THEME 2. APPROACHES TO LOCAL DEVELOPMENT: HARMONISING AGRICULTURE AND COMMUNITIES

Convenors: Davide Rizzo, Maria Rivera Mendez, Intissar Ferchichi, Maria Kernecker

LOCAL AND MULTI-STAKEHOLDERS ORGANISATION MODELS

The Influence of Information Disorder on Climate Change Adaptation Practices of Farmers in Lagos State, Nigeria

Uduak Edet[a], Ataharul Chowdhury[a] and Khondokar H. Kabir [a] Nasir Abbas Khan [a]

[a]University of Guelph, uedet@uoguelph.ca

[a]University of Guelph, ataharul.chowdhury@uoguelph.ca

[a]University of Guelph, kabirk@uoguelph.ca

[a]University of Guelph, nkhan23@uoguelph.ca

Abstract

Climate change poses a threat to agriculture which impacts food production and livelihoods. However, access to accurate information improves farmers' capacity to manage these challenges and ensures food security. This study investigates how information disorder influences climate change adaptation among Iju Farmers' Association members in Lagos State, Nigeria. It highlights the importance of accurate information in farmers' decision making and how information disorder might hinder this process.

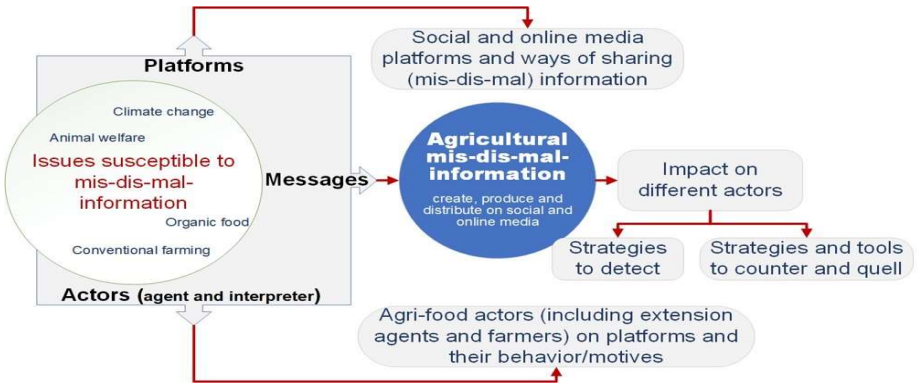
The research utilized online surveys and interviews and employed descriptive analysis, multinomial logistic regression, and binary logit model in SPSS for survey data analysis. Thematic coding in Nvivo was applied to analyse the interview data. The findings indicate that farmers receive information from various sources, including government extension agents, peers, radio, and social media. Misinformation from peers, which is circulated without the intention to deceive, could lead to the non-adoption or postponement of climate change adaptation practices. This demonstrates the importance of reliable information sources and raises awareness of information disorder for effective climate change adaptation in agriculture.

Purpose

Accurate information helps farmers make informed decisions and adapt to climate change (Onyeneke et al., 2022). Although social media and online platforms facilitate information exchange, they can also spread false information, which may have hindered efforts to manage public health during the COVID-19 pandemic. The agricultural sector faces similar challenges, particularly in areas such as climate change adaptation, food safety, and soil management (Adebesin et al., 2023). In Nigeria, misleading information may contribute to the excessive use of fertilizers and pesticides by small-scale farmers and worsen debates about the potential health risks of genetically modified seeds. (Food and Agriculture Organization of the United Nations, 2020; Oyedele & Omojunikanbi, 2022).

Information disorder refers to the development or sharing of a fabricated message that mimics the original content. Different forms of information disorder include misinformation, disinformation, and malinformation (Wardle & Derakhshan, 2017). Misinformation is commonly used as a general term in the broader literature (Treen et al., 2020). It has four typologies based on social context: outdated (used at the wrong time), conflicting (lacking consistency), incomplete (insufficient or one-sided), and perceived intimidation (linked to negative impressions of social actors) (Ruokolainen et al., 2023). Misinformation is circulated without the intent to deceive, and disinformation is created and circulated with the intent to deceive. Conversely, malinformation occurs when factual information is unlawfully disseminated with the intent to cause harm (Hasan & Halder, 2020). These three forms of information disorder are jointly associated with variations in truth and are characterized by the presence or absence of an intent to deceive. Climate change and information disorder present significant challenges for sustainable development (Treen et al., 2020). However, there is a lack of scholarly sources on information disorder in the agricultural sector. Several studies have focused on farmers' access to information regarding climate change adaptation, emphasizing government support for farmers and extension agents (Emeka et al., 2023; Ozioko, 2022). Although, providing accurate information is important, psychological and socio-economic factors may also play a significant role in how individuals perceive, evaluate, and respond to information. Therefore, this study investigates the major sources of information for farmers, the common types of information disorder within the group, and how information disorder influences farmers' decisions to adapt to climate change. This is important because widespread information disorder in agriculture could pose threats that undermine the value of science, research, decision-making, and climate change adaptation. Chowdhury et al. (2023) proposed a conceptual representation of information disorder to study misinformation in the agri-food sector (Figure 1).

Figure 1: Conceptual Framework for Information Disorder in the Agri-Food Sector (adapted from: Chowdhury et al, 2023).



The framework focuses on the relationship between the actors, platforms, messages, impacts, and strategies to curb information disorder (Cook, 2018; Lewandowsky et al., 2012).

Methodology

The Iju Farmers' Association was established in 2008 and currently has 149 small-scale farmers as members. A random sampling technique was used to survey 128 participants, while a purposeful sampling technique was employed to select six farmers (three males and three females), one

extension agent, and two government officials for interviews. The association was chosen for its relevance to the study and accessibility to participants, as the study aimed to engage Nigerian crop farmers who face agricultural challenges due to climate change. Lagos State was selected for its strong connections between agricultural research organizations and private sector input-supply firms (Nwanade, 2017). Quantitative data was analyzed using Multinomial Logistic Regression and Binary Logit Model in SPSS, while qualitative data was analyzed using thematic analysis in Nvivo.

Findings

Farmers mainly rely on government extension agents (98%) for information, followed by other farmers (51.5%), radio (47.6%), and social media (7.8%). Newspapers (6.2%), television (3.9%), and private extension agents (1.5%) made minor contributions. The most sought-after information includes information on crop rotation, cover crops, effective fertilizer and pesticide use. Farmers are the primary actors in the agricultural information system, as they contribute practical knowledge and experience, making them a reliable source of information. The Lagos State Agricultural Development Authority, research institutions, and farmers' associations play important roles in enhancing agricultural practices. Government extension agents serve as trusted intermediaries and provide useful information to farmers. They also facilitate communication between the government and farmers, collect feedback from farmers, and share it with research institutes. Private extension agents have limited involvement, as their services come at a cost compared to the free services provided by government agents. However, they have the potential to serve as intermediaries in the agricultural system.

Further analysis revealed that 71% of the surveyed farmers received conflicting or confusing information from their peers. Additionally, more than half (55.4%) of the farmers believed that such information was unintentionally spread. Although knowledge sharing is important, relying on a single source can hinder critical thinking skills and lead to selective exposure, making farmers more susceptible to misleading information from a particular source (Van-der-Linden, 2023). Farmers mainly communicated through face-to-face interactions and WhatsApp and viewed instances of misinformation as honest mistakes made by their peers. This suggests that misinformation rather than deliberate disinformation or malinformation was the primary type of information disorder in this group. During the interviews, the participants explained that the extension agents occasionally conveyed information via group leaders. The information disseminated may become distorted as it spreads from farmer to farmer, and accurate information could also be misconstrued due to the use of ambiguous language. Farmers shared experiences of receiving misleading messages regarding climate change adaptation. For instance, one farmer applied fertilizer in a specific way based on another farmer's advice, but the close spacing caused the chemicals to interfere with the roots, resulting in crop loss. Another farmer revealed that many farmers in the group believed that genetically modified organisms (GMOs) caused cancer and other illnesses, thereby preventing them from adopting these crops. Identifying individuals responsible for spreading information disorder, whether intentionally or unintentionally, is challenging because of the tendency to conceal their identities (Calo et al., 2021). Participants were better able to identify perpetrators of misinformation than to identify perpetrators of disinformation or malinformation.

Table 1: The Coefficient Estimates of the Binary Logit Model

Explanatory Variables	**Crop Rotation**	**Cover Cropping/ Mulching**	**Cultivation of Improved Seeds**	**Effective Use of Fertilizers**	**Effective Use of Pesticides**	**Changing of Planting & Harvesting Dates**
Age	-0.756*	-1.001***	-0.516*	-0.589*	-0.503*	-0.282**
Gender	0.054	0.584**	0.034	0.029	0.115	0.059
Education	0.017	0.020	0.017	0.014	-0.015**	0.028
Experience	0.004	0.001	0.001	0.001	-0.008**	-0.011**
Income	-0.199**	-0.065	-0.244**	-0.084	-0.079	-0.242**
Infestation of pests	-0.761**	-0.913*	-0.259	-0.107	-0.561**	-1.023*

, **, * indicates significance level at p < 0.1, p < 0.5, and p < 0.01 respectively*

Table 1 shows the coefficient estimates that determine the influence of information disorder on a farmer's decision to engage in climate change adaptation practices. The negative coefficient for age (*p < 0.01),* suggests that older farmers are less likely to adapt to climate change practices when influenced by information disorder. Experience also showed a negative coefficient (*p < 0.5*) for the effective use of pesticides and changes in planting and harvesting dates. One interviewee explained that the lower likelihood to adopt newer agricultural practices due to misinformation caused older and more experienced farmers to rely on their years of experience and continue in their traditional farming practices. Gender was positively significant across all practices, especially cover cropping *(p < 0.5)*, suggesting that, upon receiving misleading information, female farmers are more likely to seek accurate resources that enable them to continue adopting climate change practices. Education demonstrated a positive relationship with most practices, indicating that higher educational levels may lead farmers to disregard conflicting information. However, the negative relationship with effective pesticide use suggests that educated farmers are less likely to use pesticides when they are influenced by information disorder. Income had negative coefficients across most practices, indicating that farmers with lower income were more susceptible to the influence of information disorder. This could be due to financial constraints that limit farmers' access to accurate information or their ability to invest in climate-smart agricultural techniques.

The consequences of misinformation within the group led to postponement and non-adoption of climate change adaptation practices. The non-adoption of climate change adaptation practices may worsen rural communities' vulnerability to climate impact and reduce agricultural productivity. Consequently, crops may become more susceptible to floods, droughts, and pest outbreaks, causing increased yield loss, which negatively affects food security and income for farmers and communities. Delaying the implementation of climate change adaptation practices may lead to prolonged dependence on traditional farming techniques, increased production costs, and resource depletion, as farmers may continue to rely on outdated and less efficient methods.

Practical Implications

The study findings reveal the complexities of misinformation within social contexts. To enhance agricultural extension services in Lagos State, it is important to increase the number of extension agents and employ digital tools to convey information directly to the farmers. Clear and comprehensible communication from government extension agents is essential, as farmers can not only serve as reliable sources of information, but also contribute to the spread of inaccurate information. Farmers must also understand the consequences of disseminating misinformation and how it spreads across various platforms. The interaction between socioeconomic factors and information disorder on farmers' decision-making in climate change adaptation is significant. Female farmers are generally more proactive in seeking accurate information and are more likely to continue adopting sustainable practices even when faced with conflicting information. This highlights the need for gender-inclusive approaches in agricultural extension services to ensure equal access to information and support for all farmers. Financial barriers can worsen the negative impact of information disorder on adoption, making it important to eliminate these barriers. Farmers often evaluate the costs and benefits of adopting adaptation practices more carefully when faced with conflicting information, which may cause them to hesitate in investing in practices that require significant financial resources. Therefore, it is essential to support rural communities with targeted interventions, such as financial assistance and capacity-building programs to address information disorder while promoting community resilience to climate change.

Theoretical Implications

Applying the conceptual framework was useful for exploring the research questions, including the influence of information disorder on farmers' decisions to engage in climate change adaptation practices. Based on this study, farmers and extension agents are main actors in the spread of misinformation. However, it would be beneficial to explore the roles of other actors in the system to gain a deeper understanding of how they might contribute to information disorder. Information sources are important to an agricultural system; however, cognitive biases may arise from overdependence and trust in peer information, as farmers do not question credible sources and readily circulate misinformation from such sources. This builds an understanding of the factors contributing to farmers' vulnerability to misinformation, and the social dynamics involved in the spread of such misinformation within the group and across platforms. In addition, the findings of this study demonstrate that information disorder is not limited to online platforms as it can also occur in offline settings. Therefore, it is essential to extend the current framework to integrate the evidence of misinformation in both contexts. By examining these factors, researchers and policymakers can develop more effective strategies to combat misinformation and promote accurate dissemination of information in farming communities. Overall, this study emphasizes the importance of effective communication and sustainable practices in agricultural systems and demonstrates that the influence of information disorder on farmers' climate change adaptation practices can be detrimental, negatively impacting decision-making processes.

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Gender and power in pastoralist households of Senegal: How a dairy unit has shaken ancient balances

Serena Ferrari[a], Oumy Diop[b], Kharifa Cissokho[b], Arona Diaw[c], Baba Ba[d], Jean-Daniel Cesaro[a]

[a] CIRAD/Selmet. Saint-Louis, Senegal; *serena.ferrari@cirad.fr*

[b] ISRA-CRA, Saint-Louis, Senegal; *oumoudiop07@gmail.com*

[c] Laiterie du Berger. Dakar, Senegal; *a.diaw@ldb.sn*

[d] ILRI. Dakar, Senegal; *b.ba@cgiar.org*

Abstract

In Senegal, pastoralist women play a key role in dairy production; yet, they face huge constraints in getting access to economic resources. Lower income translates into an unfavorable position in decision-making within their households, which in turn negatively impacts their access to income sources, thus generating vicious circles of discrimination. In this context, an important innovation was brought by *Laiterie du Berger*, a dairy processing unit that was set up in the sylvo-pastoral area to collect milk from pastoralists and sell its products to urban consumers. Based on a relational approach to durable poverty, inequality and power, as well as on quantitative and qualitative data, this paper aims at bringing light on the impact of *Laiterie du Berger* on gender relationships within pastoralist households, more exactly on the vicious circle between poverty and power inequality in which women are trapped. Our results show that, although women were initially pushed aside from the economic transactions with the dairy, they would have gradually taken over the sale of milk, thanks to the leadership of the most empowered ones, and partially exit from their vicious circle. This study offers a useful case study to scale up innovation in the dairy sector.

Keywords: Gender, power, poverty, dairy, milk, Senegal

Purpose

In Senegal, pastoralist women play a key role in herd and animal product management. In spite of that, pastoralist women face huge constraints in getting access to resources, productive assets and, more widely, socio-economic opportunities. Lower income for women translates into an unfavorable position in decision-making within their environment (household, community, etc.), which in turn negatively impacts their access to income sources, thus generating vicious circles of discrimination.

An important organizational innovation in these dairy marketing mechanisms has been brought by *Laiterie du Berger*, a dairy processing unit that has been set up in the northern town of Richard-Toll (Senegal) to collect milk from extensive herders and sell its products to urban consumers at national level. On one hand, by setting up regular economic transactions and a monthly payment, *Laiterie du Berger* allows its milk suppliers to save money and invest in a more strategical way than before. On the other hand, by increasing the economic value of milk, *Laiterie du Berger* has been generating a growing interest for the dairy sector on the part of men. Women, generally having lower negotiating power and/or smaller herds, would have been excluded from the benefits

coming from milk. In this paper, *we aim at bringing light on the impact of* Laiterie du Berger *on gender relationships within pastoralist households, more exactly on the vicious circle between poverty and power inequality in which women are trapped*.

Methodology

This paper is based on a relational approach to durable poverty (Mosse, 2010, 2007), which examines chronic poverty from the point of view of social relations and power. According to that, poverty and the process of impoverishment are not merely economic, and are "perpetuated and stabilised by social mechanisms such as categorical inequality and adaptation [to existing divisions]" (Mosse, 2007). Inequality in the distribution of power, wealth and opportunity is reproduced by historical relationships. As well synthesized by Feldman (2019), following the relational approach, poverty occurs simultaneously at two levels : material and discursive/cultural. At the material level, poverty occurs as a consequence of processes of capital accumulation, implying the exploitation and exclusion of specific groups. At the discursive/cultural level, poverty is created by discourses developed by the non-poor, who establish the standards of poverty, the reasons underlying and how society should behave in this framework. These discourses crystallize and downgrade the status of the poor, thus perpetuating their subordination.

In this paper, *we assume that it exists a vicious circle between poverty and power inequalities for women in the Senegalese pastoralist context*. In defining poverty, we adopt the notion, developed by Amartya Sen (2000), of poverty as a lack of capabilities. Indeed, according to Sen, the problem is not about having or not having economic resources, but the possibility for individuals to use those resources to satisfy their basic needs. This possibility is closely linked with the cultural identity of the individuals, for instance their age, gender, nationality, etc. That means that there might be poverty even where economic resources are abundant, but the individual cannot benefit from them to be fulfilled. That could be the result, for example, of illiteracy or gender-based discriminations. Thus, poverty is a lack of capabilities, coming from the position of the individuals into their society, rather than a natural condition (Sen, 2000). Existing power relations resist efforts to allow capabilities, so that empowerment for those who are in a situation of chronic poverty is a challenge, since they cannot establish themselves without breaking those relations. Though, such a confrontational solution is highly risky for vulnerable people, who finally show the tendency to aligns their interests to those of their exploiters (Mosse, 2007). With gender lenses, we can think of those women who justify the macho discourses of men based on tradition and culture, thus perpetuating their downgraded status into society.

To describe and analyze poverty, we focus on both levels – material and discursive/cultural. On the material level, we analyze women's access to productive assets. On the discursive/cultural level, we investigate beliefs, perceptions, practices and institutions relating to the place and role of women into their households and society. In a context of high poverty rates (the pastoralist area of Senegal), we mainly look at the relative poverty of women in comparison of men's. Power relations are seized through some key components, such as decision-taking, roles and responsibilities, task sharing, and participation in networks. This bundle of components/indicators allows us to demonstrate the bilateral links between poverty and power inequalities. It also helps show *how* Laiterie du Berger*, by introducing disruptive factors into well-established rules and practices, has been contributing to modify some of the components of poverty and/or power inequalities, thus making the vicious circle shift to the advantage or disadvantage of women*.

We collected both quantitative and qualitative data, under the project *Fracture Numérique* (2021-2023). A first large survey – conducted on 1260 individuals from 316 households in the agro-silvo-pastoral area of Senegal – has provided data on the structure of the households, as well on the possession of livestock for each of the members. Afterward, two successive qualitative surveys – conducted through semi-structured interviews and focus groups – allowed to collect information on the role of women in milk-related activities (milking, managing, marketing, earning) within their households, as well on the management of the dairy income.

Findings

Our results show that, in our study area, women are poorer than men, at both a material and discursive/cultural level.

Poverty at material level

At a material level, we have considered weak access to productive means as a proxy for poverty. Indeed, in the Sahelian pastoralist context, a huge share of the economy is not monetized, since salaried jobs are exceptions and most of the transactions are in nature – that's true especially for women, who carry out mainly household tasks. In this context, the main productive assets are livestock, thus we focused on women's livestock possession in comparison with men's.

Table 1. Percentages of individuals owning livestock heads, and average size of herds, by gender (men/women)

Species	Men		Women	
	% of men owning livestock heads, on the total male sample	Average number of livestock heads in men's herds	% of women owning livestock heads, on the total female sample	Average number of livestock heads in women's herds
Cattle	84.52	11.46	82.89	8.23
Sheep	71.59	17.74	70.70	10.89
Goats	67.48	10.97	69.09	8.95

Women access to livestock through three parallel channels: i) the dowry she receives from her spouse at the time he asks for her hand; ii) the inheritance from her relatives; and iii) the purchase of livestock heads in case of savings. Data shows that men and women own animals in equal measure: the percentages of men owning livestock out of the total male sample are about the same as the percentages of women out of the total female sample (Table 1). However, women have smaller herds on average compared to men: for example, a woman's average cattle herd has 8.2 heads, while a man's has 11.5.

Poverty at discursive/cultural level

At a discursive/cultural level, a gender-based division of labor obliges women to carry out household tasks and eventually – if time permits – other activities that may generate income. This state of things is integrated by both women and men through their socialization process that teach them what they can and cannot do based on their identity. This division of labor reduce the opportunities for women to earn money, so that they are considered less able to carry out income generating activities and to well manage economic resources. This leads to a form of infantilization of women, according to which women's needs are seen are "whims" – especially when they want

to buy something. Men often talk about the way women spend money in a condescending manner, referring to them as they were children ("they buy their little stuff"). At the same time, women show the tendency to integrate a sense of inferiority and do not show interest for leisure or tools such as mobile phones, as explained by this woman:
"I see people with their phones, but I don't know what they do with them other than making phone calls. Personally, I don't need a phone. I am always in the house, there is everything I need there".
Dairy is the only activity women are usually allowed to carry out outside the household. Traditionally, women are in charge of milking, processing and trading the milk by themselves. They usually bring the milk to the weekly markets of surrounding villages and, most of the time, exchange it for other food such as rice or oil. When they sell it for money, they usually use that money to buy beauty products.

Power inequalities between women and men

Due to women's poverty in comparison with men's, within the household, power relations are unbalanced in favor of men. By culture, women are supposed to serve their husbands and execute what men dispose, without the possibility to speak out explicitly even if they do not agree. This is seen as a key component of the education of women, that makes them appreciable as wives and contributes to the household's serenity. We can see, as an example, how this concept is made explicit by this man, talking about milk management within his household:
"If it happens that I ask her [my wife] not to sell milk for example, she will not retort because she will know that there is a good reason behind it."
Through the interviews, we could observe that women, the elder and richer in terms of livestock heads they are, the more decision-making power they get. Indeed, as age increases, their status evolves within their household and society. They get more power, can speak out and take decisions on the household management. This is particularly true for women who are household heads being, for instance, widows. In that case, all decisions relating to the management of milk and its income come from them. They thus have the capacity to make decisions on the quantity of milk to be sold and the one to be consumed at home, as well on the way to spend the money coming from milk sales. Accordingly, the results have shown us that it rarely happens that young girls make such decisions. In most cases where it is the woman who has the decision-making capacity, we see that she is in fact a person aged at least 50 or more.
We can conclude that there is actually a vicious circle between poverty – at material and discursive/cultural level – and power inequality in gender-based relations within a household. This is well synthetized in the quote below, taken from an interview with a man:
"I left four cows to my daughter. When she will have a husband, she will bring them with her. If she goes to her husband's home without a cow, she will not be respected by her in-laws."
Owning livestock leads to be more empowered, that in turn leads to have more power to grab the income coming from livestock – thus establishing a virtuous circle.

The establishment of Laiterie du Berger

Through its establishment, *Laiterie du Berger* introduced new ways of trading milk, by putting in place the bases for more formalized economic transactions with a cumulative monthly payment. To become *Laiterie du Berger*'s milk supplier, a producer should provide a telephone number to be included into the database of milk suppliers. At the beginning, in 2006-2007, mobiles were not very common and only an elite of people used to have one – that is to say, men and among them

the elder. Moreover, by culture, for the relations with people outside the household, it is up to the household head to take the lead. Thus, despite de fact that women were the real milk producers, almost only men were included into *Laiterie du Berger*'s database as milk suppliers. They were also the ones who were contacted at the end of the month to get the payment, and realized there was a strong economic interest behind milk. As a result of this first discrimination based on the possession of a mobile phone and their inferior social status, women were initially pushed aside from this trade and saw their status and capacities downgraded further.

