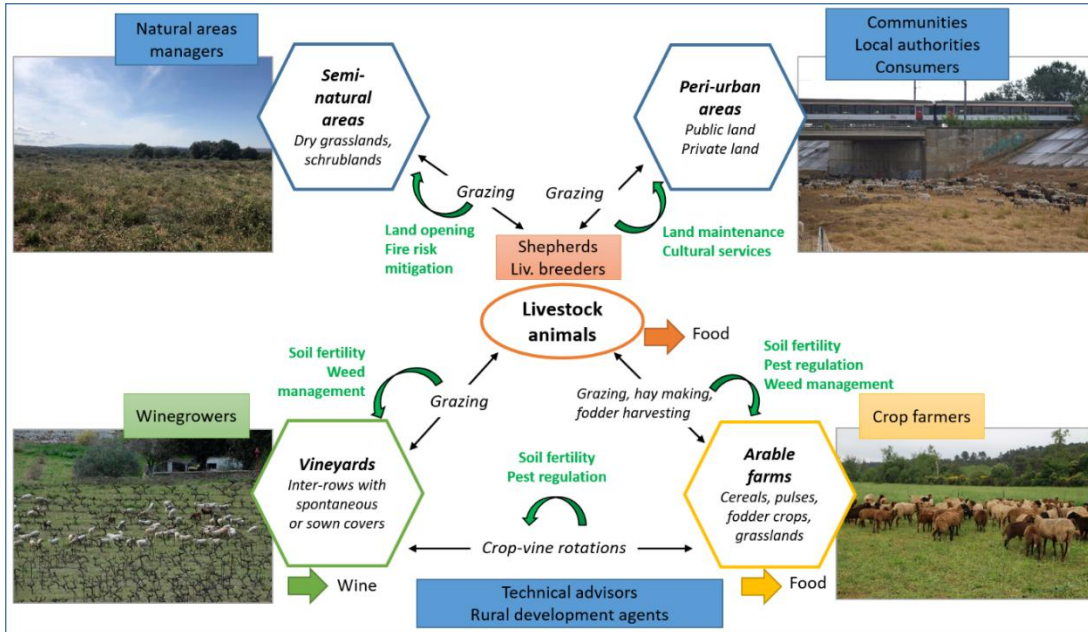
Figure 2: Mapping and seasonal distribution of the potential feed resources in the Minervois.



The *collective scenario* designed for the development of ICLS includes the return of wastelands to cereal production in rotation with grazed or mowed temporary grasslands (Fig. 3). In complementarity, grazing on semi-natural areas appears highly interesting to get feed sources in summer and fall, and to get out of vineyards in winter in case of rain, though avoiding the risk of soil compaction. This requires a coordination with the managers of natural areas, through more or less formalized agreements (grazing conventions, charters, contracts). Hunters and practitioners of open-air sports (hiking, mountain bike) should also be concerted to communicate on the advantages to have animal grazing these areas, and avoid accidents or conflicts in case of lack of communication. Actors of peri-urban areas can also play an important role to allow grazing on additional surfaces (infrastructures such as water retention plains, communal land).

The *assessment of performances, benefits and limits* of ICLS practices has shown that agronomic benefits obtained from grazing of animals in crop plots and vineyards are often very good, according to the observations of farmers. The control of cover crops is better with grazing than with mechanical weeding, and save time, money and fuel consumption. Few damages have been observed (broken wires, dismantled dry-stone walls), and no soil compaction which was a potential problem for winegrowers. A diversity of cooperation has been observed, ranging from large herds on small wine estates to small herds on large estates. Hosting animals on the domain is often considered as a commercial argument, and as a theoretical ideal. A farmer claims that “animals are needed everywhere, they are part of the system”.

Figure 3. A scenario for innovative integrated crop-livestock system in the Minervois.



The *factors of transition in practices* towards ICLS development are numerous and require attention and commitment from several stakeholders. The role of technical advisors and rural development agents is very important to make explicit the conditions and requirements of each part of the farmers' partnerships. The emergence of a territorial model of agroecology depends on the network of actors, the existence of common values shared within this network, the development of tools, knowledge and marketing channels, and the construction of a local legitimacy that is more or less formalized in public support policies.

4. Practical Implications

In the Minervois, the technical and organizational skills of farmers and the specificity of some marketing channels may limit the development of this model to niches. However, intermediaries such as animators of organic farmers' associations can help to elicit the technical knowledge needed to run agroecological systems, as they are already doing through training courses for local farmers. The cooperative of organic farmers "Graines Equitables" has proven that very diverse crop productions can be grown, collected and marketed with an interesting added value for farmers. The question of how to scale up this model of territorial agroecology is the core of a new project driven by the cooperative and gathering many local partners: agricultural land authorities, public authorities, consumers' associations, etc. The knowledge elaborated within the SagiTerres project will be mobilized to communicate and accompany collective action on the territory, to bring references, guidelines and answers to the main obstacles that have been identified. Our work draws the perspective of an innovative farming model at territory level, in which livestock plays a central role in the valorization of diverse local resources and the supply of a range of ecosystem services. In this respect, it may constitute an alternative to the current predominant farming systems, mainly viticulture and conventional cereal cropping.

5. Theoretical Implications

Despite being a socio-technical niche, territorial agroecology in the Minervois seems to be well structured and potentially supported by elements of the socio-technical landscape: incentives to reduce inputs in viticulture, motivations from local authorities to relocalize food supply, notably within the framework of Territorial Food Projects, carbon storage issues in soils (4/1000 plan, carbon credits), development of the landscape continuities for biodiversity, etc.

In methodological terms, this analysis seems complementary to the approaches by *Transition Studies*, as it anchors in a territorial reality what appears to be a weakly contextualized theoretical approach. Our approach to territorial agroecology is not focusing on the actors' networks and controversies, which is nevertheless a determining factor in the ability of agroecological innovations to sustain and develop. Such an analysis, inspired by Multi-Level Perspective approaches, would be a useful convergence. For example, in the Minervois case study, we might consider the ability of organic ICLS to question the currently dominant agricultural models. Identifying the ways in which these models can coexist, and their respective places in a local ecosystem would be a promising line of work.

In return, the framework for reflection proposed by territorial agroecology, inspired by the numerous research on agroecology and territorial approaches to agricultural development, can help to "relocalize" *Transition Studies* theory, which focuses on socio-technical systems and their evolution within a socio-technical landscape, but is rarely linked to territorial contexts with their specific issues and resources.

In proposing to formalize the issues, determinants and territorial resources for the development of a territorial agroecology, we offer a more attentive look at the local specificities of agroecology, while enabling analysis of the dynamics at work and past and future developments in the study area. This analysis can be used to support local stakeholders to find routes for transitions in agricultural and food systems, in the context of climatic and ecological crises.

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