Nonetheless, over time, probably under the lead of the most empowered women, the share of female Laiterie du Berger's milk suppliers increased and is nowadays (2024) 50% of the total number1. Women also started to physically go the dairy unit at the end of the month to get the monthly payment they thought to deserve. We could observe that, for those women who kept the exclusive decision power on the management of the dairy income even after the establishment of *Laiterie du Berger*, being involved in formal and long-term economic transactions made possible to develop more leadership and capacity of decision-making. They gave their own names and telephone numbers to *Laiterie du Berger* and had the opportunity to get interesting amounts of money and decide autonomously how to use it. It also occurs that some women allow other women to register as milk suppliers by giving their own telephone number as a contact – thus excluding the men from the relations with the dairy. This process provided breeding ground for a progressive shift of the poverty-power vicious circle toward female empowerment. We can see here below, for instance, the discourse of a female *Laiterie du Berger*'s supplier:

"We are four women in this house. Our cows obtained as a dowry constitute the herd. That is 100 [cows] in total. There are only three of us who sell milk [to Laiterie du Berger]. Of the 100 cows, only 30 produce milk. I have 15, and each of the other two women has eight and seven dairy cows respectively. The badge is mine. I'm going to get the money, since we are currently being paid by Wave[2]. When I come back home, I give them their money and keep mine. I have more cows, that is why my name is on the badge. But, if we are paid, for example, 150 FCFA[3], I take 75 FCFA and they share the remaining 75 FCFA."

Regarding how to spend the income coming from milk, 80% of the interviewed affirm this is the result of negotiations within the household and it is decided in a concerted manner between the husband and the wife. The remaining 20% say that it is the husband or household head who decides how to allocate it. In any case, a huge part of this income is used to pay the animal feed provided by *Laiterie du Berger* over the past month as a loan. Part of it is then used to purchase food products for the household, such as rice, oil, sugar or tea. The remaining money, that in good times may represent 50% of the total amount, is then shared between the husband and the wife for their personal expenditures. This is the place for negotiations between the spouses, who confront each other from their respective (unequal) positions. We can observe here that women acquire nowadays new power *vis-à-vis* their husbands, since they are the ones *granting* money – whereas before they were always the ones *asking*. Moreover, they have the possibility to manipulate bigger amounts of money, since the payment for milk is cumulated over the month. Nonetheless, if before they could manage the whole income coming from milk sales, nowadays they are obliged to give part of it to their husbands. Thus, if women's situation has improved, it has

[1] The remaining 50% are men, but in most cases, behind male names, there are still women managing milk and its income.

[2] Wave is one of the mobile money services available in Senegal, allowing to deposit money into an account linked to a mobile phone number, and then access a range of services, in particular transferring money domestically and internationally, or paying bills.

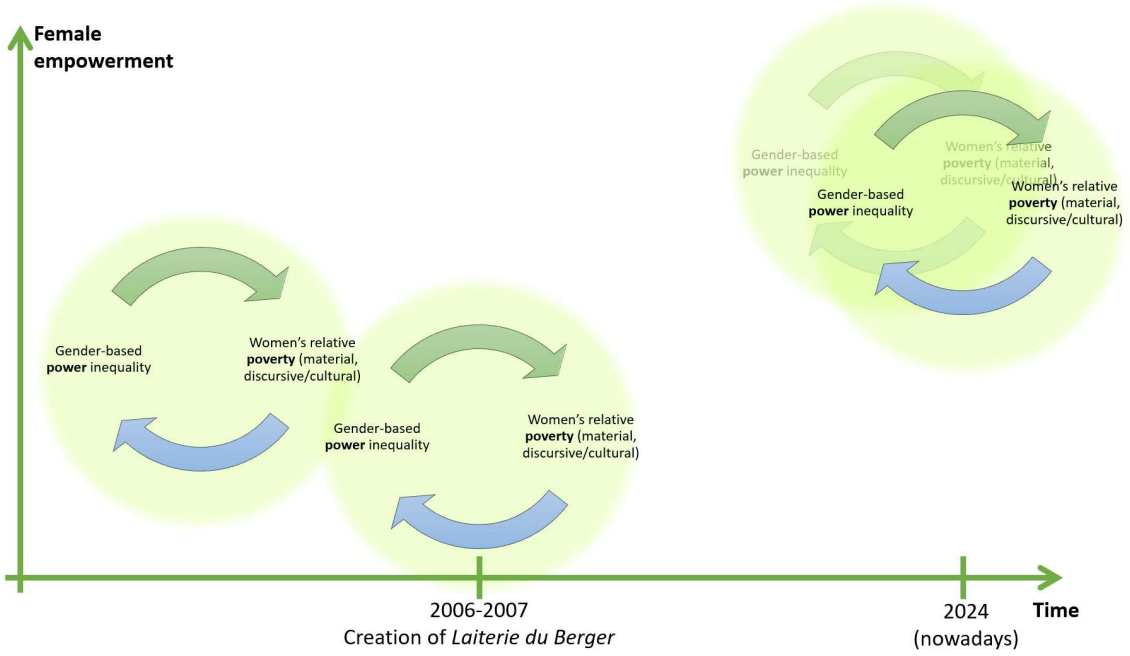
[3] Franc CFA (or FCFA) is the devise adopted by the Economic Community of West African States.

not improved as much as it could have done if women had had more power from the beginning. We can also wonder whether, if men had been in charge of managing the milk production, would they grant part of their income to their wives?

Implications

Figure 2 illustrates graphically our results, by showing how the poverty-power vicious circle in which pastoralist women are trapped has shifted over time, as a result of the creation of Laiterie du Berger. Before 2006-2007, women used to suffer from forms of poverty in comparison with men, since they used to have weak access to productive assets and embody a social representation following which women are less "capable" to manage money. Thus, their capability to take decisions and influence their own path was relatively weak. Milk production represented for them a room for maneuver, since it provided them with small amounts of money on a daily basis. Latierie du Berger, by introducing a constraint in the official recognition of their role in milk production (possession of a telephone number), contributed to reduce their access to the income coming from milk, thus worsening their relative poverty vis-à-vis men, as well as their decision power. This change is represented in Figure 2 as a shift of the poverty-power vicious circle downwards in terms of female empowerment. Yet, some women managed to escape this vicious circle, thanks to their privileged position within their household and/or society, and helped other women to do the same, even only by setting an example. The vicious circle shifted upwards toward stronger empowerment. Nonetheless, men still manage to negotiate partial access to the income coming from milk, thus causing oscillations of the vicious circle.

Figure 2. The evolution of the poverty-power vicious circle for pastoralist women in the *Laiterie du Berger* dairy basin: a shift over time toward female empowerment



These changes in multi-centenary practices and gender relations are very recent and, in spite of that, quite deep. As a result of several oscillations and multiple negotiations within households and societies, they will probably lead to new gender equilibria, including new gender-based allocation of tasks and rights. The results of this study are of utmost importance, since they show that well-established gender inequalities can evolve thanks to external organizational innovations. This paper offers several contributions to reasonably scale up innovations in the dairy sector, showing

that apparently trivial technical details, when applied in a context of unequal capabilities and power distribution, might impact deeply the vulnerability of the poorest. Our case study also shows that it may be useful to rely on key groups of people that, being more empowered, can take the lead and set an example for the vulnerable. Generally speaking, development-oriented interventions need to consider the fact that the most vulnerable might be affected by any small detail, because of their fragile situation characterized by lack of power. The vicious circle between poverty and power inequalities offers a framework allowing to foresight possible counterproductive impacts.

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A diagnostic of alternative food network: the case of Participatory Guarantee System of Parma (Italy)

Rosalia Filippini[a], Michele Maccari[a]

[a]Department of Economics and Management, University of Parma

rosalia.filippini@unipr.it; michele.maccari@unipr.it

Abstract

The Participatory Guarantee System (PGS) is a second party certification system, recognized as a reliable certification system that could be alternative and/or complementary to the Third-Party Certifications, such as the organic ones. PGSs are based on horizontal relationships and trust among farmers and between farmers and consumers. Nevertheless, few study have analysed the social structure of PGS, especially in developed countries. This study aims at understanding such social structure. To do so, the study applied Social Network Analysis and community detection methods to a PGS based in Parma (Italy) and grouping 30 farmers. The results highlight the existence of 2 main groups of farmers. The first one is more cohesive and groups farmers participating in farmers' markets, while the second one groups farmers that do not participate in such farmers' markets and also has lower cohesiveness. This study is relevant because it can help the PGS members to understand the current situation and implement interventions aiming at improving the social relationships of farmers. Moreover, the study contributes to the current scientific discussion on alternative food networks and the effective social engagement of farmers.

Keywords: Alternative Food Networks, voluntary certifications, social network analysis, Italy

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Purpose

The purpose of this work is to analyse the social network of farmers participating in Participatory Guarantee Systems (PGS), through Social Network Analysis (SNA). In particular, the study analyses the flow of information among farmers.

Design/Methodology/Approach

The study applies SNA and community detection (Fortunato, 2010) to detect the social relationships of farmers participating in PGS. Indicators such as Density, Transitivity, Assortativity, as well as nodes' Degree, Indegree and Outdegree were used to analyse the groups identified by the community detection and characterised the centralities of farmers in the groups (Borgatti et al., 2009). Density describes the cohesiveness of the network; transitivity refers to the capacity of the nodes to form clusters; assortativity refers to the capacity of nodes with many connections to link with nodes with few connections. Degree refers to numbers of connections that a node has; the indegree measures the number of connection that a node receive, in other words how many other nodes have declared to have a connection with that node; on the contrary, outdegree indicates how many other nodes a node has declared to have a connection with.

The case study is the PGS developed in Parma (Italy) in 2013 by the local Distretto di Economia Solidale (Solidarity Economic District - DES). The study is based on the interviews to 29 farmers participating to PGS in 2022.

Findings

The community detection procedure resulted in two connected sub-groups and a modularity score of 0.31 (Table 2). For both clusters the internal density (0.44 and 0.31 respectively) is higher than the density of the original network (0.28), meaning that the relationships farmers have inside the subgroups are denser than the relationships they have outside. Subgroup 1 results more cohesive than Subgroup 2 since its density is higher. Consistently, the transitivity index is much higher in Subgroup 1 than in Subgroup 2, highlighting a greater global clustering of the community than Subgroup 2. Consistently, the assortativity index shows that Subgroup 1 is more disassortative than Subgroup 2, meaning that in Subgroup 1 there is a greater tendency of central nodes to attach with more peripheral ones. In other words, in Subgroup 1 core and periphery seem to be more connected than in Subgroup 2.

An analysis of statistically significant indicators characterizes the farmers that belong to the subgroups. Subgroup 1 is mainly composed by horticultural farmers that participate in a farmer market, while Subgroup 2 is mainly composed by livestock producers that do not take part to FM.

Practical Implications

In 2022 the coordinating committee of PGS asked the researchers to develop a survey to collect the opinions of farmers participating in PGS. The results of this work are therefore important for the coordinating committee to i) identify the current weaknesses and strengthens of the PGS system; and ii) address the critical issues, organizing capacity building initiatives targeting the PGS farmers. The results of the analysis have therefore very practical implications and will be used for further analysis, research and to implement training and awareness initiatives among farmers.

The data collected and the analysis are indeed particularly useful to identify the main characteristics of the farmers belonging to PGS and to organize these characteristics according to a set of clear and defined criteria. This process is extremely helpful to get a full understanding of the vast heterogeneity of the farmers and to reorganize them into specific clusters associated with key aspects.

Considering the results of this analysis, the participation to markets can be used as an indicator for weighing the importance of the markets in strengthening the sense of belonging to PGS and – consequently – to identify alternative ways to increase the level of engagement for farmers not attending the markets. Despite the Statute of PGS highlights the importance of social commitment and of the establishment of dialogue and relationships between farmers beyond the economic purposes of the initiative, this study shows that the social relationships are mainly built because farmers participate to an economic activity such as FM. Thus, it is necessary to work on creating other occasions of socialisation among farmers, to support the resilience of PGS.

Theoretical Implications

Participatory Guarantee Systems (PGS) allow overcoming some major challenges presented by other food certification systems, which entail costs and specialized technical knowledge (Fonseca, 2008). PGS are low-cost, local systems for product or value chain quality assurance, that strongly emphasize social control and knowledge-building. Their approach is based on diffused rather than specialist technical knowledge, inclusion rather than marginalization of some actors, and collective instead of individual accountability (Loconto, 2017). PGS are networks, created within local communities, that include producers, experts, public sector officials and consumers. All the

stakeholders can actively participate in the process, establishing the PGS norms tailored to local conditions and sociocultural context and playing a key-role in the control procedures, as all actors could be engaged in control activities having access to all the documentation generated during the control process. This active participation of the stakeholders enhances transparency, trust, social networks, knowledge exchange and a form of social control. The active participation is in line with the concept of food citizenship (Lozano, 2017) in which citizens play an active role and participate in the governance of food systems at all levels: from food production to consumption, making responsible food choices (Cuéllar-Padilla, 2018). The risk of losing the PGS membership is relevant for farmers not only for economic reasons, but mainly for social reasons. Social support network, group-based product marketing and a general sense of belonging to a group, are social aspects that are extremely important for farmers and the risk of losing them because of non-compliances, represent the main reason to comply with the PGS control system (Cuéllar-Padilla, 2018). Participation and horizontality are key aspects of PGS membership that promote producer self-awareness and self-confidence (Sacchi, 2015). Nevertheless, few studies have analyzed the architecture of the social relationships of farmers participating in PGS, particularly in the European context. Most of the literature about social implications of PGS is focused on Developing Countries, especially Latin American. This study wants to fill this gap. The replicability of the methodology is another aspect that can be considered important, since the same approach can be used for other studies and research in other contexts, in developed and developing Countries. The results show that currently the participation in the markets is the factor that helps to assure social relations and exchange of information. This is peculiar since, according to farmers, their first purpose in participating in PGS is not the economic profit, thus the participation to supply chains. The predominance of social factors over economic ones as a motivation to join and remain in PGS, undoubtedly represents an innovative aspect to which further research and in-depth analysis should be dedicated. At the same time, the farmers that do not participate in the market are less connected. Thus, actions should be developed to improve the overall connectivity and social exchange between farmers, beyond their participation to the farmers' market. This study also suggests to better investigate why farmers participate to farmers markets, in line with other scientific claims (Montri et al., 2021). Our results seem to suggest that specific kind of farmers – well educated, women, selling horticultural products – are keener to participate.

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A three-pronged approach to excavate digitalization-innovation-sustainable rural development nexus among Italian farms

Martina Francescone[1], Luca Bartoli[1], Concetta Cardillo[2], Marcello De Rosa[1], Chrysanthi Charatsari[3], Evagelos D. Lioutas[4]

1: University of Cassino and Southern Lazio, Department of Economics and law, Cassino, Italy mderosa@unicas.it; martina.francescone@unicas.it; bartoli@unicas.it

2: CREA - Council for Research in Agriculture and Economics Agricultural Analysis – Centre for Policies and Bioeconomy, Rome (RM), Italy; concetta.cardillo@crea.gov.it

3: Aristotle University of Thessaloniki, School of Agriculture, Department of Agricultural Economics, Thessaloniki, Greece, chcharat@agro.auth.gr

4: Department of Supply Chain Management, International Hellenic University, Katerini, Greece, evagelos@agro.auth.gr

Abstract: The present work aims to analyse possible connections between digitalization, innovation and sustainable rural development through a three-pronged nexus thinking approach, where three sectors are considered. This link is examined under a 'discrete context' perspective, by assuming heterogeneity (which means that differences among farms may emerge in the innovation adoption process) as a characteristic in innovation adoption and by investigating the potential impacts on local rural development. Through a Multivariate Analysis, farms from the last Italian Census of Agriculture are grouped in homogenous clusters according to selected context dimensions. Results reveal a very interesting reality characterized by high levels of territorial heterogeneity in the adoption of digital and innovative solutions, bringing about scattered "geographies of innovation" in the Italian farming system. At the same time, the empirical analysis demonstrates different typologies of entrepreneurial strategies behind farms adopting digital solutions and/or innovation, which may bring about different impacts on the promotion of smart rural development.

Keywords: digitalization-innovation-sustainability nexus, Italian agriculture, smart rural development

Purpose

Digitalization is a fundamental driver of innovation that, at the same time, may boost sustainable agrifood systems and smart rural development (Torre et al., 2021). On the other side, literature has emphasized non-neutrality issues, that is the risk of excluding potential beneficiaries from the advantages of new digital technologies. This risk may be linked to context-related variables, and, consequently, have diversified impact on agrifood systems and on local development. As a matter of fact, scholars have pointed out that non-neutrality is particularly associated to small-size farmers, especially those who are elderly, less educated, and located in remote and/or marginalized areas (Schnebelin et al., 2021). Therefore, assuming digitalization as a social process implies acknowledging different potential impacts at the individual and local level. Thus, this paper analyses heterogeneity in the adoption of innovation by pointing out that "*heterogeneity among farmers is the main cause of different levels of adoption*" (Heiman et al., 2020, p.22). Moreover, it focuses on the nexuses between digitalization, innovation, and sustainable rural development

from a heterogeneity perspective, by assuming a nexus thinking perspective (Ponce Oliva et al., 2021). Widely used for exploring the water-energy nexus to analyze possible solutions for a more efficient use of natural resources and to boost sustainable adaptation (Albrecht et al., 2018), the nexus approach has been used also for other purposes. In our paper, we focus on a three-pronged approach, according to which three sectors are considered (Ponce Oliva et al., 2021), by exploring the digitalization-innovation-sustainable rural development links. The hypothesis is that the 'disruptive' nature of digitalization may stimulate heterogeneous dynamics in the innovative processes and in rural entrepreneurship, with consequent diversified impacts on the agricultural system and on local rural development. Heterogeneity is analyzed through a 'context' perspective, as put forward by Welter (2011): by considering the multiplex facets of context, the business, social and spatial context in which farms operate are analyzed. In particular, while acknowledging Welter's (2011) distinction between omnibus (which refers to a broader perspective) and discrete context (focused on specific variables), we stress an emphasis on a discrete context lens, which allows us to investigate how digitalization-innovation nexus may impact on rural entrepreneurship, meant as entrepreneurial activities embedded in rural contexts and drawn on rural local resources (Korsgaard et al., 2015).

Methodology

The empirical analysis is drawn on secondary data extracted from the last Italian Census of Agriculture (Istat, 2020). The sample includes 226,668 farms, and is limited to the farms that adopt either innovations or digital technologies or both. Due to the high number of observations and with the purpose to excavate heterogeneity in the three-pronged nexus, we conducted a Multivariate Analysis (through the SPAD software), made up of a Multiple Correspondence Analysis (MCA) and a Cluster Analysis (CA) through a Mixed (both hierarchical and non-hierarchical) method (Fabbris, 1989). The MCA allows to identify the main factors that contribute to the shaping of the clusters. Subsequently, the objective of the CA is to group statistical units into clusters that are characterized by the maximum homogeneity within the same groups and by the maximum heterogeneity amongst different groups. Clustering of the statistical units is carried out by using a mixed method, starting from a non-hierarchical method, later integrated by a hierarchical method. The choice of the optimal number of clusters is realized by cutting the tree-like diagram (the dendrogram) where the branches are longer, that is where the internal groups variance starts increasing. The selected partition is coherent with the aims of the analysis and allows to clearly highlight the differences among the groups. With the purpose of exploring the nexus digitalization-innovation, a new variable was created to assess whether farms adopt digitalization and/or innovation; this variable, called '*digitalization and/or innovation*', comprehends three modalities: only digitalization, only innovation, digitalization and innovation. Moreover, as far as innovation is concerned, the available data allow to classify the innovations in different typologies, such technical or managerial/organizational innovations. Furthermore, to excavate the three-pronged nexus (digitalization-innovation-sustainable farming and rural development), we have selected the following variables related to impact on sustainable farming practices and rural development: as far as sustainable farming is concerned, we have selected variables related to the presence of "organic" or in "conversion to organic" farming practices, which can be considered as indicators of the adoption of agronomically sound agricultural practices. Regarding sustainable rural development, the adoption of diversification strategies at farm level and the localization in specific areas classified by the national plan for rural development are considered, under the

hypothesis that the presence of digitalization-innovation nexus in remote rural context (*D areas*) has great impact on the promotion of smart rural development[4] as underlined in the Long Term Vision for Rural Areas (European Commission, 2021).
The choice of the aforementioned variables allows also to target specific SDGs of the 2030 strategy, such as responsible production and consumption, no poverty and reducing inequalities in rural contexts. Therefore, 19 active categorical variables were contributing to the building of the homogenous clusters, while 34 supplementary categorical variables were useful to better describe the resulting clusters (through their positioning in the factorial space). The variables are represented in table 1, specifying the active and the supplementary ones: active variables contribute to identifying the clusters, while supplementary variables provide relevant information to characterize the homogeneous groups of farms.

Table 1 – Discrete context variables used in the empirical analysis

Type of context	Discrete	Variables
Business	Characteristics of industries and markets	Utilized Agricultural Area (active), Livestock Units (active), standard output (active), technical and economic orientation (active), Other on-farm and off-farm activities (active), Passive subcontracting (supplementary)
Social	Network relations; composition and roles of household/family	Associationism (active), Farmer's age (active), Farmer's level of education (active), Farmer's gender (active), Number of days worked by the farmer (active), Training programs joined by the farmer (active), Organic farming (supplementary).
Spatial	Characteristics of physical business location	Types of rural areas (active), Altimetric zone (supplementary)

Findings

The MCA conducted with the abovementioned variables led to the generation of four factorial axes explaining 94% of the variance, reevaluated using the Benzècri's reweighted formula (Greenacre, 1984); these axes can be briefly described as follows:
Factor 1 - Structural characteristics of farms. It contrasts farms with small and small with greater physical and economic dimensions.
Factor 2 depicts the farm's *innovation adoption*: it contrast farms that do not innovate at all, and farms adopting one or more innovations.
Factor 3 specifies the presence of *digitalization* and/or innovation, contrasting farms taking only digital solutions and farms with only innovation without digitalization.
Finally, Factor 4 stands out for the *territorial localization of the farms*, contrasting farms in rural remote areas and farms in area with specialized and intensive agriculture.

[4] The rural policy of the EU targets measures and tools to particular territorial contexts and individuate specific measures for stimulating growth in those areas. As a consequence, territories of the European Union have been divided up into homogeneous areas: urban poles (A areas), areas with intensive agriculture (B areas), intermediate rural areas (C areas) and rural marginal areas (D areas). Dedicated policies are provided for rural areas, with special reference to rural areas with complex problems of development, with the purpose of improving the quality of life and fostering diversification strategies.

According to the analysis of the dendrogram, cluster analysis has permitted to clearly identify five groups of homogeneous farms (figure 1).

Cluster 1 accounts for 36.3% of all farms, prevailingly located in intermediate rural areas (such as hill areas), but also in area with intensive agriculture. Farms declare a limited adoption of digital technologies, while they declare to not innovate. Other gainful activities provide these farms with multifunctional attitude to some extent, with relatively good impact either on reconfiguring the local agricultural systems. Farms in this cluster are quite small: 68.9% of them have a Standard Output lower than € 25,000 and 63.2% have no more than 10 hectares as UAA. Moreover, they are more specialized in arable and permanent crops, with no animal farming.

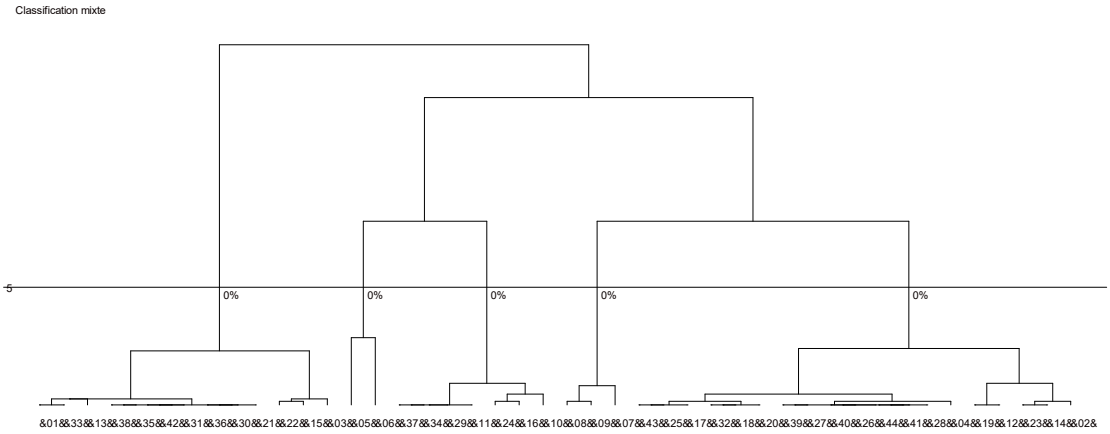
Farms grouped in cluster 2 are mainly specialized in breeding herbivores and are mostly localized in remote rural contexts; this cluster is mainly characterized by medium-sized farms, prevailingly managed by women farmers. In this cluster, the three-pronged nexus is fully verified, in that the farms display both digitalization and innovation, which, in many cases, support diversification strategies, either on-farm and off-farm diversification, aimed to empower multifunctional agricultural systems: software here are mainly used for managing the breeding program, while investments are made in innovations concerning livestock housing, but also automation and the management of infrastructures.

Cluster 3 is made up of farms that operate within conventional farming systems, mainly located in areas with specialized and intensive agriculture in Northern Italy. Innovation and digitalization are largely adopted for animal breeding. This cluster is typified by a more intensive livestock farming, with 86.5% of farms having more than 100 Livestock Units, and with a large share of farms with a Standard Output higher than € 500,000.

Farms grouped in Cluster 4 typify farming systems characterized by small farms, managed by old farmers with low levels of education and absence of relational assets (no adhesion to collective farmer marketing initiatives). The innovativeness of farms is principally reflected on crops. Most of the farms are on hills (49.7%) and located in intermediate rural areas (42.4%). The main innovations adopted are about automation (49.2%) but also crops-related: for example, for planting and seeding, for soil management, for irrigation and for arboretum pruning. This cluster is distinguished by the absence of any kind of digitalization.

Farms in Cluster 5 adopt innovations and digital technologies. For most of the farms, digital tools are used for business purposes (89.7%), and software are used for administrative services (73.3%) and for crops management (34.3%). At the same time, also the innovations adopted are much concentrated around aspects of the farm related to cultivation (60.3%), and for business organization (10.5%). The main innovations adopted in this cluster range from planting and seeding to irrigation to soil management. Moreover, these farms are also characterized by the adoption of organic farming practices.

Figure 1 – Cluster extracted from the analysis (percentage values)



Practical implications

Despite the fact that the study presents some limits, related to the use of secondary data, the results of the analysis provide useful insights if read through the lens of the three-pronged nexus adopted in this paper. The empirical analysis has evidenced three main types of nexuses:

a) in the first one the digitalization-innovation-sustainable rural/agricultural development nexus clearly emerges and depicts two different strategies: 1) the first one is a territorial strategy (cluster 2), which points out a sound entrepreneurial approach which is functional to strengthening rural communities and landscape management, thanks to the implementation of strategies of diversification carried out through on and off farms diversification into farm related and farm diverse activities (Vik, McElwee, 2011). Digitalization encourages innovations aimed to promote smart rural development and to increase the degree of multifunctionality of the farming systems in remote rural context, so improving the quality of life of local rural communities (Torre et al., 2021). Our results are coherent with the idea that, notwithstanding the vicious circle of rurality in which they are trapped, farms located in marginal rural areas contribute to the local development of those areas, then confirming that they hold the potential to take advantages and benefits from digital transformation (Arcuri et al., 2023). Set against this background, digitalization-innovation nexus emphasizes new "disruptive" technologies aimed to boost sustainable farming systems and smart rural development, with high impact on agricultural and rural local communities. Moreover, dynamics found in remote rural areas are coherent with the 'Long-term vision for rural areas' (European Commission, 2021): having 'digitally connected' rural areas by 2040 will somehow favor the adoption of innovations in those areas. 2) The second strategy is grounded on entrepreneurial strategies working within sustainable agrifood systems, where digitalization/innovation nexus is functional to pursue the adoption of various innovation (product/process/organizational) aimed to strengthen differentiation strategies based on organic and/ conversion to organic farming practices (cluster 5), particularly in farm specialized in crops and located in areas with intensive agriculture or in urban/periurban contexts. Therefore, farms of this group are oriented towards digitalization and innovation serving transition towards sustainable farming systems. Moreover, digitalization engenders new communities of practices (Dubois et al., 2019), as demonstrated by the high rates of adhesion to farmers' cooperatives or producers' organizations.

b) The second type of nexus is partial and concerns only the digitalization-innovation nexus. This nexus is consistent with productivity strategies aimed to consolidate entrepreneurial strategies within the agro-industrial paradigm, where the digitalization/innovation nexus is functional to

pursue efficiency logics within a globalized mode of food provisioning (cluster 3), mainly in the livestock sector, particularly in the intensive animal farms located in lowland areas of northern Italy. Consequently, the choice of digitalizing and innovating is adopted within a well-identified and conventional business model.

c) In the third type, the nexus is not working at all. More precisely, a first group of farms (cluster 1) adopts digital solutions, but they have introduced no innovation in the last three years. In this case, the nexus between the introduction of other innovation and farms with digital technologies cannot be taken for granted; as a consequence, the analysis demonstrates how digitalization is not a *condition sine qua non* to innovate due to the variety of dimensions and contexts that characterize innovation. On the other side, the use of digital solutions is also functional to the adoption of diversification strategies, which increase the rate of multifunctionality of the farms with positive impacts on the promotion of sustainable entrepreneurial strategies. A second group of farms (cluster 4) evidences an innovative character but with no digitalization. Innovation is mainly targeted to empower the level of farm's mechanization, so generating higher levels of production efficiency. In this backdrop, the lack of 'technological infrastructure' (Lioutas, Charatsari, 2022) seems to limit the adoption of further innovations. Against the backdrop of the abovementioned heterogeneous scenario, rural policies may, on the one side, furtherly empower the three-pronged nexuses; on the other side, they may attempt to incentivize farms to obtain the minimum (digital) technological requirements for adopting an innovation, as the recent measures for digitalization expected in the current rural plan 2023-27 for rural development of the EU. This may accelerate transition towards more diversified and digitalized rural areas.

Theoretical implications

The three-pronged approach here adopted has been explored through the help of secondary sources, and allowed us to excavate more in depth the potential impact of digitalization and innovation in building up sustainable farming practices and smart rural development processes. Sustainability of agrifood systems and rural embeddedness through the activation of diversification strategies strongly rooted in rural contexts (like D areas) set up the basis for alternative and sound business models grounded on the idea of either weak (like in cluster 1) or, mostly important, strong multifunctionality (Wilson, 2008), such as those revealed by the cluster 2. Here, the presence of women farmers strengthens the degree of sustainability and contribute targeting the sustainable development goals, through fulfilling several SDG of the Agenda 2030. Nonetheless, future researches are needed to better the nexuses and to shed a light on the institutional context in which farms operate, as it is not considered in this study.

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Enhancing the impact of social agriculture. A focus on re-education and social reintegration of prisoners in Italy

Irene Selvaggio[1], Gaetano Chinnici[2], Agata Matarazzo[3], Alessandro Scuderi[2] and Donatella Privitera[1]

[1] Department of Educational Sciences, University of Catania, Via Biblioteca 4, 95124 Catania, Italy, irene.selvaggio@phd.unict.it, donatella.privitera@unict.it,

[2]Department of Agriculture, Food and Environment, University of Catania, Via S. Sofia, 100, 95123 Catania, Italy, chinnici@unict.it, alessandro.scuderi@unict.it

[3]Department of Economics and Business, University of Catania, Corso Italia, 55, 95129 Catania, Italy, amatara@unict.it

Abstract: The article explores the potential of social agriculture in aiding the re-educational path and social-work reintegration of prisoners, aiming to enhance their quality of life. Social agriculture, an innovative approach intertwining agricultural practices with social services, seeks to diversify rural activities by generating social and welfare benefits for marginalized populations, also local development. Italy has recently experienced a surge in social agriculture programs within its prison system. Applied methods are contextual analysis and semi-structured interviews with key stakeholders. Case study is in Ragusa, in the south of Italy, where 8 out of 27 penitentiary institutions have embraced inmate rehabilitation. We see the case as a comprehensive study of what can be considered an example of social farming activities in prisons, connecting inmates with civil society. At an early stage, we conclude this initiative contribute to the mental and physical well-being of prisoners, fostering positive self-perception and improving their overall quality of life linked to green care.

Keywords: wellness of disadvantaged individuals; agriculture and detention; multifunctional approach; case study.

Purpose

The aim of the study is to explore the potential of social agriculture in facilitating the re-educational path and social-work reintegration, ultimately improving the quality of life for vulnerable individuals, notably prisoners. The complex food systems involves production, processing, and distribution, influencing accessibility, affordability, and systemic outcomes (von Braun et al., 2021). Food systems operate at various levels, spanning globally, regionally, nationally, and locally. Local food systems exhibit great diversity and are heavily influenced by their specific locations. Transforming these systems is crucial, but challenges exist. There are multidimensional, multi-scalar perspectives of the relationship between space and food systems (Hendricks, 2024). A focus is on the relocalisation, reconnection and reterritorialization. From the conceptualization of space (Harvey, 2006) need of looking to territory to identify a food local system represented by the research of mechanisms - aggregations of public and private subjects – because it has a direct spatial connotation (e.g. region, place, local, etc.) that come across as an indicator of local self-organisation (Dematteis, 2003). Consequently, it is relevant the model based on the interaction between the actors and scales regarding food systems in a given territory, where each place is regarded as a system of inter-subjective relations. Through governance instruments and policies, the food territorial elements can act as catalysts for local development (Tecco et al., 2017).

Social agriculture represents a transformative approach that integrates agricultural practices with social services, aiming to diversify rural activities (Borsotto and Giarè, 2020). It involves a range of initiatives carried out by individual farmers or social cooperatives, designed to generate social and welfare benefits and services for disadvantaged segments of the population (Di Iacovo, 2014). It is pertinent to address the potential of social agriculture in the context of food and agricultural systems research because is other point of view of the farmers to create wellbeing to society and of integrated rural land care. New methods consistently arise to foster alignment among farmers, local communities, and additional parties involved. These approaches facilitate the journey toward sustainable development by offering customized solutions that address the unique requirements of local communities and their surroundings. Social agriculture represents a tool for implementing the European Green Deal (Com/2019/640) as it addresses the growing needs of the rural population, both from a social, economic, and environmental perspective, and in terms of offering diverse services (EU, 2020) directed not only towards human subjects but also towards the environment and cultural landscape. In addition, social agriculture refers to agenda 2030 - plan of action for people, planet and prosperity - to contribute to the Sustainable Development Goals, particularly the need for farms as well policy analysts creating a new spirit motivating people to implement common social projects to increase the number of adults who have relevant skills, for employment, dressed jobs and entrepreneurship, and empower and promote the social, economic and political inclusion of all, as agreed by the 194 countries of the UN General Assembly in 2015 (United Nation, 2015).

In Italy, social agriculture is regulated by Law 141/2015 as an integral aspect of multifunctional agricultural enterprises, dedicated to the development of social, social-health, educational, and social-employment interventions and services.

Recently, the implementing decree (dm 12550/2018) has been approved, but the regulation currently appears incomplete (Borsotto et al., 2022). Social agriculture operates locally, fostering organizational innovation and contributing to local development by enhancing capital. The evolution of agricultural processes is described by multifunctionality and diversification concepts, intertwined with various geographical contexts. In addition, digital innovation has become a noteworthy addition to these dynamics in the agricultural and rural sectors (Wilson, 2009).

Taking up the concept of green care linked to social agriculture, it combines the care of individuals with the care of territories to promote the health and well-being of individuals at risk of social exclusion through nature as a central element (García-Llorente et al., 2018). Green Care is an umbrella term used in reference to different types of intervention: care farming, social farming, therapeutic horticulture, farming for health. Although these concepts are often used synonymously, they are based on different theories and have different representations in each country. When green care initiatives make use of agricultural practices, it is referred to as green care in agriculture (Dessein and Bock, 2010). Specially, green care in agriculture integrates aspects characteristic of traditional healthcare systems with agriculture, landscape and nature conservation, animal husbandry, and zootechnics, creating connections and thus generating new benefits for the involved actors (Haubenhofer et al., 2010).

Recently, Italy has witnessed a surge in social agriculture programs within its prison systems to disadvantaged individuals, which is taking place in various types of detention facilities. As defined by Law 193/2000 (Smuraglia Law), an amendment to Law 381/1991, disadvantaged individuals encompass individuals detained or interned in penitentiary institutions, convicts, and those admitted to alternative measures to detention and community service (Law 354/1975, art. 21, as

amended). These initiatives encompass diverse activities, including the establishment of social gardens, the production or transformation of agri-food.

Design/Methodology/Approach

This research employs primary and secondary sources, including a case study, to explore social agriculture linked to green care within the context of Italian penitentiaries, focusing on the role of prison labour. It comprises two phases involving literature analysis, data collection, and direct interviews with key informants. At this time, the research unveils examples of best practices in Sicily, in the south of Italy, illustrating agricultural social innovation in spaces primarily custodial, providing initial results for further investigation. The design incorporates triangulation of qualitative methods like field research, participant observation, and semi-structured interviews (Yin, 2009: 18). The first research phase involved documentary collection and literature analysis to provide an overview of the topic in Italy, including data, national and regional laws and regulations. Specifically, we look at examples of virtuous models to empirically illustrate the type of agricultural social innovation adopted in spaces whose primary function is not productive but custodial.

At the end of 2023, the number of inmates in Italian prisons was 60,166, with approximately 33% being working detainees, of whom 2% are employed in agriculture. Agricultural work in Italian prisons mainly occurs in agricultural estates in around 40 penitentiary institutions and in agricultural penal colonies in Sardinia and Tuscany. Observing Sicily, the Sicilian adult penitentiary institutions number 23, they accommodate a total of 6,711 inmates. Additionally, there are 4 Juvenile Detention Centers that house minors or young adults up to 25 years old, with a current count of 79 as of January 15, 2024 (DGMC, 2023).

Regarding employment, as of June 2023, the total percentage of adult inmates engaged in work is 31% of the total population (76% of whom are men). Inmates under the jurisdiction of the Penitentiary Administration account for 95%, mainly employed in institutional services (84%), extramural services (7%), and routine maintenance of buildings. According to Department of Prison Administration data, only 8 inmates are employed in agricultural work, representing just 0.4% of the total working inmates in the region. In Sicily, different penitentiary institutions have adopted agricultural activities as a rehabilitative and socially reintegrative measure for inmates. These are diversified activities sometimes managed by the Penitentiary Administration, and at other times by third parties such as agricultural companies, social cooperatives, and social promotion associations. Among these experiences, which involve various types of penitentiary facilities, are horticulture, floriculture, and nursery gardening, beekeeping, as well as the production of processed agricultural products.

The case study refers to the project *Libere tenerezze, Laudato sì – Orto umoristico rigenerativo* at the Ragusa Penitentiary (in Sicily, Italy) originated in the spring of 2020. Following a social initiative within the institution, volunteers from the clown doctor's association *Ci Ridiamo Su* gifted agricultural seeds to inmates. One detainee expressed a desire to plant them in one of the prison's plots of land. The agreement between the prison administration of Ragusa and the association was established in 2021 until 2023. The key informants of the interviews were the owners of the association, which includes not only clown doctor educators but also experts in the fields of agronomy and communication. Unfortunately, in this penitentiary, we are waiting for permits for the application of the participant observation method and the realization of focus groups with the involved inmates.

Findings

The project, in its implementation, promote the acquisition and development of agricultural skills to facilitate the social reintegration of inmates, focusing on the experience of regenerative agriculture and placing emphasis on the environmental and socio-economic sustainability of agricultural activities. It receives funding through various means: on one hand, the association secures funds from donations, fundraising, and sponsors; on the other hand, the project is financed by the Ministry of Justice regarding the inmates' allowances and concerning the technical equipment and all the necessary tools.

The comment from the association's leader is reported as follows: «*We have established a protocol in which we take care of both the agronomic and educational aspects of the detainees, as well as the communication of the project. The products obtained were given to us so that through donations, we could refinance this project*». The fundamental objective of the project is an applied of social agriculture as well as an effective and innovative model of territorial development within the space of the prison. The project aims to enhance soil quality, biodiversity, and polyculture through the use of probiotics and seasonal rotation techniques.

The plots of land within the penitentiary are three: the smaller ones, 280 sqm and 130 sqm, are cultivated with seasonal vegetables, while the largest, 2500 sqm, has been reserved for the establishment of an arboretum. The prison's location positions the garden as a green lung in the city

center, surrounded by tall buildings. Also, it serves as a tourist attraction and sometimes is photographed. The cultivated products are different: kiwi, persimmons, prickly pears, blueberries, and fruit trees such as pome fruits, stone fruits, mangoes, and papayas. Furthermore, the association hopes to expand the project through poultry farming and beekeeping. The involved detainees are two, rotating voluntarily. Additionally, two other detainees have participated in specific activities such as the construction of fences and more. These are detainees who can be assigned to work outside (Law of July 26, 1975, No. 354, Article 21), and thanks to the project, two daily allowances have been provided. These individuals support their families. Previously of this project, this was not possible. «*We are talking about very delicate social situations*», affirms the association's leader. Really, however, it is not an income-generating project but rather «*combines the agronomic aspect with the relational one*» and it is referred to as a humorous garden, because it combines agricultural activity with humor therapy. The focus is on the non-economic, but rather relational and social aspect, which is why the green care is defined "humorous". The project connects the social aspect of agriculture with comic therapy, typical of the association activity, triggering perspective changes and fostering dialogue, sharing, and community openness, emphasizing inclusive and social aspects. Caring for green spaces within the prison helps inmates in their daily well-being and in achieving and completing the life cycle of agricultural products. The project encourages relationship exchange and dialogue among voluntary farmers, inmates, the association, and prison governance. Synergies and network activities act as a bridge between inside and outside, connecting prison structures with external entities, supported by numerous collateral initiatives. Specifically, this project no provides agricultural education and training activities to improve knowledge and skills in farming of the inmates, try to care their well-being and transmit the realization of an objective during the everyday life.

From a productive standpoint, agricultural products, like jams, fund not only the project but also other initiatives in different social spaces (e.g., oncology hospitals or with the elderly). Promotional activities are carried out in schools. In 2022, as one of the side initiatives, inmates donate a plum

tree to the *Rogasi* comprehensive Institute in Pozzallo. This gesture is meant to commemorate police man *Alfredo Agosta*, who was killed in a mafia ambush in Catania in 1982.
How the interviewees narrate it: « .. *allow me to create, as we always do, a bridge between the prison structure and extra prison structures. That's why we go to schools, that's why we attend conferences, that's why we talk about this project. Because through communication, we aim to change the perception of the inmate in the local communities*». In addition, allows the people who is detained in prison «*to recognize their self-efficacy, to work on self-esteem*», so that the inmate could «*feel useful*» inside the prison, and at the end of their detention could have new skills. Also, the project encourages dialogue between inmates and other types of actors, how the different groups interact with each other, what kind of information they share, the topics of discussions, the conditions that support sharing. In fact, in addition to the participating prisoners, the project involves other categories of indirect beneficiaries. These include, first and foremost, the prison community as a whole.

Practical Implications

The outcomes of case study analysed establish a meaningful connection between the prison environment and civil society. Inmates are provided with opportunities for professionalizing work, which holds significant therapeutic and rehabilitative value in terms of mental and physical well-being, fostering positive self-perception, and enhancing their overall quality of life. Consequently, social farming activities within and out places of detention exhibit substantial re-educational potential, contributing to the reintegration of prisoners into society and improving their overall quality of life. AS's experiences in Italy are diversified, and involve different prisons and individuals and kind of activities. In this context, the project *Libere Tenerezze, Laudato Si – Orto umoristico rigenerativo* inside the Ragusa prison is a tangible example of how AS can promote social inclusion, rehabilitation and environmental regeneration.
First and foremost, the project represents a tangible opportunity for inmates to acquire agricultural and interpersonal skills that facilitate their social reintegration. The model of social agriculture not only offers practical experience in farming but also promotes values of environmental and social sustainability, thereby contributing to the formation of aware and responsible individuals. Secondly, active involvement in the agriculture activity and success in plant care provide inmates with the opportunity to develop self-esteem and self-efficacy. This is crucial for their rehabilitation journey, as it helps them to recognize their own value and feel useful, thus fostering a positive change in their perception of themselves and their abilities. In addition, the project creates an opportunity for the creation of inclusive communities, both inside and outside the prison facility.

Theoretical Implications

The potential of the AS to become an effective and innovative model of territorial, participatory, and community service development is significant, as it aims to bring together needs, identities, and forms of protection, regardless of their capacities or vulnerabilities. It attributes value to work, not only as a source of individual income but also as an element of an inclusive, sustainable, just, and solidarity-oriented society for the formation of a collective identity, contributing to the transformation of the agricultural and rural world. The case study highlights the link between social agricultural and re-education and social reintegration of prisoners.

The limitations of this contribution are linked to the progress of research, especially in relation to obtaining permissions to carry out field observations, and given the qualitative nature, further observations are needed.

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INTEGRATION BETWEEN AGRICULTURE, LANDSCAPE MANAGEMENT AND DESIGN

Territorial design for sustainable agrifood systems: development and testing of a cross-disciplinary review framework

Lorène Prost[a], Marion Casagrande[a]

a Université Paris-Saclay, AgroParisTech, INRAE, UMR SAD-APT, 91120, PALAISEAU, France

The transitions to sustainable agrifood systems face systemic challenges that require to consider the influences of different stakeholders. Focusing on the territorial level, which encompasses spatial, social, institutional, and ideal dimensions, is crucial for effectively supporting these transitions. This study outlines the development of an exploratory review framework, derived from literature, to extract and identify key features of territorial design across disciplines. The resulting framework categorizes key aspects of territorial design such as territory dimensions, designed objects, design activities and group characteristics. The framework was then tested on five articles from various disciplines. The cross-cutting analysis revealed that territorial design involves creating spatial objects and governance processes accounting for spatial and social dimensions of a territory, and in some cases the design of public policies and/or symbolic representations (institutional and ideal dimensions). Emphasizing co-design, stakeholder dialogue and collaborative learning, often through transdisciplinary and interdisciplinary approaches, the process integrates analysis and synthesis phases. Our analysis also highlighted gaps, such as a limited focus on agricultural issues. These results need to be confirmed by studying a larger number of articles. If confirmed, this could lead to further research to develop methods for implementing territorial design that effectively supports sustainable agrifood transitions.

Keywords: Landscape, territory, design, review, cross-disciplinary

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Purpose

Numerous research studies have underlined the highly systemic dimension of the transitions required to move towards more sustainable agrifood systems, encompassing primary agricultural production, food distribution and household consumption (FAO, 2021). We will further refer to these transitions as SAS – sustainable agrifood systems – transitions. The SAS transitions raise a large number of challenges in terms of farming systems: farmers' work, representations, organizations and knowledge (Prost et al., 2023). Nonetheless, as shown by studies about lock-ins (e.g. Vanloqueren and Baret, 2009; Meynard et al., 2018), treadmills (e.g. Bakker et al., 2020) or relational dimensions (e.g. Darnhofer, 2020), such transitions are also shaped by the other agrifood system stakeholders: input suppliers (e.g. availability or not of resistant cultivars or specific equipment), purchasers (e.g. requirement of purity), processing industries and value chains (e.g. requirement of using standardized raw products, in quality and quantity), consumers (e.g. requirement on the quality and prices of products) or institutional actors (e.g. regulations about agricultural practices). In addition, the spatial dimension of transitions needs to be considered when addressing sustainability issues such as improving water quality in catchments, enhancing biodiversity or introducing legumes in crop sequences.

To seriously investigate and support this highly systemic nature of transitions, one solution is to work at an integrative level encompassing all elements of the agrifood systems. This is what systems agronomy intends to do when it calls for working at a landscape or territorial level (Rizzo et al., 2022). In this communication, we consider that the territorial level includes four dimensions: (i) material (spatial or physical), (ii) social (organizational or relational) (iii) institutional (formal or informal) and (iv) ideal (symbolic representation) (Pachoud et al., 2022; Angeon et al., 2024). What would it mean then to consider transition at a territorial level? When addressing SAS transitions, a whole body of literature assumes that such transitions call for innovative design. They require agriculture to move in directions that are for now ill-defined, full of uncertainties, context-dependent and, in short, fundamentally unknown (Prost, 2021). The research studies on such design processes described their nature, the way to support them or the tools to organize them (see Prost (2021) for an overview). However, except for a very few studies (e.g. Etienne, 2014; Della Rossa et al., 2022; Boulestreau et al., 2023), these studies are focusing on changing farming practices and systems. They rarely explicitly encompass (i) the needed changes in the practices of the various stakeholders involved in SAS transitions and (ii) the territorial level. We thus aim at investigating the concept of "territorial design" as it seems promising to analyze and support SAS transitions. However, it varies from one author to another, and from one discipline to another, which means that there is no consensual definition but rather a multi-faceted concept (Prevost et al., 2018). As a result, we are interested in identifying the diversity of definitions and implementations of this concept across disciplines to improve its application in supporting SAS transitions. In other words, we aim at exploring what is known about territorial design, what we can learn from this approach, and what is missing if we want to use territorial design to support SAS transitions. This communication is a first step in that direction: it aims at developing and testing a review framework (this communication) that will then be used, in further studies, to produce a comprehensive literature review on territorial design and ultimately support territorial design processes in research projects to contribute to SAS transitions.

Approach

We carried out two-step exploratory review, which is close to a scoping review (Munn et al., 2018) where the identification and selection of the references are not systematic.

Firstly, we built a review framework, from the literature, that sheds light on various aspects of the concept of territorial design: '*territory*', '*design*', '*territorial design*' as such. The *territory* aspect was explored according to the 4 above-mentioned territorial dimensions (Pachoud et al., 2022; Angeon et al., 2024). The *design* aspect was characterized according to the description of co-design processes in design literature (Stempfle and Badke-Schaub, 2002; Cross, 2007; Barcellini et al., 2015). We also relied on the few articles directly describing different types of *territorial design* (Parente & Sedini, 2017; Hémon et al., 2023): design 'in the territories' considers territory as a design context, design 'of territories' considers territory as a design object or design 'for territories' considers territory as a complex relational system that includes and amplifies the two other types. These elements were combined to build a framework that constitutes the first result of the "Findings" section.

Secondly, we applied this framework to a sample of 5 articles (Barrett, 1992; Neuman and Zonneveld, 2018; Braun et al., 2021; Jolivet-Duval et al., 2021; Pachoud et al., 2023). We selected these articles as they described approaches and/or results likely to lead to the design of sustainable territories. As we wanted to test the ability of our framework to be used on a diversity of disciplines

and approaches, we chose these 5 articles from different disciplines: ecology (Barrett,1992); landscape architecture and urban planning (Neuman and Zonneveld, 2018); in economics (Braun et al., 2021); design sciences (Jolivet-Duval et al., 2021) and geography (Pachoud et al., 2023).

Findings

First version of the review framework

We have developed a review framework, summarized in Fig. 1, that explicitly relies both on territory and design aspects.

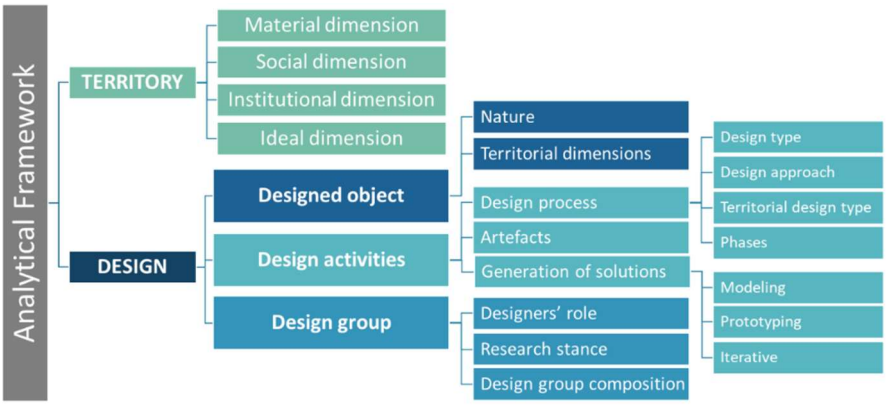

Figure 1 – The review framework relies on different aspects (first level), dimensions (second level) and categories (third and fourth level).

On the one hand, the review framework distinguishes the dimensions of the territory that are addressed: (i) spatial, (ii) social (iii) institutional and/or (iv) ideal. The material dimension refers to tangible territorial resources (spaces, flows, infrastructure, e.g. plots, rivers, storage facilities). The social dimension refers to organizational or relational dimensions (e.g. coordination between stakeholders along supply chains). The institutional dimension refers to "the rules of the game" included in formal institutions (political structure, contracts, property rights) or institutions (beliefs, norms, culture, etc.) and the ideal dimension refers to intangible resources, such as the symbolic representations that stakeholders have of the territory.

On the other hand, we used 3 dimensions to characterize the design aspect: 1) the type of designed object, i.e. the objects devised to attain specific goals, 2) the characteristics of the design activities and 3) the characteristics of the design group. We described the *designed objects* according to their nature (e.g. a combination of cropping systems, a coordination between value-chain actors, public policies) and the territorial dimensions they cover (spatial, social, institutional, ideal). We described the *design activities* through: (i) the characteristics of the design process (type, approach, territorial design type, number and type of phases) (ii) the type of artefacts used to represent the design objects (e.g. sketches, pictures, maps, mock-ups, mind mapping) and (iii) the way the solutions were generated (e.g. modelling and simulation, stakeholder workshops). We finally paid attention to the *design group* characteristics and described (i) the role of the designer (with regard to the whole design group), (ii) the type of research stance (transdisciplinary and/or interdisciplinary) and (iii) the composition of the design group (number and type of stakeholders when available).

First outcomes of the cross-cutting analysis

We first applied the framework to each article, sorting the information and content according to the different dimensions and categories of the framework (see Fig. 1). We then compiled all these elements into a cross-cutting analysis, in which we compared and synthesized the information for each category of the framework. From the analysis of the 5 articles, we gained more insight on the territorial design approach. “Territorial design” is a design approach applied to the territory, which involves considering stakeholders, co-constructing and experimenting (Jolivet-Duval et al., 2021). The approach results in designing a spatial object (spaces and flows) and/or a process that creates governance capacity (Neuman and Zonneveld, 2018), which respectively contribute to the spatial and social dimensions of territory. Jolivet-Duval et al. (2021), Neuman and Zonneveld (2018) and Pachoud et al. (2023) also reported a strong connection with the design of public policies, thus accounting for the institutional dimension of territory. The design of symbolic representations, accounting for the ideal dimension of territories was addressed in Jolivet-Duval et al. (2021) and Pachoud et al. (2023). Barrett (1992) only addressed the spatial dimension of territory, through landscape design, while Braun et al. (2021) emphasized the social dimension when designing the organization of an agrifood value chain.

In this approach of territorial design, the process of engaging stakeholders in dialogue and the tools designed to support this interaction (Neuman and Zonneveld, 2018; Jolivet-Duval et al., 2021; Pachoud et al., 2023), as well as the resulting collaborative learning (Braun et al., 2021), are key. These elements stand out as more important than the formal outcome (i.e. the implementation of the designed object) The approach therefore calls for co-design of solutions, that could create governance capacities (Neuman and Zonneveld, 2018) and co-production of knowledge (Pachoud et al., 2023). Co-design requires to involve a diversity of stakeholders: architects, landscape architects, urban planners, associations, elected representatives, policy makers, civil servants, farmers, food processors, trading companies, inhabitants and researchers from various disciplines (geography, sociology, anthropology, urbanism, agronomy, agro-landscape ecology, climatology, geomorphology, agribusiness, communication sciences, food economics) (Barrett, 1992; Neuman and Zonneveld, 2018; Braun et al., 2021; Jolivet-Duval et al., 2021; Pachoud et al., 2023). As a result, in the 5 studied articles, the authors described both (i) transdisciplinary processes, bringing together researchers and non-academic actors to solve complex problems and (ii) multidisciplinary processes supported by a bundle of disciplines.

The territorial design process also appears as encompassing (i) analysis (understanding the problematic) and (ii) synthesis (generating and formulating solutions) phases (Barrett, 1992; Neuman and Zonneveld, 2018; Braun et al., 2021; Jolivet-Duval et al., 2021; Pachoud et al., 2023). Barrett (1992) also explicitly added an evaluation phase to the process and Jolivet-Duval et al. (2021) and Pachoud et al. (2023) described a “pivot phase”, between the analysis and synthesis phases, that aims at generating controversy to transform perception. Depending on the articles, the approach is based on artefacts that address different territorial dimensions: spatially explicit artefacts (e.g. maps) (Barrett, 1992; Neuman and Zonneveld, 2018; Jolivet-Duval et al., 2021; Pachoud et al., 2023), social and organizational artefacts (e.g. mind mapping) (Braun et al., 2021), ideal artefacts with symbolic representations of the territory (e.g. drawings or photomontages) (Jolivet-Duval et al., 2021; Pachoud et al., 2023). The generation of solutions can result from modeling (Barrett, 1992) or from expert knowledge elicited during facilitated workshops (Braun et al., 2021; Pachoud et al., 2023).

Practical & theoretical implications

The first version of the review framework was successfully applied to 5 articles whose content was classified into framework's categories. We will therefore carry on our exploratory review by applying the framework to a larger number of articles that cover a diversity of disciplines and approaches that contribute to the design of sustainable territories. However, we will not seek to carry out an exhaustive review. We expect that the cross-cutting analysis of a larger body of literature will help to complete and refine the outcomes of the first analysis.

Beyond the characterization of territorial design approaches provided by the cross-cutting analysis of 5 articles, this analysis also highlights blind spots. We found that the 5 articles studied did not address all the issues needed to support the territorial design of more sustainable agrifood systems. In other words, in the articles analyzed (except for Pachoud et al. (2023) territorial design does not take agricultural issues on board, and we have not identified any agricultural objects being transformed as part of the approach. For example, in those articles, agronomy is not mentioned as a discipline to be associated in the interdisciplinary process, whereas it could support the agricultural dimension of change. Also, detailed information on tools and artefacts are lacking in the 5 articles, whereas this could be very useful to undertake new action research aimed at designing more sustainable territories. We will thus endeavor to find articles from various disciplines and describing new case studies to fill the above-mentioned gaps when carrying out the overall study.

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Biodistricts: definition, functions and means for local development from a capability-based perspective

Alberto Sturla[a], Giulio Guarini[b]

[a]Council for agricultural research and Economics, Centre for policies and bioeconomy (CREA PB): alberto.sturla@crea.gov.it;

[b]University of Tuscia, Department of economics, engineering, society, business organization; giulioguarini@unitus.it

Abstract: Biodistricts are gaining momentum as feasible tools for local development. This brings to the need of harmonizing the notion of "biodistrict" so to lay solid the foundations on which building future actions. This paper interprets biodistrict at the light of industrial district theory and adopt a twofold analytical framework based on agroecology and capability approach theories in order to describe their peculiarities and roles in local development and ultimately suggesting a possible framework for their evaluation. Following a qualitative analysis, authors highlight the elements that, describe biodistricts as institutions providing factors for activating capabilities that, otherwise, couldn't be achieved. From a practical perspective, findings could be used as a basis for the evaluation of biodistrict action that takes into account common local well-being
Keywords:Agroeclogy, Capability Approach, biodistricts. Local Development

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Purpose

Biodistricts are seen as institutions capable to operationalize organic farming principles (IFOAM, 2020) for the benefit of local communities. They in fact aims at involving farmers, supply chain actors, citizens and other stakeholders in a development process grounded on the values of organic farming. Despite the great momentum they are gaining by being acknowledged by national legislations and addressing strategies in Europe and Worldwide, their role and functions in local development are yet not clear, for at least three reasons:

Their semantical connection with industrial districts implies concept of clustering of firms, activation of external economies of scale, presence of skilled labour & knowledge spillover that don't do not fully describe biodistricts, whose specificity lays on being based on certified productions and on codified set of principles.

Farming activities, being so closely linked to the territory are subject to a series of interactions with the local environment, to whose evolution they contribute, make the simple juxtaposition with the district concept not immediately applicable to biodistricts and agri-food districts in general (Franco, 2015)

Their very "bottom up" nature and their being born from grassroot initiatives have generated a wide variety of local approaches to the matter, that assign to bio districts a variety of tasks, also beyond production.

Therefore, there's the need to harmonize the notion of "biodistrict" and, therefore, of territorial approaches to organic farming in local development, so to lay solid the foundations on which building their conceptualization and for an evaluation of their action more in line with biodistricts' set of values such as wellbeing, empowerment, freedom of choice, sense of belonging.

Design/Methodology/Approach

In order to develop the analytical framework, at first biodistricts as institutional arrangements are interpreted by mean of the notions of "industrial district" and "cluster" (Marshall, 1920, Porter, 1998). Both are used to explore the characteristic of "territorial approaches to organic farming" that foster the raise of a "district atmosphere" (Marshall, 1927, p. 287), intended as a local milieux of knowledge sharing, sense of belonging, interdependencies and shared values that creates a series of industrial relationships stable over time and place (Ravix, 2020). In a word the "social capital" made of relationships, sense of common interest and connection with local community that are fundamental in realizing the economic potential of a district (Porter, 1998), so that a district could be intended as a community gathered around a productive system (Becattini, 2017), where economic relationships are embedded in local social context (Granovetter, 1985).

On a second step, in order to get to a normative description of biodistricts and their action, a twofold theoretical framework has been used. Firstly, agroecology paradigm and its principles (HLPE, 2019) have then been used to identify the elements that could include in the analysis the systemic approach to local development which is inherent to the definition of biodistrict and take into account territorial interactions of farming activities. The use of agroecological approach is backed up by the consideration that interactions between communities and local sociotechnical networks through participation, co-creation of knowledge, networking, supply chain integration (Sverrisson, 1994; Becattini, 2017), are inherent to district arrangements, although in biodistrict interactions with different landscape elements such as natural and agricultural objects also must be taken into account (Wezel et al. 2016; HLPE, 2019).

Then, a capability approach (Sen, 1999; Akire, 2005) is adopted as an unifying framework able to put together the theory behind bio districts as institutions and agroecology so to become to a sound normative analysis of biodistricts, as to pinpoint their specificities and provide for an evaluation framework that is more coherent with that conceptualization. The main assumption here is that biodistricts can provide the factors needed to activate local actors' freedom (of being and doing) that otherwise won't be achievable.

This paper relies on a qualitative analysis based on a deductive approach. On a first step literature on industrial districts and capability approach applied to food systems has been carried out, so to draft a framework functional to the description of biodistricts as institutional arrangements that allows the rise of the social and environmental factors capable of activating capabilities (table 1). Then such a framework has ben has been applied to:

documental information from biodistricts themselves (charters, websites) and grey literature (reports, case study analyses, etc...), so to describe biodistricts as institutions.

Interviews collected over the years of research on biodistricts by the Centre for Policies and Bioeconomy of the National Council for Agricultural Research and Economics. In total, 20 interviews to farmers and epresentatives of 6 biodistricts have been analysed, collected over two distinct research initiatives: the firsts on was carried out between 2018 – 2019, and the second one in 2002- 2021.

Direct open interviews with relevant actors, mostly targeted at further exploring elements emerged in the previous two steps. This last step involved 5 farmers and 1 representative of the Biodistrict of Val Camonica, whose activities aimed at recovery a supply chain for local cereal varieties (Project "*Coltivare Paesaggi Resilienti*" – "Growing Resilient Landscapes) has been taken as a case study to verify whether agroecology activates conversion factors for eliciting capabilities or not.

Table 1: conceptual framework

Institutional arrangement / **Industrial Districts Theory**	**Conversion Factors (Agroeco. principles - HLPE, 2019)**	**Related Capabilities***	
Population of firms; External economies of scale (Porter, 1998; Becattini, 2017)	Economic diversification; Fairness	Work	Access to market & Distribution
			Access to supply chain arrangements and infrastructures
			Access to financial opportunities
			Access to planning and support
Shared values; Social embeddedness (Granovetter, 1985; Becattiini, 2017)	social values and diet	Relationships	Meaningful employment
			Sense of fulfilment
			Direct relationships Producers-consumers
		Life/health/security	Cultural identity
			Access to affordable healthy food
Supportive Institutions (Porter 1998; Becattini., 2017)	Land and natural resources governance	Environment	Access to sustainably managed resources and ecosystems
	Participation	Participation/Agency	Political participation
			Activism and agency
			Autonomy in decision making
Knowledge spill-over (Marshall, 1920)	Co-creation of knowledge	Knowledge	Access to innovation
			Access to shared Knowledge

**Source: Motzer, 2019; Belda-Miquel, 2022; De Lima et al., 2023*

Therefore, this paper will get to provide a systemic and sound understanding of biodistrict as an institution for community development.

Findings

Biodistricts are bottom-up initiatives that approach local development from an holistic point of view, starting from the enhancement of local organic supply chains. Regardless of the degree of clustering of organic farms and structuring of the related industry and services already in place, biodistricts aim at shortening the distance between consumer and producers so to guarantee a higher value added to the farmer and contribute to local food sovereignty. Farmers acknowledge that Bio-district plays a key role in promoting local products, not just in terms of mere visibility but also by forging new business relationships. Some of them are just propitiated by the biodistrict (for instance by putting together local retailers and producers, by organizing Purchasing groups etc.) some others have been developed in the framework of more structured action for supply chain development, for instance by setting up logistics platforms, e-shops, traceability systems, etc. whenever the Biodistrict have got access to public funding. Consumers education and involvement in local productions, for instance through Community Supported Agriculture (CSA) schemes, training courses and information campaigns, is an integral part of the strategy for strengthening local organic agriculture and a strategy for reducing information asymmetries, so that biodistricts tasks and objectives go well beyond agricultural matters at the point of embracing cultural and societal change.

Such initiatives have the primary goal to enhance economic sustainability of small farmers, not just to make consumers and producers closer, but mainly in order to make farmers the cornerstone of an high-reputation system, where the values of the biodistricts are embedded in the whole productive system (Guareschi et al, 2023). Nevertheless, these participatory initiatives face hindrances related, for instance, to their being highly time consuming both for farmers and consumers. Also, such initiatives contains innovative elements that are not always promptly recognized by the institutions, for instance when pooling machinery is involved. Institutional support it is therefore fundamental in favouring the scaling up of grassroot initiatives. Local administrations, namely municipalities, play a fundamental role in fostering a supportive institutional environment, for instance by addressing local productions via Green Public Procurement, and local rules (on the use of chemical herbicides in public spaces, for instance). Moreover, in the setting up phases, they give agency to citizens by organizing workshops, participatory planning meetings and lately by providing structures for biodistricts social initiatives. Knowledge transfer relies essentially on tacit knowledge, often of the DUI (Doing, Using and Interacting) (Hermans, 2021) kind, although more structured initiatives have already put into place through Operational Groups or other specific financial support. biodistricts puts together farmers around shared objectives that foster knowledge spillovers as well as the creation of a local pool of contextual knowledge that is typical to each biodistrict and involves community at large by mean of Participatory Guarantee Schemes (PGS), recovery of local, traditional cuisine and awareness raising campaigns. The involvement, in the district partnership, of a scientific / consultancy partner it is strategic in order to allow that knowledge is transferred in a tailored way to small farms. These, in fact, are most often manage according to traditional techniques that, although consistent with agroecology principles, lack of understanding that the agroecological transition don’t stop s at farms gate (Dara Guccione et al, 2023).

"Growing resilient landscapes" case study has been taken as a case in point in describing Biodistrict as an institution capable of approaching local development through agroecology and therefore, activating capabilities otherwise unattainable. The Biodistrict acted as a leader of a public private partnership aimed at reactivating the supply chain for local varieties of rye. The main aim was to foster a new source of income for local farmers securing local outlets for the grain and containing production costs by pooling the machinery and favouring knowledge spillover. As a result, farmers have gained the capabilities of accessing a new market, have become furthermore independent from organic seeds for their rotations and have contributed in counteracting land abandonment. Most importantly they gained a set of relational, multi-actor capabilities and organising practices that have made them more independent from conventional supply chains thus reaching new freedom of being and doing. On the other way, consumers have been directly involved in the project from the very beginning being active and passive recipients of its initiative (e.g. They have been taught how to bake local rye, have been informed of its nutritional properties…) and have therefore gained the capability of being more autonomous in food -related decision making.

Practical Implications

The inherent characteristics of biodistricts place them outside the main category of "industrial districts" and also a step further that of "rural districts" as intended by Italian legislation. Their action goes beyond the local productive system at the point of involving local communities. This is in line with principles of agroecology and enrich the definition of district with an element that is peculiar to the biodistrict, as the role of community goes beyond being functional to the "district atmosphere" through embeddedness in the local socio-cultural and political context, to the point of acknowledging local demand for public goods (for instance: food safety, environmental conservation) so to incorporate it in development strategy and ultimately foster a set of capabilities both from producers' an local consumers' side. There's therefore the need to acknowledge such a peculiarity with feasible policies targeted at both directly and indirectly remove possible hindrances, for instance to raising consumers awareness by mean of information/dissemination campaigns or targeted to supporting or acknowledging participation in agri-food systems (e.g.: purchasing Groups, CSA, PGSs). Moreover, a novel evaluation framework it is needed to grasp such a peculiarity. This paper argues that capability approach could do the job, as it allows the assessment of district action that goes beyond the mere economic sphere, as to embrace common well-being.

Theoretical Implications

This paper aims at contributing to literature on biodistricts by suggesting that a capabilities-based approach may be best suited to describe their action, as it is more consistent with their nature as multi-actor, agroecology-based institutions. The results allows a more holistic vision of their action, since they highlight the instrumental role of the freedoms connected with the activated capabilities in contributing to the expansion of local actors' freedom in general, and thus to promoting development, in the wake of the theories elaborated by Amartya Sen (1999).

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Spatial representation of agricultural landscapes to support intersectional reflections in public spatial planning dynamics for agroecological transition

Amélie Cénet[a], Valérie Viaud[b] and Lolita Voisin[c]

[a] INRAE, UMR 1069 SAS , 35000 Rennes France, *amelie.cenet@inrae.fr*

[b] INRAE, UMR 1069 SAS , 35000 Rennes France, *valerie.viaud@inrae.fr*

[c] Université de Tours, UMR Citeres– 37000 Tours France, *lolita.voisin@insa-cvl.fr*

Abstract: Agricultural changes over the past 50 years have caused agriculture to become disconnected from rural territories. New agricultural models require considering spatial processes at a territorial scale. This reconnection of agriculture to rural territories concerns a wide range of local stakeholders. In France, local authorities in charge of territorial planning can be a relevant level at which to address agricultural transition. However, there is a lack of shared understanding of the challenges of agricultural transition issues in the sector-oriented approaches of territorial planning. To address this problem, we developed a new methodological approach based on existing landscape concepts. The approach uses a collective spatial projection process that is spatially explicit, transversal, and place-based to share territorial representations and involve a variety of stakeholders. This approach has been design and applied in France in the Urban Community of Dunkerque with urban community's stakeholders at the beginning of territorial planning processes, particularly a landscape plan design by landscape architects. A qualitative analysis highlights effects of this approach on issues concerning spatial configuration, relationship between agricultural and non-agricultural stakeholders, and potential for local authorities to support the agricultural transition. It questions the transmission of these methodological approaches and results to local stakeholders and landscape architects, and the roles of research in local dynamics for territorial and agricultural transitions.

Keywords: landscape management, spatial design, farming system, public authorities, local stakeholders, territorial planning

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Purpose

In France, as in many other Western countries, agriculture has been transformed greatly over the past 50 years leading to a loss of the connection between agriculture and rural territories (Rieutort, 2009). The current context of environmental and social changes calls for new agricultural models, such as agroecology (Altieri et al., 2017), expected to provide agricultural goods and benefits for farmers and a wide range of functions and services for society (Cairol et al., 2009). Addressing the agroecological transition requires considering farming changes at a scale larger than that of the farm (Duru et al., 2014) to involved functional interactions produced at the territorial scale (Caquet et al., 2020). To use these spatial processes the agroecological transition calls for reconnecting agriculture to rural territories (Arnauld de Sartre et al., 2019). Along with the transformation of

agriculture, rural areas have been transformed greatly due to the spread of more urban lifestyles (Prost, 1991). Farming is no longer the only activity considered for the use of space, and agriculture transformation issues concern a wide range of local stakeholders (Kristensen et al., 2022). To date, however, spatially explicit design of agroecological systems at a territorial scale and from a multi-stakeholder perspective remains rarely developed (Wezel et al., 2015).

In France, local authorities (i.e. municipalities, groups of municipalities) can be a relevant level at which to address transition at a territorial scale. Because of the gradual political decentralisation, they are now expected to develop transversal policies to plan for the ecological transition. In this context, some local authorities are showing new interest in agricultural issues and considering the agroecological transition as an important mechanism for achieving their transition objectives (Lardon, 2015). From the perspective of agronomic sciences, local authorities have also been identified as a relevant governance level at which to support the agroecological transition (Gascuel-Odoux and Magda, 2015). However, local authorities' political capacity to influence agriculture remains limited (Pahun, 2022), as they have no jurisdiction over agriculture and little experience in cross-sectional management of agricultural issues (Torre et al., 2023).

Given these observations, it appears that lack of shared understanding of the challenges of agroecological transition issues in the sector-oriented approaches of territorial planning prevent connecting and co-designing agricultural and territorial transitions (Benoit et al., 2012; Thenail et al., 2022). This context argues for a cross-sectoral vision of a territory that fully considers agriculture and is shared among a variety of stakeholders to design sustainable agroecological transitions in line with territorial transitions. To do this, we believe that new methodological approaches are needed and can be developed from multiple visions of the landscape (Pereponova et al., 2023). Spatially explicit approaches to agricultural, ecological, and environmental processes at the territorial scale are available in agri-environmental sciences to address spatial issues and interactions between farming systems and their territories. They can rely on process-based spatially explicit mathematical models and on prospective simulations of the impact of alternative landscape configurations on ecological processes (Houet and Verburg, 2022). In the field of territorial planning, landscape research and design consider the landscape as an integrative concept in order to implement collaborative approaches to designing territorial changes. It uses perceived characteristics of the landscape and powerful imagery and narratives to engage people and generate relationships and collaboration, especially in projects supported by local authorities (Follea, 2019; French ministry of ecological transition, 2023). Few studies in landscape or territorial agronomy have addressed the collaborative dimension of this approach in order to address interactions between farmers and non-agricultural stakeholders (Lardon et al., 2012; Rizzo et al., 2013), sometimes using representations of space developed by landscape architects to address agricultural issues in an accessible way (Bonin and Follea, 2018).

We assume that the implementation of new methodological approaches that are inspired by and complement existing approaches can provide a better understanding of the issues of connecting and co-designing agricultural and territorial transitions. More specifically, we aimed at identifying new and more multifunctional spatial configurations and potential for local authorities to support the agroecological transition.

Methodology

2.1 – A new methodological approach

We propose developing new methodological approaches based on a collective spatial projection process built on three dimensions: (1) spatially explicit, transversal, and place-based approach as a way to understand spatial interactions of farming systems within the local territory; ecological and biophysical processes; and housing, transportation, and leisure activities, (2) shared and accessible representation of these spatial interactions to enable multiple stakeholders to be concerned collectively, and (3) the central role of an iterative process to involve stakeholders and co-design perspectives for territorial changes. These three dimensions are considered as a methodological framework to guide the design of singular approaches adapted to the specificities of each territory.

2.2- Application of this methodological approach in the Urban Community of Dunkerque

The collective spatial projection process is currently being designed and applied to four local authorities in France. In this article, we present its application in the local authority of the Urban Community of Dunkerque (UCD), a dynamic urban territory of about 300km2, located in a coastal area in northern France (51° 02' 18" north, 2° 22' 39" east), with a population of 192 635 inhabitants. This local authority is characterised by high pressure for the use of space due the superposition of major and expanding industrial activities, further development of port activities, urban development, intensive agriculture, tourism activity, and landscape and natural protected areas. To support these multiple territorial dynamics, the urban community implements a variety of sectoral territorial plans. Agriculture is concerned in each of them to meet specific expectations, such as providing areas for urban and industrial extensions in Local Urbanism Plans, providing compensation area for renaturation projects in the local sustainable development plans, producing local food in the local food plans, ensuring ecological continuity, preserving landscapes, or hosting sustainable transport infrastructures. However, these territorial plans are currently managed separately, and with methodologies derived from urban planning, inducing little interaction with farmers and agricultural stakeholders, and low consideration of spatial configuration of farming systems. In 2021, landscape architects[5] implemented a transversal approach to design a landscape plan at the scale of UCD. To integrate the UCD's desire to develop local food production and agricultural transition, the landscape plan suggests the creation of an "Agricultural Park" on 650 ha located on the eastern edge of the town, between the coastline and natural protected areas. The design process of this plan did not explicitly consider current agricultural systems and farmers.

Our research work took place between September 2022 and January 2024 with the objective to share an understanding of agricultural transition issues with UCD's stakeholders at the beginning of territorial planning processes, particularly from the landscape plan and agricultural park project. It involved collaborations with UCD's stakeholders, especially project managers working on Local Urbanism Plans, local sustainable development plans, public land management and local food plans, who have little experience of collaborating with agricultural stakeholders.

First, we performed a joint analysis of existing farming systems' spatial configurations and of the current territorial plans' spatial boundaries, objectives and expectations for agriculture. This analysis was based on a documentary research from territorial planning documents, territorial diagnosis realized by the local agricultural authority's in 2017 and spatial information on agricultural land use. We analysed farming systems' spatial configurations, with specific attention to spatial distribution of fields, distance with farming buildings, roles of different field in crop rotations, location of upstream and downstream supply chains, land ownership, farms' temporality and projects, and hydrological and soil and climate context.

Second, we designed axonometric maps for UCD's stakeholders, who were not familiar with agricultural activity. The axonometric maps were graphically superimposed to enable different information to be read in parallel. The layers employed for the axonometric maps illustrated the analysed farming system's spatial configuration and the proposals of UCD's territorial plans. Spatial configurations of farming systems were illustrated in simple terms, and the spatial boundaries of the territorial plans were clearly described to serve as spatial references for UCD's stakeholders.

Third, we implemented an iterative action research process including phases in which spatial analyses and their representations were developed and phases in which they were discussed with UCD's stakeholders. Three workshops were organized with the UCD's stakeholders over six months: (1) the first workshop was based on a presentation of the axonometric maps and the collection of comments; (2) after the design of complementary axonometric maps integrating ideas shared during the first workshop, the second workshop aimed at sharing ideas about public action levers for agricultural transition; (3) the final workshop relied on a presentation of all the axonometric maps and enabled to generate discussion on the territorial planning process between UCD's project managers and political representatives. During these workshops, discussions were conducted openly, based on participants' spontaneous reactions to the axonometric maps.

We evaluated the results of this experiment depending on its effects on the interaction between territorial planning approach and farming systems initially observed. We considered that the new methodological approach was successful if the understanding of issues related to this interaction had evolved during the process. For that, we implemented a qualitative analysis based on the content of the methodological approach, the analysis of spatial projections, and the reactions of stakeholders involved in the process.

Findings

In the UCD, the qualitative analysis highlights effects of the collective spatial projection process on issues concerning spatial configuration, relationship between agricultural and non-agricultural stakeholders, and potential for local authorities to support the agricultural transition.

In terms of spatial configuration, the collective spatial projection process questioned the spatial scales and perimeters relevant to support agricultural transition of existing farming systems and its correspondence with spatial scales adapted to local food supply. It challenged the spatial limits of the agricultural park and enabled stakeholders to discuss about the spatial location of a variety of farming systems in relation with other territorial issues.

In terms of relationships between agricultural and non-agricultural stakeholders, the collective spatial projection process highlighted the need for the UCD's stakeholders to have a better knowledge of the current agricultural dynamics, especially those occurring at the farm scale. It

also highlighted the need to reinforce the links between the urban community and other public structures such as the coastal conservatory or the local agricultural authorities, and to encourage interactions between these different structures and between the different administrative units into the urban community.
In terms of potential for local authorities to support the agricultural transition, the collective spatial projection process raised questions about place-based public action levers depending on territorial issues and existing farming systems. In this way, it highlighted the central issue of land acquisition by public authorities. Regarding the agricultural park project, the collective spatial projection process raised questions about the positive and negative effects of this urban planning approach and of the concept of park to address agricultural changes. Lastly, concerning the regulatory approaches relating to ecological compensation for industrial development, questions were identified about the role of agriculture and food production in renaturation projects located in agricultural areas.

Practical and theoretical implications

These results showed that new methodological approaches implemented into local authorities' territorial planning approaches can be efficient to address the interaction between territorial plans and spatial configuration of farming systems. The representation of territorial and agricultural issues on the basis of their spatial configurations and their illustration with axonometric maps appeared to be graspable by the local stakeholders and usable as discussion support to highlight place-based territorial issues. The context of the UCD highlighted the importance of explicating and sharing these transversal issues at the beginning of territorial planning processes. However, the development of the collective spatial projection process in the UCD was an initial experiment and was implemented over a short period of time compared with the timescales of territorial planning process in local authorities. In addition, local political tensions between the UCD and agricultural stakeholders prevent us to include them into the process, limiting the access to detailed and place-based information on farming systems.
Our research work was included into current territorial planning processes in response to questions from the UDC's stakeholders and provided them a specific framework to work together on agricultural subjects. Developed from the work of landscape architects, this research also questioned their design process and proposals. One challenge is now to think about the transmission of these methodological approaches and results to local stakeholders and landscape architects to enable them to appropriate and adapt these approaches as part of territorial planning processes. From a research perspective, it highlights questions about the roles of research in local dynamics for territorial and agricultural transition. By integrating the multiple UDC's expectations concerning agriculture and farming systems' spatial configurations, this approach can be a way to address agroecological issues at the territorial scale.

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Dynamics and Dependencies in Regional Collaboration for Biodiversity Restoration: Reflections from the Netherlands

Sabine Baumgarten[a], Noelle Aarts[b], Jan Fliervoet[c] and Lotte Krabbenborg[d]

[a]Radboud University, Institute for Science in Society, Nijmegen, The Netherlands, sabine.baumgarten@ru.nl

[b]Radboud University, Institute for Science in Society, Nijmegen, The Netherlands, noelle.aarts@ru.nl

[c]Research group Communication, Participation & Social-Ecological Learning, Van Hall Larenstein University of Applied Sciences, Velp, The Netherlands, jan.fliervoet@hvhl.nl

[d]Radboud University, Institute for Science in Society, Nijmegen, The Netherlands, lotte.krabbenborg@ru.nl

Biodiversity restoration on a landscape level requires people with different backgrounds to connect and collaborate over an extended period of time. Hence, understanding how conservation and restoration goals are negotiated and achieved necessitates an understanding of the dynamics of the social fabric: the social networks and interactions that develop, underpin, and sustain collective action. This paper identifies patterns and factors that have contributed to constructive collaboration for biodiversity in the rural area of *Ooijpolder-Groesbeek*, which has been at the vanguard of nature and landscape development in the Netherlands. We conducted a historical analysis of the period between 1985 – 2022, based on a broad range of literature and interviews with key actors in the region. We provide a narrative account of the tipping points and the preceding processes that propelled the region to its current state. The emergence of these tipping points is analyzed through the lens of a conceptual framework on the dynamic interplay between practices, social interactions, events, and circumstances. Our findings reveal how an integrative landscape approach, the use of suitable boundary objects, and continuous network building and relation management across various levels have contributed to the success of the collective effort.
Keywords: Biodiversity restoration, Nature-inclusive agriculture, Multi-stakeholder collaboration, Collaborative governance, Self-organization, Social-ecological systems

Purpose

Sustainable nature management and conservation have become increasingly important in the light of unprecedented biodiversity loss. Much attention is put on the role of land-use and, in particular, on agricultural practices as direct drivers of biodiversity loss (IPBES, 2019). Transforming those practices presents a multi-faceted challenge due to the intertwinement of biological and social processes, spanning multiple spatial and temporal scales (Fischer et al., 2021).

It is broadly acknowledged that collaboration across organizational, geographical, and juridical scales is key to halting and reversing the loss of biodiversity. Yet, much is left to learn about the circumstances under which collaboration for biodiversity recovery lives up to its promises. According to Cockburn et al. (2018) and others (Carpenter et al., 2012; Nkhata, Breen & Freimund, 2008), there is an urgent need for contextualized, place-based research that pays attention to the temporal and social-relational dynamics as well as to the contextual processes that mediate and sustain collective action. Up until this point, only a few studies have addressed the long-term dynamics of social relationships in the context of social-ecological systems (e.g. Imperial et al., 2016; Ostrom, 1990).

With this study, we aim to deepen our understanding of how people in a local context mobilize other actors over time and across (organizational and professional) boundaries to trigger collective action for the recovery of biodiversity. We incorporate the proposal put forth by Winkelman et al. (2022) and direct analytical attention to the processes and events leading up to tipping points in nature and land use management. While our primary focus is on the relational and temporal aspects of collaboration for biodiversity recovery, we heed Ostrom's call for a configurational understanding of change processes (2007). Thus, we place special emphasis on examining the interplay of events, processes, and feedback loops that ultimately drive qualitative changes in the environment. Our primary focus centers on changes within the nature-agriculture nexus, given the significance of biodiversity recovery in this context.

Research design

The study has been conducted as part of the 'Living Lab Ooijpolder-Groesbeek' – a transdisciplinary research project funded by the Dutch Research Council (NOW) with the aim to investigate ecological and socio-economic conditions for the restoration of biodiversity in Dutch rural areas. The Ooijpolder-Groesbeek region (OG) is nationally known as an exemplary case for nature and landscape development and conservation practices. Previous studies in this area indicate that biodiversity has improved over the past decades due to local restoration initiatives and a shift towards more collaborative forms of governance (Van Bussel et al., 2020). Ecological research throughout the years also confirmed an increase in landscape and species diversity in different parts of the area (Nijssen, Remke & Versluijs, 2014). Together, these studies suggest that local initiatives in this particular region contributed to demonstrable positive outcomes for landscape biodiversity. The region has hence been designated a living laboratory to investigate the underlying processes responsible for the results obtained so far, as well as new initiatives towards consolidation and upscaling of regional successes.

Research Approach

We took the results of previous studies and the national reputation of the region as a starting point to our qualitative and exploratory study and employed a back-casting approach to reconstruct *how* local actors negotiated local restoration objectives and *how* they managed to bring about and sustain novel practices in an ever-changing context. This approach was guided by a theoretical framework which combines the concept of *tipping points* with the analytical framework by Van Woerkum, Aarts, and Van Herzele (2011) on *different sources of change*.

The notion of *tipping points* has been commonly employed in the natural sciences, and more recently in social sciences, to understand change processes in socio-ecological systems (SES) and refers to critical thresholds beyond which a system undergoes a rapid and possibly irreversible change (See Lenton et al., 2022, for a comprehensive review on different conceptualizations and applications). The concept appears particularly valuable for studying historical developments in nature and land use management as it helps to identify critical moments of transformative change and pinpoint key events and interactions.

Yet, tipping points as such are merely the result of the interplay between various variables. To unravel the preceding processes leading up to these tipping points, we utilize the analytical framework by Van Woerkum et al. (2011). Based on extensive empirical research in the context of spatial planning, environmental policy, and the management of public goods, they found that changes within these domains are the result of a continuous interplay of *three sources of change:*

(1) change driven by *events and changing circumstances* (e.g. shifts in societal values, policy changes, technological advancements, crisis) (2) change driven by *social interaction* (e.g. everyday social exchanges, the use of language, and networking) and (3) change driven by *practices* (e.g. alterations in routine activities, habits, and the execution of scripts and plans).

Data collection and Analysis

The data collection took place throughout various phases from December 2021 until June 2023. First, we built a historical profile of the study area based on secondary data, such as scientific publications, reports, minutes, policy documents, newsletters, and newspaper articles. The resulting timeline served as input for semi-structured interviews. We conducted ten in-depth interviews with key informants who were involved in the region's nature and landscape development over a long period of time. Participants were selected using snowball sampling, starting with a central, well-connected figure in the area. We intentionally included a diverse range of voices that reflected both the local community and the broader institutional context, including local and regional policy makers, conservationists, engaged farmers, and process facilitators.
The interviews were audio recorded and later transcribed. Analysis was performed using qualitative data analysis software (ATLAS.ti). We used coding in an iterative process, complementing primary data with grey literature and relevant scientific publications. We combined deductive coding using the concepts of the analytical model by Van Woerkum et al. (2011) with inductive coding, allowing for themes and links to emerge from the data. Categories were established through a process of thematization by identifying recurring tipping points and themes as well as the relations between those themes. While this approach allows for rich, qualitative insights, it also introduces the potential for researcher bias in data interpretation. To address this, we employed triangulation, using multiple data sources to validate findings, and engaged in peer discussions to challenge our interpretations, thereby striving to enhance the reliability of our analysis.

The Ooijpolder-Groesbeek region

The case study area is situated in the east of the Netherlands near the German border, with the river Waal to the north and the city of Nijmegen to the west, covering a land area of about 90 km^2 and housing about 35.000 inhabitants. Since the second half of the 20th century, the intensification of agriculture has started to threaten local flora and fauna. In the context of a broad land consolidation process in the 1980s, the increasing conflict over seemingly irreconcilable land use practices caused local actors to explore different pathways in order to halt the loss of biodiversity. Over the course of more than three decades, local farmers, conservationists, and other actors have joined forces to experiment with novel nature and landscape development and conservation practices. Nowadays, large parts of the region are characterized by a diverse landscape with polders, floodplains, grass-, and farmland, intersected by landscape and water elements such as hedges, flower-rich dikes, pollard trees, and pools, forming a green mosaic of ecological connection zones and recreational hiking paths.

Findings

The emergence of multi-stakeholder collaboration for biodiversity restoration in Ooijpolder-Groesbeek was marked by four distinct tipping points, each representing a shift in practices and stakeholder engagement:

Land Consolidation based on a 'separation of functions'

During this period, national policy changes and local land consolidation led to the spatial division of agricultural and natural areas in the region. The underlying rationale of 'separation of functions', and the associated land sparing debate, was a contentious issue for various local conservationists and farmers, prompting them to consider alternative ways forward.

Introduction of Agricultural Nature Management

The subsequent introduction of a new practice - *Agricultural Nature Management* - marked a significant shift as farmers, supported by local ecologists, began to engage in nature conservation practices on their farmland. This development blurred the previously established boundaries between agriculture and nature, making farmers key players in environmental management and landscape conservation.

Formulation of an integrative Landscape Development Plan

The third tipping point involved the participatory formulation of a *Landscape Development Plan*, which introduced an integrative approach, merging agricultural nature management with broader landscape considerations. This plan represented a significant advancement in regional policy, fostering a holistic view of land use. It was significant for embedding new practices into municipal policy.

Creating Legal and Financial Conditions for Green Service Provision

The fourth tipping point centered on establishing legal and financial frameworks for *green service provision*. This development provided farmers with long-term contracts for landscape management, ensuring financial stability and clarity for ongoing conservation efforts, thus solidifying their role in sustainable landscape stewardship.

The case study found that farmers, nature conservationists, local governments and other actors have gradually developed a collaborative and integrative approach to nature and landscape management. Central to this collaboration was the recognition of mutual dependencies —not just among the actors involved but also between local practices and wider societal changes. This necessitated a shift from a narrow focus on individual gains to a broader perspective that encompasses the social and ecological dimensions of landscape and nature management for the region as a whole. By recognizing the value of diversity and capitalizing on relationships, actors in the region effectively leveraged their resources for ecologically beneficial outcomes. Furthermore, the determination and persistence of key actors played a pivotal role in ensuring the integration of nature-inclusive practices into local structures. Over time, their long-term commitment was sustained through continuous experimentation and the implementation of small-scale projects. This iterative approach allowed actors to learn and adapt along the way. Simultaneously, they could build on incremental successes, which served as a positive feedback loop, reinforcing actors' dedication to the collective effort. The visible impact of these successes played a vital role in gaining legitimacy and attracting the interest of local politicians and policymakers, as well as financial support from various sources.

The study highlights the role of collective action frames (Benford & Snow, 2000; Dewulf et al., 2009) in aligning diverse interests and objectives and emphasizes the importance of boundary objects (Star & Griesemer, 1989), such as the *Landscape Development Plan*, as tools for collaboration across different sectors. The resilience displayed by the actors in OG can be attributed to their continuous efforts to build lasting relationships across professional and disciplinary boundaries. Moreover, the sensitivity demonstrated by the actors to broader developments (economic, juridical, policy-related) enabled them to adapt swiftly to potential threats and seize emerging

opportunities. The integrative and collaborative approach adopted by the community has been a key factor in maintaining this resilience.

Practical Implications

Based on our findings, we derive the following practical implications for practitioners involved in the design, facilitation, or governing of participatory multi-stakeholder processes for biodiversity restoration on a regional scale:

Historical awareness: Actively seek knowledge of long- and short-term historical developments and previous agreements between actor groups. A (joint) 'historical exploration' can unravel interdependencies between the actors involved and help to recognize tensions to circumvent potential pitfalls in future interactions. The process as such can be useful in fostering mutual understanding of 'how things have become'.

Working in established networks: Consider working on a local scale and with established networks to enhance collaboration, trust, and efficiency in addressing complex socio-ecological issues and to leverage existing resources, knowledge, and relationships. Acknowledge grassroots movements and community-rooted individuals who naturally assume the role of connectors, adept at fostering communication and facilitating the exchange of knowledge. We also encourage practitioners to embrace the role of boundary spanners themselves by actively seeking new connections, reaching across networks, engaging with people who think and act differently and by building sustainable relationships.

Promoting inclusivity and diversity through dialogue: Create an environment where individuals from diverse backgrounds can actively participate by facilitating open dialogue and adopting an integrative negotiation style, including joint fact-finding, the integration of different knowledge types, and concern for the actors involved. Investing in the creation of spaces and situations that encourage unscripted and informal conversations between actors holds the potential for sparking 'catalytic conversations'.

Fostering continuous experimentation and learning: Acknowledge the complex and uncertain nature of sustainability-related issues and the time it takes to achieve transformative change. Promoting an adaptive approach based on continuous experimentation, monitoring, evaluation, adjustment, and learning is crucial for exploring socio-ecological interdependencies. Celebrating and showcasing incremental and visible successes can help maintain motivation and support.

Translating complexity across actor groups: Be aware of the value of boundary objects that are being deployed in the collaborative process. Invest in communication and translation across diverse actor groups, e.g., through visualization, kitchen table conversations, or first-hand experiential learning. Identify and support individuals who can serve as 'translators', particularly in contexts that require specialized knowledge from both ecological and social domains.

Theoretical Implications

This study contributes to the literature on SES and environmental management by providing empirical evidence of effective strategies, successful collaborations, and the interplay of various factors in shaping sustainable nature and landscape management over time. We support the idea that building lasting relationships at the regional level and fostering social networks significantly enhances the ability to adapt to changing circumstances over time, foster better communication, and effectively seize windows of opportunity.

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Social farming and needs of local communities: an analysis through the Census data.

Patrizia Borsotto[a], Francesca Giarè[b]

[a]CREA – Politiche e Bioeconomia, patrizia.borsotto@crea.gov.it

[b]CREA – Politiche e Bioeconomia, francesca.giare@crea.gov.it

Abstract:
According to Italian census data, social farming (SF) comprises only 1.4% of farms engaged in related activities, despite a rise in diversification from 4.7% to 5.7% over a decade. This suggests diversification as a defining aspect of Italian agriculture, particularly in the central-northern regions. Southern Italy shows lower participation in diversification efforts, impacting farm performance stability. With 904 SF farms, comprising 0.1% of Italian agricultural holdings, Tuscany, Lombardy, Piedmont, Emilia-Romagna, and Veneto host 65% of them, showcasing an inclusive model.
This study aims to assess SF's coverage in underserved areas, analysing census and municipal fragility data from ISTAT. SF farms are evenly distributed across regions but at NUT-3 level they are more concentrated in intermediate rural areas (C) and in rural areas with development problems (D), aligning with CAP interventions. They also appear in municipalities facing high fragility, indicating their presence in areas with limited access to essential services. This suggests SF's potential to address service gaps and meet specific legal mandates, underscoring its role in rural development and social inclusion.
Keywords: spatial analysis, Italian social farming,

Purpose

Social Farming (SF) is defined as a set of practices connecting agricultural and socio-inclusion activities, or rehabilitation (both physical and psychic), re-education, or - again - recreational activities (Hassink and Van Dijk, 2006; Hine et al., 2008; Di Iacovo and O'Connor, 2009; Sempik, 2010). Considering the different purposes and activities, depending also on the different contexts in which it takes place, SF can be considered as a "concept", i.e., as something in the making, which can take new forms and develop (van Elsen, 2016) to generate benefits for the weaker segments of the population. In Italy, in the last fifteen years, it has seen considerable growth, highlighting a diversification of both experiences and proposed actors and beneficiaries, proving to be a vital and innovative field, capable of introducing new interventions in the socio-health sector (Genova, 2018; D'Angelo et al, 2022; Moretti, 2020) and new opportunities for diversification in agriculture (Dell'Olio et al., 2017; Di Iacovo, 2020; Viganò et al. 2020).
However, knowledge of the phenomenon is still partial, as there is yet no statistically homogeneous quantitative study/data collection. In Italy, some online surveys involved an interesting number of SF actors (Borsotto and Giarè, 2020; Barana et al., 2020), highlighted that Italian SF is characterized by a predominantly inclusive function (Borsotto and Giarè, 2020) and provides for the activation of socio-occupational inclusion paths including guidance and training, traineeship, and stable employment. These activities generally are part of individual projects designed and realized in collaboration with the local social and health services, to meet the needs

with a comprehensive and long-term strategy and contribute to the construction of cohesive and supportive communities, especially in areas lacking services (García-Llorente, 2016; Di Iacovo, 2020).

According to the national law on SF (141/2015), in addition to social-occupational inclusion, SF consists of three other activities: local community services; co-therapy service; educational and recreational activities for disadvantaged people and preschool children. Even in these cases, collaboration with the local public services is key to finding and implementing the best solution to face the specific identified issue. The network is the key to the success of SF and represents a challenge, mainly where there is a lack of public services and/or they have the worst performance. In this regard, a recent study on the Italian Health System (Betti et al., 2023) highlights disparities in the Prevention area, Community health services area and Hospital one, with the worst performance in the South.

Few studies on SF had a spatial approach. In England, where SF is understood to improve the quality of life for the individuals accessing care farm services, Mitchel et al. (2021) reveals spatial inequality regarding SF facilities, with more deprived northern areas are lacking in terms of services. Indeed, they are located mainly in areas that the most deprived communities will be unable to attend, due to a lack of transport or other issues. I. Recently, Tian et al. (2023) realized a comparison of SF in Japan and the Netherlands by using GIS and data from national statistics, highlighting that social farms are not evenly distributed at the regional level in both countries and are more frequently distributed in areas with abundant agricultural resources.

This work aims to verify if Italian SF covers the territories lacking services and in need of specific interventions. Therefore, a spatial analysis of SF in Italy takes into account territorial differences, including risk and marginality factors.

Design/Methodology/Approach

The study aimed to assess the spread of SF in Italy relative to the availability of social, educational, and health services across different regions. Data from the Italian Institute of Statistics (ISTAT) were utilized: the 7th General Census of Agriculture conducted in October 2020 and data relating to the Municipal Fragility Index (MFI). The census marked the first time SF information was collected as part of the data on Other Gainful Activities (OGAs) conducted by farms during the 2019-2020 agricultural year. The analysis focused on characterizing diversified farms, with specific attention to those engaged in SF and on spatial analysis that involved cross-referencing this data with the Italian typological classification of rural areas (RRN, 2020a), which categorizes regions into four areas based on EU agricultural policies: A. Urban poles; B. Rural areas with intensive and specialized agriculture; C. Intermediate rural areas; D. Rural areas with comprehensive development problems.

The MFI, defined as the susceptibility of a territory to risks of natural and anthropic origin and critical conditions associated with key demographic, social, and economic characteristics (ISTAT, 2023), offers data for 2019 at the NUT-3 level: The composite index is a combination of 12 elementary indicators that describe the main dimensions (territorial, environmental and socio-economic) of municipal fragility and the value of the MFI is expressed in deciles, where the highest indicates the greatest fragility. Due to space constraints, only two of the 12 indicators composing the MFI were selected for analysis, chosen based on their relevance to the paper's objective: the index of accessibility to essential services (AESI), which measures the degree of peripherality of territory with respect to the centres of supply of essential services, calculated as the average road travel

time to reach the nearest pole municipality, identified based on the simultaneous presence of the three essential services (education, health and mobility); the adjusted old-age dependency ratio (OADR), which is the ratio of older people (aged ≥65 years) and younger (aged ≤19 years) to working-age people (aged 20-64 years).

Findings

According to census data, in October 2020 Italy had 1,133,023 active farms, among which, 65,126 were engaged in at least one OGAs with only 1.4% (904) involved in SF (Table 1).

Table 1 Some structural features of Italian farms (Average, OIGA, SF, year 2020)

Indicator	**Total**	**OGA**	**SF**
Number of agricultural holdings	1.133.023	65.126	904
Organic farm (%)	7,6	18,8	35,4
Surface management, own propriety (%)	59,7	51,3	42,3
UAA - Arable land (%)	57,5	50,4	53,5
UAA -Orchards (%)	17,5	18,7	16,8
UAA_ Permanent meadows and pastures (%)	25	30,9	29,7
Age (average)	64,1	53,2	51,1
Male (%)	68,5	76,7	70,7
School qualification - primary school (%)	58,8	52,8	56
Digitalization farm (%)	15,8	61,7	71,5
Investiment along the last 3 years (%)	11,0	39,1	46,1
Associated with other producers (%)	17,6	28,1	30,2
Associated in network of enterprises (%)	0,9	4,1	12,7
Associated in other farms (%)	27,6	45,4	44,6
Used of third-party services (%)	27,6	31,4	33,0

Source: Adapted Gismondi, 2023

SF farms have an average UAA of just over 20 hectares, twice the national average of 11 hectares; the 35.4% practice organic farming, significantly higher than the national and OGAs averages. SF farms' agricultural land is owned by 42.3% and rented by 44.6%, while the Italian average and for multifunctional farms the land owned is the most suitable solution (59.7% and 51.3%). While the number of social farms is limited, there is variability in terms of agricultural specializations. In SF farms the coexistence of crops and livestock is significantly more common (42.2%) than the other ones (14.6%.) Regarding production type, surveyed SF farms primarily focus on arable crops (53.5%), orchards (16.8%) and permanent meadows and pastures (29,7%). Farm managers tend to be younger on average than in the national average yet similar in gender distribution and educational qualifications, with over half having attended only primary school.

The analysis reveals that SF farms engage in other related activities and invest in innovation, showcasing greater dynamism compared to others, and exhibit significantly higher levels of digitization (71.5%) compared to the average (15.8%). The characteristics of SF probably act as a driver for the alignment of the farms with the social needs and the requests of a society increasingly interested in the multifunctionality of agriculture. Additionally, networking is more prevalent in SF farms, facilitating knowledge exchange and relationship-building with other producers, enterprises, and farms. The importance of networking in the SF highlights the capacity of the agricultural sector to implement a 'new' development paradigm, which is achieved through

the creation of 'relationships' capable of bringing knowledge and innovation to companies and territories, facilitating the rural transition process rural to stimulate innovation in the welfare system (RRN, 2020b).

SF farms are in 742 municipalities (10% of Italian municipalities) (Table 2) and are spread in the national territory quite homogeneously; however, greater concentration characterizes some Regions (Toscana, Lombardia, Piemonte, Emilia-Romagna, Veneto, Sicilia, Puglia and Lazio).

According to the Italian rural area typology used in the Common Agricultural Policy (CAP), 45% of SF farms are in area C, comprising intermediate rural areas; about 32% are situated in area D, i.e. in rural areas with development problems; 20% are in rural areas of intensive agriculture (area B) and only 3% are in area A, urban and peri-urban areas (table 2). The CAP has recognised the growing significance of multifunctionality and SF in rural areas, offering several alternative options for funding SF projects by the rural development programmes (RDP). During the 2007–2013 RDP Axis 3 measures supported diversification into non-agricultural activities, basic services for rural population, and training for actors operating in the field; space was allocated for SF with sub-measure 16.9, which supports cooperation for the diversification of agriculture into social activities and sub-measure 6.4 that support investments in the creation and development of non-agricultural activities (RRN, 2023).

Table 2 Italian SF distribution for rural area typology

Rural area	**SF (n)**	**Municipality (n°)**								
		Total	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**13**
A	26	21	18	2		1				
B	180	155	136	16	2			1		
C	407	311	248	49	5	7	1			1
D	291	255	228	23	2	1			1	
Total	904	742	630	90	9	9	1	1	1	1

Source: 7th Italian Census

In conclusion, the spatial analysis shows that SF enterprises are mainly located in intermediate rural areas and rural areas with development problems but are also distributed to varying degrees in the other two areas. The inhomogeneity of distribution is also revealed by analysing by municipal fragility index (ISTAT,2023): 79% of the farms with SF have an MFI between the first and eighth percentile but 11% have an MFI of 9, i.e. they have been classified in 'highest' fragile conditions and 10% with an MFI in the last percentile are among those in 'very high' fragile conditions (Table 4). The index of accessibility to essential services indicates an average value for farms with SF of 31,05 and includes values between 21.86 and 44.14; SF farms with an MFI of 9 and 10 deviate from the average value by 30% and 40 % respectively. The adjusted old-age dependency ratio shows that in areas with 'highest' fragile conditions there are 74,12 dependent persons (younger and older population) for every 100 persons aged 20-64; the value increases to 79,90 in 'very high' fragile conditions area. In these contexts, SF can play a role in overcoming critical issues both from a farm perspective (e.g. by providing an additional source of income) and from a health/social care perspective (e.g. by providing social care facilities in rural areas). FS exploits

latent assets and resources, which are often under-utilised, in new, creative and community-beneficial ways.

Table 3 Italian SF distribution for Municipal Fragility Index (MFI). Accessibility to essential services Index (AESI), adjusted old-age dependency ratio (OADR)

MFI	Municipality (n°)	SF (n°)	AESI (average)
1,00	80	96	21,86
2,00	87	103	24,92
3,00	65	94	25,64
4,00	72	88	25,20
5,00	70	82	31,12
6,00	72	87	30,82
7,00	76	86	33,16
8,00	70	82	38,40
9,00	78	99	41,03
10,00	72	87	44,14
Total	**742**	**904**	**31,51**

Source: 7th Italian Census and Municipal Fragility Index (ISTAT)

Practical Implications

In Italy, SF is present mainly in the North, where the NHS has the best performance; these territorial disparities suggest that better planning or economic resources could play a key role in the development of new welfare strategies in the rural areas. Regarding the CAP, for instance, the use of cooperation intervention for promoting SF networks involving socio-health and social services, farms, cooperatives, and other local actors, could favor the diffusion of SF in specific territorial contexts and support the local services in their activities. At the same time, a policy mix approach, including mainly agricultural, social (FSE) and cohesive policies, could support the growth of SF experiences based on adequate structure, appropriate expertise, and effective partnerships.

Theoretical Implications

The spatial analysis offers a new point of view for studying the SF, considering different types of data, such as the accessibility of essential services and people's dependence, or the public services performance level. The limited number of SF in Italy compared to the numerosity of municipalities, however, does not allow more sophisticated statistical methods to be applied to identify explanatory factors. Therefore, the results show how the presence/lack of services and/or the difficulty in accessing them is a possible key for understanding if and in which way SF can contribute to more inclusive and cohesive communities. That suggests that, in future studies, the social capital concept could be useful to explain the development of these practices in Italy.

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Governance for sustainable transition in rural areas: investigation of document consistency

Naomi di Santo[a], Concetta Menna[b], Teresa Del Giudice[c],Roberta Sisto[d]

[a] University of Foggia, naomi.disanto@unifg.it

[b] CREA – Center of Political and Bioeconomy, Naples, concetta.menna@crea.gov.it

[c]University of Naples Federico II, teresa.delgiudice@unina.it

[d] University of Foggia, Roberta.sisto@unifg.it

Abstract: In recent years, policy priorities have increasingly focused on supporting sustainability transitions due to the various challenges faced by different sectors, such as the energy sector, the agri-food sector, and the economy. Rural areas have assumed a crucial role in this transition, gaining attention under initiatives like the "Long-Term Vision for Rural Areas" by the EU" intended to outline future rural area plans up to 2040. Given the urgency for sustainability and considering the new role of rural areas, there is a need to investigate whether policy documents at different administrative levels (e.g. the CAP National Strategic Plan and Regional Complement for Rural Development) provide essential information for developing governance supporting these territories. The focus is on Local Action Groups (LAGs), the main driving units in rural areas. Specifically, the documents investigation through a deductive analysis will focus on four document aspects: factors facilitating sustainable transition; barriers to sustainability transition; governance tools; stakeholder involvement. Investigating these aspects provides valuable implications for policymakers since this analysis represents the initial step to understanding which elements of the documents may require modification. Moreover, it establishes a foundation for future research on governance applicable to various territories, addressing diverse social and institutional challenges.

Keywords: Sustainability transition; Governance; Rural areas; Local Action Group; Document analysis; Southern Italy.

Purpose

Since the early '90s, several researchers have developed studies on the need for radical change at the socio-technical and governance levels to implement a transition towards sustainability

(Weiland, 2010). To succeed in this complex and dynamic process, governance based on a perspective that integrates various systems and dynamics is essential. This transition is also more required in Europe, where different policy documents have this topic on their agenda. For example, despite the European Green Deal aiming to promote an integrated change not only to manage climate change but also to transform land use and resource consumption, pushing towards a climate-neutral and circular economy, progress is currently too slow, with global emissions increasing and biodiversity loss persisting (Skjærseth, 2021). Specifically, to achieve the goals of the European Union, a fundamental and strategic role has been attributed to 'good governance,' which plays a strategic role in economic productivity and societal well-being. In addition, a new and crucial role has been assigned to rural areas, which are increasingly attracting interest both academically and under EU initiatives such as "Long-Term Vision for Rural Areas", intended to outline future rural area plans up to 2040. In this context, rural areas, crucial for biodiversity, require particular attention and public support to adopt sustainable solutions. However, these territories often face obstacles, with limited resources, low credit ratings, and high indebtedness. So that, inappropriate documents hinder public policies from addressing these issues. Given the urgent necessity for a shift towards sustainability and the changing role of rural areas, there is a compelling interest in examining whether different policy documents offer the essential information and key factors to support good governance in these territories. Considering the complexity of rural areas, territorial management is no longer seen as sectoral management; instead, adopting a policy mix approach is required. According to Rogge et al. (2020), the policy mix can be described by considering three key elements: i) political strategy, encompassing political objectives delineated in long-term goals and the main plans to achieve them; ii) policy tools, integrating diverse objectives and ensuring both the coherence of the policy tools employed and alignment across various policy sectors and governance levels; iii) political processes, which include, for example, planning, coordination, communication, among others, to enhance the coherence of political processes.

The study aims to verify the alignment between elements influencing good governance that emerged in the literature review and administrative documents. Specifically, it aims to identify the presence or absence of fundamental elements that form the good governance framework supporting sustainable transition.

Starting from this point, the purpose is to investigate the “Local Development Strategies” of Local Action Groups (LAGs). The decision to use LAGs as the units of study is motivated by several reasons. Firstly, these public-private partnerships significantly influence the quality and likelihood of success of local public policies. Additionally, focusing on these entities can contribute to exploring the role of new forms of governance in local contexts (Derkzen and Bock, 2009). Moreover, these groups are called upon to play a key role in developing and implementing integrated policies in rural areas. Whereas in the past, the objectives were mainly focused on aspects such as territorial animation and social inclusion, currently, LAGs can be the real supporters of the sustainability transition, managing complex situations that arise in these areas (Vávra et al., 2022).

Considering the wicked interplay of multiple sectors and technologies and the new challenges for policy and research (Ohlendorf et al., 2023), this paper not only contributes to the existing literature on rural areas but also can help bridge the knowledge gap between governance and policy mix by identifying important insights and some key parameters that can support policymakers in shaping

Design/Methodology/Approach

To achieve the paper's aim of verifying if the LAG documents encompass all elements of good governance, a preliminary step was to conduct a literature review. The working group utilized Scopus and Web of Science databases, entering keywords such as "policy mix" and "governance" into the search streak to identify key aspects that governance could include to support sustainability transition. It was chosen not to include keywords like "rural areas" or "sustainability governance" for two reasons: i) considering the topic's novelty, it was preferred not to limit the search, potentially missing important elements and ii) to test whether the linkage and conditionality to sustainability topics would emerge independently of the query used. Indeed, this would confirm the literature's assertion of the strong connection between policy mix and governance for achieving sustainable transition. The elements resulting from this review would be used as the basis for analysing the LAG documents.
In this study, a deductive analysis was chosen because it allows for verifying the alignment of documents with results from other contexts. Moreover, it is generally based on theories, conceptual models, and literature reviews. Conversely, inductive analysis could appear less appropriate because this approach provides the opportunity to explore a document and identify categories not previously established. In fact, the researcher relies on open coding, enabling them to analyse documents by creating categories and then grouping them to identify macro-codes. However, in this study, the results of the literature review were utilized.
To achieve the research objective, the Local Development Strategies for the period 2023-2027, written in Italian language, were explored from each LAG within the Campania region. This choice was driven by the region's predominantly rural nature, featuring multiple LAGs with diverse initiatives, allowing for a comprehensive gathering of varied information. Specifically, we obtained 15 documents, each corresponding to one of the 15 LAGs in the region.

Findings

Four macro aspects that support good governance were highlighted in the literature review: i) Factors aiding sustainable transition, encompassing information relating to the assessment and types of policy tools or temporal dynamics (Eckersley et al., 2022; Oberthür & Homeyer, 2023); ii) Barriers to sustainable transition, including policy flexibility and economic rationality (Öberg et al., 2018; Weitz et al., 2017); iii) Governance tools, covering economic, institutional, and soft tools(Bahn-Walkowiak & Wilts, 2017; Könnölä et al., 2021); iv) Document indications regarding stakeholder involvement(Feindt et al., 2020).
After the extrapolation of these factors that could increase good governance, the research group explored these elements on LAG documents. This comparison between literature findings and elements extracted from LAG documents are summarised in Table 1.

Table 1. Comparative Analysis of Literature Findings and LAG Document Elements

ASPECTS	LITERATURE RESULTS	FINDINGS IN LAG DOCUMENTS
Factors aiding sustainable transition	General ambition	Objective of the LAG
	Binding nature and rigour of the political framework	Extent of intervention scope

	Depth/diversity of the instruments mix	Indication of an instrument mix, including calls for proposals, public notices, and funding mechanisms.
	Extension of policy integration/ Political fragmentation	Indication of linkage with the Regional Complement for Rural Development
	Alignment of more relevant policy sectors	References to coherence with other territorial policies
	Intentional or conscious nature of policy design	/
	Types, selection, and evaluation of policy instruments	/
	Administrative dynamics	Description of the composition of the LAG administration.
	Control and longevity of municipal funding/ Temporal dynamics	Indication of the timeframe for the LAG activities.
	Substantive policy tools: regulation, expenditure, taxation, and information	References to tools mentioned in the documents or on the LAG's website
Barriers to sustainable transition	Disregard connections between sectors	References to other sectors included in the documents, such as tourism, energy, transportation, and education
	Economic rationality	Inclusion of references to program efficiency in the documents
	Unequal distribution among actors and institutions	/
	Different institutional frameworks of different sectors	/
	Lock-in	Inclusion of SWOT analysis of the reference territory in the documents
	Cultural, market, and regulatory barriers	Inclusion of SWOT analysis of the reference territory in the documents
	Policy flexibility	Reference to the chosen thematic area reflected in the regional complement
Governance tools	Mitigation tools	References to information and awareness-raising strategies
	Financial and economic tools	Description of the economic and financial capacity of the LAG
	Policy experimentation	/
	Demand analysis tools	/
	Regulatory tools	Inclusion of information regarding certifications achieved with the assistance of the LAG
	Soft tools	Description of soft tools, such as media, publications, focus groups, and the website
Stakeholder involvement.	Stakeholders involvment	Inclusion of references to stakeholder involvement in the ex-ante and in-itinere phases
	Resilience	Quote on the need to strengthen resilience in the territories

To found connections between the factors identified in the literature, the working group analyzed the descriptions or examples used to draft each element, and subsequently sought their equivalents in the LAG documents. For example, given the complexity of sustainability-related issues, two key elements that enhance the level of good governance are the "Extension of policy integration" and "Political fragmentation" (Kivimaa & Sivonen, 2021). It becomes evident that integration with other sectors, political instruments, and plans is necessary. In exploring this aspect in the LAG documents, a clear connection with Regional Support for Rural Development emerges. Moreover, many documents feature a section titled 'Complementarity and Integration with Other Territorial Policies.' In essence, this entails analyzing, highlighting, and explaining the connection between the main theme of a strategy and the thematic areas it addresses, as well as how these correlate with the specific objectives of the strategy. This analysis also considers how these objectives may align with those outlined in other territorial policies, such as Quality Agri-food Districts or the National Strategy for Inner Areas.
In addition, to identify soft tools in the documents, it was necessary to refer to examples provided in the literature, which describe them as awareness campaigns, codes of conduct, and recommendations (Lambin et al., 2020). Consequently, the documents list the tools that these groups can employ to conduct awareness campaigns or promote codes of conduct less formally. These tools include websites, social media platforms, informational meetings and seminars, local press and media, newsletters, and press releases.

Practical Implications

The results of the comparison between elements identified in the literature and those reported in various LAG documents reveal significant considerations with potential practical implications. For instance, the documents could fully articulate some important elements highlighted in the literature. A notable example is the absence of a section where the LAGs explicitly outline the various tools at their disposal, which could be integrated into their strategies. Moreover, documents could include an apparent reference to the policy design view (now there is a temporal perspective, at least from a financial standpoint, as indicated by the timeline). However, a comprehensive long-term vision still needs specific moments to evaluate and monitor policies and strategies.
Moreover, the absence of an apparent reference to sustainable transition is evident, even though it is desired at the European and national levels; such references are outside LAG documents. a comprehensive vision incorporating all these aspects, such as sustainability, still requires enhancement. This underscores the need for more effort to standardize language between academics and policymakers at different administrative levels.
It would be appropriate to incorporate missing components such as "Demand analysis tools" or "Different institutional frameworks of different sectors" and align the language with that of the European Union. To achieve this, it is essential to increase awareness and information campaigns, particularly targeting the stakeholders responsible for managing these documents.
Additionally, given the complexity of Campania as a diverse territory with various policies, enhancing and simplifying documents to improve good governance can lead to better management, especially in terms of sustainability, which is increasingly aimed in this rural area.

Theoretical Implications

The results presented in Table 1 highlight several theoretical implications. For instance, there is a need to strive for an improved common perspective. If many authors advocate for implementing policy mixes supporting sustainability transition, these can only be effectively implemented with a comprehensive perspective. Investigating these aspects provides valuable implications for policymakers, as this analysis represents the initial step toward understanding which elements of the documents may require modification. Furthermore, it can pave the way for a new evaluation approach for LAG strategies. Additionally, this study establishes a foundation for future research on governance, not limited to LAGs but adaptable to various types of territories, addressing multiple social and institutional challenges.

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LOCAL VALUE CREATION

Local development strategies in Campania's rural communities: the synergy of agri-food systems and resilience

Giuseppina Olivieri[a], Ferdinando Gandolfi[b], Fabrizio Ceglia[a], Teresa Del Giudice[a], Irene Paola Borrelli[b], Concetta Menna[c].*

[a]University of Naples - Federico II, giuseppina.olivieri@unina.it

[b]Campania Region, ferdinando.gandolfi@regione.campania.it

[b]Campania Region, irenepaolaborrelli@gmail.com

[a]University of Naples - Federico II, cegliafabrizio@gmail.com

[a]University of Naples - Federico II, teresa.delgiudice@unina.it

[c]CREA – Centre of Political and Bioeconomy, concetta.menna@crea.gov.it

* Corresponding author

Abstract
Local development is strongly interconnected with agri-food systems which play a crucial role in the resilience of rural communities. From a systemic and multidisciplinary approach perspective the implementation of local development strategies cannot ignore community participation, valorisation of tradition and culture and economic diversification with sustainable practices to preserve natural resources. Integrating sustainable agricultural systems into the framework of local development is an investment in eliminating inequalities, ensuring a sustainable future, and creating more resilient and autonomous communities. In this context the LEADER program has a strategic role in promoting the establishment of local partnerships. This study aims to analyse the local development strategies implemented in Campania region and evaluate the alignment of sustainable development model with the characteristics that define the region's identity. The results reveal that some regions exhibit comparable objectives concerning rural development strategies. The analysis provided by this study offers important policy implications as it accurately maps the current state of local development.
Keywords: local development, rural communities, multidisciplinary approaches; LEADER.

Purpose

Local rural development is a complex and multidimensional process that aims to improve quality of life in rural areas by promoting economic prosperity, environmental sustainability, and social inclusion of local community. Today's challenges call for continuous and permanent development of rural areas for current and future generations. It is therefore urgent and necessary to identify factors that drive this development and act on these to improve performance in productive and environmental terms and to engage communities in pro-active behaviour for sustainable development and innovative approach to regeneration of natural resources. EU Communication

“A long-term vision for EU rural areas: towards stronger, connected, resilient and prosperous rural areas by 2040” states that European rural areas are home to 137 million people, almost 30% of the population and more than 80 % of the territory of the EU. Rural areas are the primary source of food, contribute to the conservation of global biodiversity, provide a wide range of natural and renewable resources, are home to unique architectural and cultural heritages, offer open spaces and natural landscapes that encourage recreation of cultural traditions, local crafts, traditional agricultural practices, contributing to the cultural diversity and sense of belonging of local communities. Local community development is deeply connected with agri-food systems as vital pillars for the resilience of rural communities (Mantino and Vanni, 2018). European Union supports the development of rural areas through financial instruments aimed at promoting knowledge transfer and innovation in agriculture and forestry; enhancing the competitiveness of all types of agriculture and promoting innovative agricultural technologies and sustainable forest management; encouraging the organisation of the food chain, animal welfare and risk management in agriculture; encourage resource efficiency and the shift towards a low-carbon and climate-resilient economy in agriculture and forestry; preserve ecosystems related to agriculture and forestry. Viewing this through a systemic and multidisciplinary lens, effective implementation of tailored and effective local development strategies must embrace community engagement, appreciation of heritage and culture, and economic diversification through sustainable practices aimed at preserving natural resources. The evaluation of the LEADER approach is quite complex for several reasons, among which are its multifaceted nature and the fact that the effectiveness of the implemented interventions depends on the behaviour of multiple actors (Papadopoulou et al., 2011). In the current scientific literature studies are heterogeneous and there is no established methodology for evaluating the LEADER implementation. This is evidenced by a lack guidelines or universal methodological protocols. Existing research has addressed a range of issues related to the LEADER approach, including its practical implementation, its impact on rural development, the effectiveness of the measures adopted, and the challenges during the implementation process (Chatzichristos and Perimenis, 2022; Fernandez Portillo et al., 2019; Masot et al., 2019; Permingeat and Vanneste, 2019; Rahoveanu Adrian, 2012; Ruszkai et al., 2021). In addition, some researchers have suggested the adoption of specific conceptual frameworks or the combination of different research methodologies to assess the impact and effectiveness of the LEADER approach more comprehensively (Castro-Arce and Vanclay, 2020; Deže et al., 2023; Finta, 2022; Neumeier, 2017; Tsacheva and Zheleva, 2021). Within the framework of LEADER approach this study aims to analyse the local development strategies implemented in Campania region and evaluate the alignment of sustainable development model with the characteristics that define the region's identity.

Design/Methodology/Approach

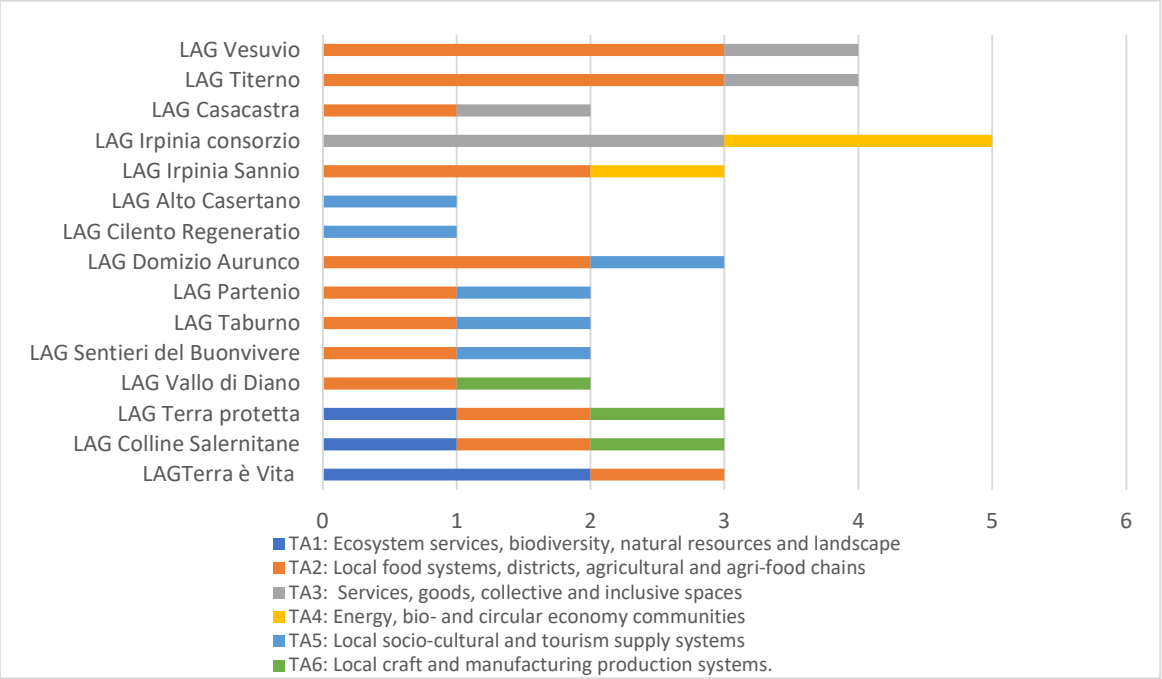
The analysis focuses on local development strategies implemented by Local Action Groups (LAGs) for the Common Agricultural Policy 2023-2027. The study area is the Campania Region, in Southern Italy. This region faces unique challenges related to its rural economy and presents unique opportunities for innovation and economic development in rural areas. In fact, the Campanian agricultural sector is characterized by a great diversity of production areas. There are areas with modern farms, cutting-edge greenhouses, and marginal areas with productions complicated by the morphological characteristics of the territory. These areas are the ones that best express the high-quality regional agricultural specificities and are most influenced by local and rural

development limits. Therefore, understanding the rural and agrifood context of Campania can provide useful insights to design policies and strategies at the national and international level. In Campania 15 LEADER areas were identified by regional authorities with the aim to maximize the socio-economic impact of the intervention. Local development strategies elaborated by LAGs will be implemented through Complex Community Projects at a later stage and must aim at a maximum of two thematic areas among six thematic areas provided by institutional bodies: ecosystem services, biodiversity, natural resources, and landscape; local food systems, districts, agricultural and agri-food chains; services, goods, collective and inclusive spaces, energy, bio-economy and circular economy communities; local socio-cultural and tourism supply systems; local craft and manufacturing production systems. For each thematic area at least, one complex community project must be drawn up by LAGs. A qualifying element of these projects is the involvement of the local community in the identification phase of the need to be met and in the project definition and implementation phase. In a preliminary phase, a qualitative content analysis was conducted on territorial development strategies of LAGs with Wordstat software to identify the main and common aspects among the strategies. Topic extraction was implemented using non-negative matrix factorisation (NNMF) that uses a matrix from a word x word correlation matrix calculated by WordStat. The segmenting option was inserted to specify that the analysis was based on cooccurrence of words in the document and. The seed was random, and the loading was a loading of 0,20, with option of topic enrichment and high default confidence level. The topic coherence measure was Normalized Pointwise Mutual Information coherence (NPMI). NPMI is a statistical measure used to quantify the degree of association between pairs of words within a text. It is derived from Pointwise Mutual Information (PMI), which measures the co-occurrence of words in a corpus compared to their individual occurrences. In the context of text analysis, NPMI is often used to measure the semantic relatedness or coherence between words or phrases within a document or corpus. Higher NPMI scores between word pairs imply stronger semantic associations, which can be indicative of cohesive text or thematic relevance.

Findings

Figure 1 shows the number of community complex projects proposed for each thematic area. Most LAGs proposed two complex community projects, one for each chosen thematic area. Only one LAG proposed 5 complex community projects, two LAG proposed 4 projects and 5 LAG proposed 3 projects.

Figure 2: Complex community projects and thematic area chosen by LAGs in Campania region



The choice of the thematic area of production chains and local food systems highlights the need for food self-sufficiency and awareness for availability, access, and use of safe, nutritious, and sufficient food to meet people's food needs in a sustainable way over time, especially in this period when geopolitical balances are being shaken by wars, disease, and adverse climatic events. Ecosystem services, biodiversity, natural resources, and landscapes are all interconnected and fundamental to human well-being and have a fundamental role in rural areas, contributing to their economic, social, and environmental well-being. The analysis of the main topics of LAGs strategies shows the main elements that led the development of the involved areas (Table 1). The topics are related to innovation, actions for cooperation, economic growth, creation of network and actions "population centered". The topic cohérence (weighted average of the correlations of words associated with the topic) of the five group is high: respectively 0.77 for innovation; 0.44 for the topic actions for innovation; 0.37 for economic growth; 0.34 for network creation; 0.29 for population centered. Innovation in agricultural production can lead to more efficient, sustainable and adaptable methods to environmental and market challenges, contributing to the economic prosperity of rural areas.

Table 1: Main topics of LAGs strategies in Campania region

Topic	**Keywords**	**Coherence (NPMI)**
Innovation	Innovative, production, services, social, system, territorial, resources, supply chain, rural, heritage, identity, population, stakeholders, circular economy, markets, farmers	0.77
Actions for cooperation	Projects, landscape, food, activities, knowledge, products, culture, farmers, communities, inclusion.	0.44

Economic growth	Process, strategy, agricultural, system, activities, networks, welfare, citizens.	0.37
Network creation	Food, landscape, resources, systems, approach, tourism, product, project, culture	0.34
Population centered	Rural, agriculture, economy, inclusion, welfare, network, communities, farmers, processes, training	0.29

Through the analysis of strategies different regional areas sharing common objectives emerged. In the inland and southern of the region, the emphasis of strategies were focused on community revitalization towards the trajectory of sustainable development. Conversely, northern areas implemented strategies focused on the promotion of territories, beginning with tourism and natural resource valorisation. Meanwhile, coastal regions predominantly addressed the innovation requirements of agricultural production.

Practical Implications

The analysis shows interesting insights for structuring future policy actions and enhancing the potential of rural areas. First of all, it is important to emphasise the holistic approach to planning rural development strategies, which aim to fully integrate the needs of today's agriculture while preparing for future agricultural challenges. This approach can be applied in similar rural contexts where attempts are made to balance present and future needs. From the analysis of the core concepts of strategies it is clear that sustainable and inclusive local development cannot disregard the valorisation of agri-food products, but it must focus on the involvement of the rural population and stakeholders external to the territories involved in the strategies for creation of human capital capable of promoting the area's culture and traditions. This concept can be applied to different agricultural contexts to make agricultural practices more sustainable and adaptable to environmental changes. The analysis of main topics shows that innovations in agriculture and services are key to promoting the economic and social development of rural areas. By creating collaborative projects and activities, new networks and systems can be created that enhance territorial resources and promote sustainability. The different objectives between the inland and coastal areas of Campania primarily are due to the geographical, socio-economic, and cultural differences that characterize these regions. The inland areas of Campania, often characterized by greater marginalization and lower population density, emphasize community regeneration. Therefore, it is crucial to focus efforts on the socio-economic regeneration of these communities through the implementation of targeted programs. The northern areas through investment in tourism infrastructure, valorisation of cultural and environmental heritage, and promotion of recreational and cultural activities, these regions can attract visitors and generate employment opportunities. In different rural contexts, it may be useful to enhance the value of agri-food products and to involve the rural population and external stakeholders in the local development process to promote their culture and traditions through agriculture and food production.

Theoretical Implications

Contemporary agriculture faces complex and ambitious challenges: uncertain markets, rising production costs and climate insecurity call for concrete actions to guide rural communities on the difficult path of transition to new forms of agriculture. To meet these challenges, improving

the resilience (Walker and Salt, 2012) of territories and communities is essential for the survival of humanity. The emphasis on innovation in agricultural production and economic growth demonstrate a good capacity to adapt to changing market conditions and environmental challenges; actions centred around the population indicate a community-based approach to resilience building; strengthening local food systems can enhance resilience to external disruptions. This results also fits into the broad framework of LEADER approach, which promotes the implementation of strategies based on local needs, cooperation and networking and integrated and multi-sectoral strategies (EU Regulation 1303/2013). A community based approach is essential to address specific challenges and achieve the goals of the local strategies to promote balanced and sustainable development. The integrated approach to the design of development strategies highlighted in the analysis actively involves agricultural producers and local communities, thus contributing to preserving rural heritage and identity. It also focuses on the economic growth and well-being of rural populations, promoting the inclusion and involvement of community through participatory processes and training programs. Furthermore, this approach supports the "twin transition" (Brunori, 2022) towards sustainable development by providing actions tailored to the specific needs of local communities and the territorial context.

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Environmental Services Markets: desectorization and segmentation of the agricultural sector

Bertille Thareau[a], Caroline Leroux[b], Alice Issanchou[c],

[a] LARESS, ESA, USC INRAE 49007, Angers, France. b.thareau@groupe-esa.com

[b] LARESS, ESA, USC INRAE 49007, Angers, France. c.leroux@groupe-esa.com

[c] SMART, INRAE UMR1302, 35011, Rennes, France. a.issanchou@gmail.com

Abstract: Considering the weakness of public policy and the demand for environmental services, the LabPSE research project group hypothesizes that private sector players are willing to pay for environmental services decoupled from consumable food products. This study analysed the way these new devices emerge. Our central hypothesis is that this emergence implies a social repositioning of farmers. Our field work consisted of 45 qualitative interviews and observations of four groups of famers who participated in a three-year experiment. Our findings are reported in a three-step process : distinction of professional groups who aim to differentiate themselves through production methods which enhance environmental services , desectorization of networks through chosen alliances in order to be recognised for their knowledge and expertise (a new mandate) and linking to institutions.
Keywords: payments for environmental services, innovation niches, device design

Context: an opportunity for farmers to market environmental services

In the past twenty years, the concept of payments for environmental services (PES) has been widely discussed (Engel et al., 2008). In France, the agroecological project launched in 2012 by the Ministry of Agriculture aligns with the European Common Agricultural Policy (CAP), recognizing agriculture's multifunctional role in food production and environmental services since Agenda 2000.

Public policy was implemented to ensure the optimal provision of these environmental public goods, such as the Agri-Environmental and Climate Measures (AECM) of the CAP. However, these policies have limits: insufficient incentives (compensation for income loss), deadweight effects (farmer already applying or having applied measures autonomously) and mixed results regarding ecosystem services provision (Le Gloux et al., 2024, Wunder et al., 2020).

Given the shortcomings of public policy and the growing demand for food production alongside ecosystem services, the LabPSE project hypothesizes that private sector entities are willing to pay for standalone environmental services.

The concept and diversity of PES are well described (Wunder et al., 2020), yet private schemes, excluding AECM or public programs and carbon markets, often remain limited in scale (Le Gloux et al., 2024). Knowledge gaps persist regarding the conditions for designing and deploying private PES.

This study aimed to trial a payment for environmental services (PES) scheme under private contracts. Employing an empirical action research approach, we observe the experiment's dynamics to understand its implications and glean insights into supporting the emergence of such PES initiatives.

The definition of payments for environmental services adhered to is that of Wunder (2005): " a voluntary transaction where a well-defined environmental service (or a land-use likely to secure that service) is being ‘bought’ by a (minimum one) environmental service buyer from a (minimum one) environmental service provider if and only if the environmental service provider secures environmental service provision (conditionality).”

Building environmental services markets for the agroecological transition: processes of professional repositioning

Conceptual framework

The construction of such environmental service markets involves designing both a service from a technical point of view, and a social and market device (Valiergue, 2021). These emerging devices are unstable socio-technical systems, and in this respect are akin to innovation niches (Geels et Schot, 2007). Our research involves following the process of emergence of these niches, with a particular focus on how farmer collectives engage in them. We adopt a sociological approach, rooted in the sociology of professions.

Within a profession, identities, as well as values and interests, are multiple. They tend to be structured and shared; coalitions develop and thrive - in opposition to others. Bucher and Strauss (1961) propose to call this process “segmentation”. It is based on singular professional situations, such as the design of environmental service markets, to give body to and claim a different way of practising agriculture, associated with privileged access to new resources. We hypothesize that the emergence of PES devices is part of a segmentation process within the agricultural profession.

In this process, we analyse more precisely the social repositionning of segments: by building a new clientele and by allying themselves with new authorities (inside or outside of the professional institutions) whose function is to guarantee farmers' ability to offer a service (Mandate) (Hughes, 1958).

Research fields and methodology

This research is based on an experiment to implement environmental markets. Since 2019, this experiment has been carried out in the west of France, where mixed farming systems dominate but where there is also a diversity of farming methods (organic, conservation agriculture, conventional, etc.) and a large number of farmers' groups. This research-action aims to help groups of local farmers experiment with private-sector PES schemes, anchored in the local area. The experiment is supported by a resource centre for agricultural and rural development. PES are seen here as an opportunity for groups of farmers to regain control over the definition of practices and systems that contribute to the agroecological transition and to lead a project to enhance the value of their activities.

In this project, four farmer groups, supported by coordinators, play a central role in developing schemes. Each group defines distinct systems, services, and partnerships. (Table 1). One of the final objectives of this project is to produce a methodological handbook so that other farmers can implement this type of PES. This handbook was developed through joint analysis and writing by researchers and the project's pilot actors (see 4. Practical involvement). Thus, for the project we carried out a survey during which we observed working meetings and conducted interviews with the project's main stakeholders (farmers and local actors involved). Over the three years of research (2019-2022), 45 meetings were observed, 21 interviews were conducted (collective and individual, with farmers and project stakeholders). To carry out our survey, we were interested in three levels of observation: problematization around the object of the PES, debates around the alliances to be built and the delimitation of the group, and enrolment around the stakeholders (Callon, 1986). We then used an inductive sociological approach to analyze the content of our observations.

Table 2 Presentation of the areas surveyed and their service offerings.

Territories	Composition of farmer groups	Other stakeholders	Service features	(Potential) buyer
Brest - Monts d'Arrée	A sheep breeder Farming method: organic - eco-pasturing on the local authority's green spaces	local authority, Environmental NGO, public institution for biodiversity conservation...	Eco-pasture: Ecological management of green spaces	The community - the project was unsuccessful
Haute Rance	Two dairy farmers Farming methods: soil conservation agriculture Belong to the equipment coop. network	hunters' federation, Environmental NGO, local public water operator, local authorities...	Agro-system: Improvement of bocage, Maintenance of functional wetlands, Soil preservation, Improvement of agroecological production system: reduction of	Potential buyer: the public water company - the project has not been completed

			phytosanitary products, soil cover, etc.	
Sud Mayenne	Four farmers Farming methods: 2 organic dairy farmers; 2 pig farmers using soil conservation agriculture Belong to two different technical networks	intercommunality, local watershed union, wood-energy cooperative, hunters' federation, Environmental NGO, Local citizen NGO	Agro-system: Improvement of bocage, Maintenance of functional wetlands, Soil preservation, Improvement of agroecological production system: reduction of phytosanitary products, soil cover, etc.	The project was unsuccessful - Group broken up
Vallée de la Seiche	6 farmers Farming methods: All livestock, 5 organics; 1 soil conservation agriculture Belong to two different technical networks	Hunters' federation, wood-energy cooperative, watershed union	Hedges: Restoring bocage continuity (green screens), Improving the ecological function of hedges	Private buyer

Results

A way of standing out from the crowd

Farmers were mobilized into groups by the project coordinator and "leader" farmers from a Living Lab. They recruited farmers known to them within agricultural networks, focusing on those with share common features, particularly in terms of production methods. Although the project aimed to promote less valued agroecological methods, most participating farmers were already certified organic.

Farmers are using this opportunity to further differentiate themselves from those who don't adopt their methods. They assert the need to position and distinguish themselves within the profession, advocating for a different approach to farming. They aim to promote a new agricultural dynamic and seek recognition for their practices and mindset. Payment for Environmental Services (PES) is viewed as a means to stand out and gain acknowledgment within the industry.

Farmers may express a desire to benefit from group diversity, but in reality, they often exclude others based on geographical area, production methods, or organic systems. Through Payment for Environmental Services (PES), farmers strive for environmental excellence, leading to ambitious specifications that could exclude some from the market. As all groups develop stringent

specifications related to practices, systems, and farm structures, questions arise about extending the approach to other farmers...

Building credibility: necessary alliances, a chosen form of desectorisation

Credible Payment for Environmental Services (PES) requires alliances and a degree of elitism in agricultural practices, often entailing distancing from traditional institutions.

Groups aim to enhance their market credibility by engaging local stakeholders, albeit under specific conditions. Discussions revolve around the alignment of players with the group project and the roles they can fulfill. For instance, in Mayenne, an environmental association and specialized technicians are involved, while in Seiche, mobilizing civil society is seen as crucial for legitimacy before approaching buyers. However, involving players like elected officials and local authorities is contentious, as it raises concerns about potential loss of control. Similar considerations arise when selecting buyers; farmers are cautious about selling PES to certain entities, particularly multinationals. Establishing these alliances raises vital questions about credibility, internal governance, and retaining control over the process.

Building PES at a distance from institutions, then moving closer to them... The disillusioned dream of the autonomous alternative

The collectives advocate for an alternative agricultural model capable of delivering credible and ambitious environmental services. This professional model is developed independently from the institutions of the socio-technical system, including local authorities, chambers of agriculture, and economic organizations in the food sector. This distancing from institutions is also manifested in an initial reluctance to adhere to regulations or labels, primarily because they perceive these as limiting their ability to design targeted practices autonomously.

The power of buyers in an incipient market

The actual sale of services in various territories has proven challenging. Five years into the project, only two contracts have been signed, with others falling through. It appears that the buyers approached hold significant arbitration power. The case of the Haute Rance region is illustrative. Farmers quickly engaged with a semi-public company responsible for supplying drinking water to the agglomeration. However, differences arose between the farmers' offer and the buyer's interests. While farmers sought to sell a bundle of services and expected recognition of their practices, the buyer aimed to restrict the contract's scope and primarily finance progress. Ultimately, agreement on price could not be reached. For the time being, farmers in this region have not been able to promote their service offering.

Getting closer to institutions at last

Along the way, local collectives encounter trials such as internal disagreements, commitment fatigue, and challenges in reaching sales targets. This prompts a reassessment of initial ambitions and the adoption of compromises. These compromises often entail a closer relationship with institutions, contrary to the distance initially sought from the socio-technical regime. Some groups, in defining specifications, eventually turn to labels. These labels, recognized by public institutions as guaranteeing environmental services, aim to enhance credibility for companies. The development of selection and control mechanisms may also rely on established rules, indicators, and mechanisms, including CAP declarations. Additionally, collectives seek methodological

support to coordinate their efforts and forge alliances. To finance this support, they access public funds and join professional federations. These ties to institutions signify a willingness to adhere to frameworks that facilitate niche emergence, limit transaction costs, and enhance recognition of their offerings to buyers.

Practical implications : a methodological handbook

The project aimed to turn findings into recommendations for emerging groups. This led to a collaborative effort between scientific and professional partners to produce a "methodological handbook" for farmer groups planning PES schemes (Bailly et al., 2022), including practical implications from our analytical results.

The first implication in this handbook concerns the initial consideration of what linking up with institutions produces and enables. Indeed, if the groups behind the schemes claim to offer an alternative to the dominant regime, they end up relying on various institutions to limit transaction costs and reinforce the credibility of their offer. From the outset, this means mapping pre-existing schemes and their proximity or distance to the group's ambition.

The second implication involves questioning the initial diversity of the collectives. Controversies often arise regarding the meaning of the schemes, which persist throughout the projects. These controversies typically revolve around two main ambitions: one seeks to recognize excellence and highlight specific features of a professional segment, while the other aims to promote broader improvements in practices within the profession. These contrasting perspectives influence decisions on technical and organizational matters, contributing to the selectivity of the system. The initial diversity of the collectives not only shapes these decisions but also impacts the scalability of the niche and its ability to connect with third parties such as buyers and institutions. Therefore, it's crucial to clarify the stakes involved in this diversity from the outset.

Finally, the ambition for autonomy claimed by the groups limits their understanding of the possible roles of third-party players. They are confined to a role of expertise, validating the service offer. However, they can take on more diversified roles: in the initial problematization, in the development of the network and access to resources. This distancing also stems from a lack of porosity between social worlds. Farmers are unfamiliar with private and local players. This calls for acculturation and intermediation. It is also a question of taking into account the interests of the parties involved in negotiating commitments and contracts, which in fact leads to a form of compromise of the initial ambition of autonomy!

Theoretical implications

Our research describes the social repositioning undertaken by groups of farmers involved in developing markets for environmental services. We can summarize these processes in three stages.

The emergence of niches relies on distinguishing from the socio-technical regime and segmenting the professional group. Claiming a technical and economic alternative, forming a cohesive group, and seeking strategic allies drive this process. While actors emphasize group autonomy, agricultural institutions play a crucial role by providing means and opportunities. This is what is at work in the allocation of public and professional funds to such action-research projects.

The second stage involves forming alliances with third parties, often selectively, and with various stakeholders playing distinct roles (Arnauld de Sartre et al., 2019). This process opens up

agricultural social realms, leading to a desectorization. Two main roles emerge: the expert, typically represented by naturalist NGOs and local authorities, who appear as new epistemic authorities intervening in the mandate of farmers' groups, and the buyer of environmental services, the ultimate arbiter of the project.

The third phase involves connecting with institutions, often discreetly but swiftly as seen in observed initiatives. In 2015, Darnhofer argued that the ability of niches to scale up depends on the development of "linking" interactions between niche and regime. We argue that niche emergence processes are also strongly related to socio-technical regimes and its institutions. This is crucial for attracting buyers and is also an economic necessity. Structuring an environmental services market entails significant transaction costs, which farmers may find challenging to bear alone. These costs, including service characterization, group facilitation, and market research, are typically covered through contracts and payments. To alleviate these initial and ongoing costs, actors often leverage existing institutions such as labels, local collectives, and associations.

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The Italian food districts as a model of transition towards a new territorial organization for local development

Lucia Briamonte[a], Teresa Del Giudice[b], Eleonora Caruso[c] and Piermichele La Sala[d]

[a]Senior researcher, CREA - Research Centre for Agricultural Policies and Bioeconomy, Roma, lucia.briamonte@crea.gov.it

[b]Full Professor in Agricultural Economics and Policy, Department of Agricultural Sciences, University of Naples Federico II, teresa.delgiudice@unina.it

[c]Master student in Agricultural Economics and Policy, Department of Agricultural Sciences, University of Naples Federico II, ele.caruso@studenti.unina.it

[d]Full Professor in Agricultural Economics and Policy, Department of Economics, University of Foggia, piermichele.lasala@unifg.it

Abstract:

Rural and local development policies require innovative tools to support economic growth, environmental protection and regeneration of local communities. In this context, where private and public partnerships become essential, food districts, regulated by Italian Law n.205/2017, may be able to promote development and networking to foster not only the market in rural areas but also improved living standards. The objective of the study is to determine and assess the requirements of food districts in relation to policies and governance models through a survey of the opinions of members of Italian districts, thus observing the structure, the type of product the district refers to, and their relationship with public institutions. The results show that districts are a potential tool for sustainable development of agrifood systems, especially if supported by research and public institutions. This study makes a contribution to the existing literature on understanding food districts and emphasizing the importance of cooperation in spatial planning in rural areas.

Keywords: Food Districts, local development, transformative policies, community, local food systems.

Purpose

Rural land is formed through the synergy between pristine natural systems, agricultural systems and communities of people who collectively help define the landscape. In these areas of extreme importance for spatial planning and the Italian production system, economic development and governance has garnered considerable interest from national and international policymakers, who have investigated various forms of planning, especially for maintaining and achieving sustainability criteria. In the Italian agricultural context, which is characterized by a highly fragmented agricultural market, cooperation agreements can be key tools for implementing economic, social and environmental development strategies. Recently, new forms of cooperation have been proposed and with Italian Law n.205 of December 27, 2017, food districts were established with the aim of providing new growth opportunities for territories and production chains. Food Districts are recognized by the Regions and autonomous Provinces; additionally, the Ministry of Agricultural Policies lists them in the National Register and encourages certain interventions—such as District Contracts—to support them.

The definition of a food district is based on the legal recognition of an agglomeration of enterprises falling within a delimited area which has been historically identified (Carillo et al., 2023). Overall, food districts identify local production systems in which agricultural and non-agricultural activities are integrated with the aim of enhancing the productions of a given area and ensuring food safety by controlling the impact the processes have on the environment. Being recent entities, there are many gaps on the degree of efficiency and impact that food districts have on territories and especially on the communities that inhabit them.
The aim of this study is to determine and evaluate the real requirements of the District Foods in relations to the policies and governance models. This information represents the knowledge foundation for defining a district model which can represent a new territorial organization active in supporting local development and capable of organizing the institutional, cultural, geographical, social, and economic aspects of the territories involved, in order to model the most suitable development trajectories. This new form of aggregation also requires new forms of representation towards regional and national public institutions. The National Food Districts Council was established in 2021 to achive this role. The study's findings also included an analysis of the districts' needs in terms of the Council's requested areas of action to support these new forms of governance in development paths.

Design/Methodology/Approach

Problem statement

Italian agri-food and rural districts have been revitalized by Italian Law 205/2017, which regulates food districts. Food Districts are recognized by the Regions and autonomous Provinces; additionally, the Ministry of Agricultural Policies lists them in the National Register and encourages certain interventions—such as District Contracts—to support them. Their objectives are to facilitate the development of improved market relations and to encourage the restructuring of the relationships amongst participants in the food supply chains. Nineteen contracts were approved by the Ministry in the first tender. There are currently 206 districts listed in the national registry, compared to 65 in 2020.The National Food Districts Council was founded in 2021 with the aim of representing the districts and contributing to the sustainable growth of the territories, protecting and enhancing the Italian cultural, landscape and food and wine heritage. The Council therefore represents the need to network between the districts —of which there are currently about 50 registered— and in relations with institutions, trade union and social representatives, committing itself to promoting development opportunities and creating synergies. In order to do this, the Coucil has inked significant agreements with national partners in the fields of innovation, finance, and research, as well as pushed initiatives throughout the country. This effort is an initial step toward increased knowledge transmission and a shared reflection on the development tactics to be employed.

Methodological approach

The study was carried out using a dual methodology, quantitative and qualitative, based on the use of a questionnaire followed by a focus group (Creswell, 2023). The choice was based on the consideration of the bias associated with the respondents' answers on personal opinions and attitudes. The focus group allowed for a broader exploration of the main themes that emerged from the questionnaire, and more specifically, the perceptions and experiences of the respondents (Adams and Cox, 2008). The study was conducted in Italy.

Therefore, the study was conducted in two phases:

1. A questionnaire on the tasks and responsibilities provided by the Council as an ecosystem of information to support the growth of the districts was distributed to district members;
2. A focus group was conducted with the Council's member districts to ascertain not only the activities and services but also the needs, perceptions, and potential development paths.

The questionnaire is divided into five sections:
asking each district about the Council's current role and activities;
listing possible activities the Council could undertake;
listing the Council's advantages and disadvantages;
listing the part districts should play in local development strategies; and
listing the ways in which the Council can assist this process.

The questionnaires were distributed online (MacElroy B. 2000) to all districts associated with the Council, achieving a response rate of 58%. The questionnaire examined the characteristics of the districts and the results arewere summarized through thematic analysis, that is, by looking at the main themes emerging from respondents' answers. The obtained results were used as baseline information within the focus groups.

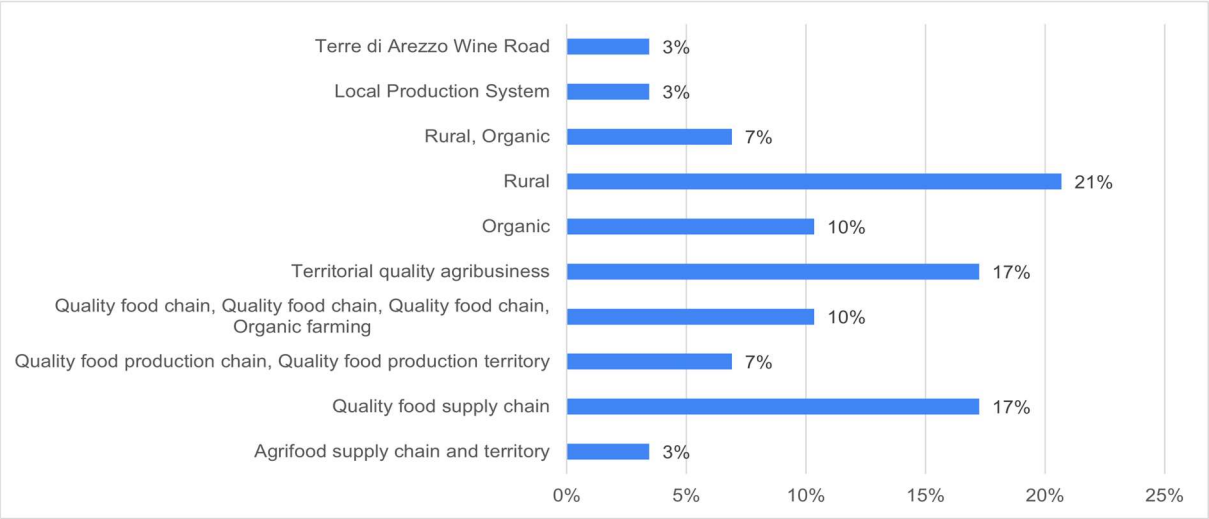
The focus group was organised in December 2023, during the General Assembly of the National Council of Food Districts. The focus group was organised by selecting 20 subjects representing districts registered with the Council and others, institutions and practitioners and researchers working on the topic. The aim of the focus group was to interpret, explore and share the results obtained through the questionnaire administration, as well as identifying future development strategies. Group interaction represented an important cognitive resource for this work (Colombo, 1997); the focus participants contributed to the co-production of the final information collected and analyzed during the focus (Acocella, 2005) and presented in this work.

Findings

The results below are divided into two sections: firstly the responses to the questionnaire and then the results of the focus group.

The survey sample consists of 29 districts from different categories, as illustrated in Fig. 1.

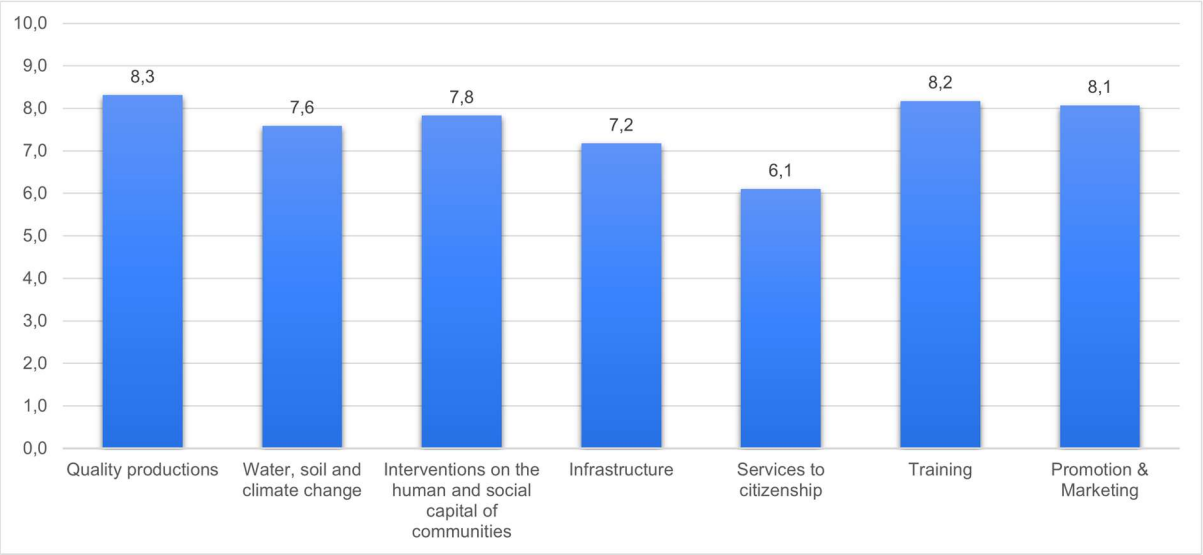
Figure 1. Districts categories



Source: Analysis of questionnaire responses

Analysis of the characteristics of the districts in the sample shows that the79% of the districts have an internal or external technical structure and 62% have legal personality. 89% of respondents had high quality productions, such as PDO, PGI, DOCG, DOC and IGT, as well as organic productions especially in the South of Italy. Participation in projets financed by national and european competitive tenders involved 65% of districts. The data reflect the characteristics of the population of the Italian food districts.The projects objectives are modernising and digitalising agricultural farms, improving training, land planning and enhancing the value of typical products.
Focusing on the districts' relations with other stakeholders, results show that the strongest relations are with public actors such as regional institution and municipalities, while those with universities and research bodies are less significant. Relations with private actors involved in local development, such as LAGs and GOs, are also less intense, although collaborations with consortia, supply chains and POs are becoming strategic. 89% of the districts are member of the National Food Districts Council and participate in the technical committee or board of directors. 58% of the respondents applied for the first Food District contract call for proposals by MASAF (Ministry of Agriculture, Food Sovereignty, and Forests). Regarding the second call promoted by Council and the Food District Table promoted by MASAF, the percentage of potential participants among the interviewed districts is 96%.
The responses to the questionnaire show a high level of intention on the part of the districts to join the new Center for the Study of Food and Rural Landscape and the School of Higher Education, rating them positively with an average score of 7.9 on a likert scale from 1 to 10. In addition, the Council memorandums of understanding with some public and private entities, such as ISMEA, CREA, UNESCO, Central Institute of Intangible Heritage, Ministry of Culture, Intesa SanPaolo and the Vodafone company, received a positive evaluation from the respondents.
The needs analysis shows that to increase technological innovation on the farm, to improve training activities and to support a better management of the territory and the production chain are the most strategic issues (Fig. 2).

Figure 2. Evaluation of areas of intervention



Source: Analysis of questionnaire responses.The results therefore show that quality production, training, promotion and marketing, and the valorisation of the territory are the areas that receive the most attention.

In general, the results of the questionnaire allowed us to identify the main challenges related to the role of food districts and, in particular, how they can be used as a tool to:
- Develop the relationship between agricultural landscape and food to protect and promote the environment, local food culture and traditions, food waste and food quality;
- Implement coordination between actors involved in local development;
- Promote networking with citizens, institutions and businesses;
- Assess the territorial governance capacity of local development.

The focus groups conducted after the questionnaires were administered were an opportunity to discuss future district development strategies through the needs analysis reconstructed from the previous interviews.

The second call for tenders on district contracts, which is anticipated in 2024, and the support role that the Council can provide for the districts in the various areas identified by the questionnaire were the main topics of discussion. This was also done in light of the experience (problems and potential) that was already accumulated with the first tender, which funded 19 districts. Among the problems that emerged from the discussion, the procedural difficulties in managing the funded resources, which jeopardise investment and contract evaluation, were highlighted. It also emerged that the greatest interest of participants in clusters is strongly linked to intangible investments such as knowledge, training, information and advice. The analysis of the results obtained from the entire survey, i.e. questionnaire and focus groups, shows that belonging to a district is an essential element for fostering innovation, both from a productive and social point of view.

Practical Implications

The results of the survey (questionnaire and focus group) highlight how the Council of Food Districts constitutes an important element of connection and governance of regional realities and an indicator of safeguarding the competitiveness of the local agri-food fabric, in the face of new and complex challenges of sustainability and food security. Indeed, in local production systems there is often a significant production force but a poor communication network between producers and between producers and institutions. Here too, the support of the Council as the representative of the districts to the institutions is relevant. Networking makes this possible:

Appreciate existing good practices;

Strengthen the planning capacity and initiative of the territories;

Setting up a system for better management of the resources available to contribute to the transition towards sustainable agri-food systems, which the institutions intend to entrust to the food districts.

Food quality and healthfulness are also influenced by the state of the landscape (sensitivity, value system awareness, ability to maintain ecosystem functions, etc.), all of which are directly related to how sustainable the whole agri-food supply chain is. Thus, food and landscape have a one-to-one link (Branduini et al., 2016; Scazzosi, 2020). According to the conducted study, the food district model presents itself as a valuable instrument and a chance to meet the agri-food system's sustainability requirements. In this direction, food districts present themselves as the ideal tool for practising participatory, shared and efficient territorial governance. In support of this, there are also numerous events organised with national and regional institutions that prove to be a positive example of promoting the territory and district policies. The presence of Food District and Council also plays a critical role in providing training and support for initiatives like the harmonization of

regional legislation, all the while taking into account the unique needs and characteristics of the constituencies and territories.

Theoretical Implications

Food Districts can constitute a form of territorial organisation of local development and governance of sustainable local food systems. If we therefore consider development as an improvement in collective well-being or quality of life, the increase in income cannot be seen as an end in itself but as a means to achieve other ends (Volpi, 2003). Territoriality is at the origin of innovation, value creation, development, consequently the governance system becomes fundamental. In this direction, the districts can stimulate the cohesion and cooperation of the small and medium-sized agricultural enterprises that are the driving force of the Italian primary sector, while at the same time offering the definition and implementation of local policies that respond to a territory's own needs and stimulate the competitiveness of the local agri-food system. In today's context, where sustainability has become a paradigm, we must not lose sight of the objectives of primary activity. In this sense, it is useful to recall the concept of the food system (Van Berkum and Al., 2018), The methodological approach is therefore related to a broad interdisciplinary conceptual framework, thus covering activities and relationships.

With the support of the Council, districts will be able to operate as an effective tool that, at the national and local levels, brings about significant change in the way agri-food systems are governed. As a result, they will be able to support the sustainable development of regions while preserving and enhancing rich cultural, natural and gastronomic heritage, thus establishing itself as an Italian best practice

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Mainstreaming circular by-product use in agriculture, forestry, food sector companies: the experiences from Baltic-Nordic region

Talis Tisenkopfs[a]

[a]Baltic Studies Centre, Kokneses prospekts 26-2, Riga LV-1014, Latvia, email address – talis.tisenkopfs@bscresearch.lv

Valorisation of by-products originating from agriculture, forestry, and food industry to derive value-added products is essential to make these sectors of bioeconomy more circular. This paper investigates the enterprise practices to mainstream the by-product use. Mainstreaming refers to integrating business practices and decisions that prioritize the reuse and repurposing of by-products within a circular economy framework. The paper is based on 12 case studies of circular businesses in Estonia, Latvia, Lithuania, and Norway of which four companies are analysed in-depth. We find that enterprises deal with two options in their reorientation towards more circular business model: to stay within the limits of existing technological and market conditions and remain a low-profile by-product operator or to reorient towards production of high value-added products from by-products through radical innovation. The latter is linked to a complex repurposing of: (i) a by-product use; (ii) a circular technology; (iii) a market for new circular products which can expand geographically and across the sectors of economy; (iv) a business model which must translate circularity in value proposition; (v) a relationship with customers. To make such transformation happen an increasing role is played by business to business, business to research and business-research-public collaboration.

Keywords: circular bioeconomy, by-products, business models, collaboration

Purpose

Valorisation of secondary bioresources (by-products, co-products) originating from agriculture, forestry and food industry to derive value-added products is essential to make these sectors of bioeconomy more circular. Studies estimate that in Baltic-Nordic region the average by-product coefficient in AFF sectors range from 0.07 to 0.57 in cereals, 0.29 – 3.57 in fruit and vegetables, 0.14 in eggs, and more than 4.0 in oils and fats (Soloha et al., 2024). Keeping these bioresources in production and consumption loops and striving for end-of-waste is key to sustainability.

This paper investigates the enterprise practices to mainstream the by-product use. A by-product is defined as an incidental product deriving from a manufacturing process or chemical reaction, and not the primary product or service being produced (European Commission, 2024). The by-products created in agricultural production may serve as a renewable source for food supplements, functional food products, and as a valuable resource in food and other industries (Faustino et al., 2019). Mainstreaming refers to integrating business practices and decisions that prioritize the reuse and repurposing of by-products within a circular economy framework. At a

company level this involves introducing circular technologies; developing new circular products; developing circular business models; adjusting upstream and downstream value chains for circular products; entering new markets; making use of financial instruments, collaborating with market and knowledge partners to become a more circular company (Carraresi and Bröring, 2022; Donner et al., 2020; Poponi et al., 2021). Although valorisation of by-products into value-added products is in line with the EU's bioeconomy strategy, at an individual company level economic and social aspects and drivers towards valorisation of by-products remain insufficiently explored (Caldeira et al., 2020).

This paper explores how by-product valorisation happens at company level. We pose two research questions: How do companies differentiate the by-product valorisation from their main product line? What adjustments in business model (in terms of value proposition, value creation, and value capture) enable by-product valorisation? An underpinning sociological interest is to understand the company practices towards mainstreaming by-product valorisation and the underpinning collaborative arrangements.

Methodology

The paper is based on the research project CIRCLE which explored circular by-product use in agriculture, forestry, aquaculture, and food sector companies in the Baltic-Nordic region countries (Latvia, Estonia, Lithuania, and Norway). In the first step, we identified 120 initiatives of circular by-product use and developed a typology of intra- and cross-sectoral and intra- and inter-organizational flows of by-products. In the second step, this typology was used to select 12 circular businesses for in-depth case analysis to explore circular by-product loops, drivers for circular applications, and business model arrangements. Several analytical dimensions were applied to explore business cases: (1) the size of enterprise, (2) type of by-product, (30 importance of by-product valorisation in company's business operation, (4) degree of innovation towards by-product valorisation (incremental and radical), and (5) collaborative arrangements supporting by-product valorisation.

Four enterprises are selected out of 12 case studies for the purpose of this paper. They include: a fruit and berries processing company upcycling berry by-product use (CS3); a larvae producer upscaling proteins from food waste (CS4); an innovative wood industry using residual wood to produce lignin and wood sugars (CS9); a food company using buckwheat hull for energy purposes and production of new consumer goods (CS11). The set of four cases covers the geographical diversity of the Baltic-Nordic region, represents companies of different size, by-product types, and by-product valorisation pathways (Table 1). The case studies were conducted between September 2022 and August 2023. Data collections methods included desk research and interviews with business managers, supply chain partners, consumers, and institutional support actors. Case study data were analysed using descriptive statistics and qualitative thematic analysis. Although case study companies have given consent to use data for research purposes in this publication company names are anonymised.

Table 1. Overview of case studies

Case study	Country	Sector	Size of enterprise	Type of by-product / waste	By-product valorisation as part of business activity	Degree of innovation	Collaborative arrangements

CS11	LT	Agriculture	Large	Buckwheat hull	Side	Incremental	Business to business Busoiness to research
CS4	NO	Food	Medium	Municipal food waste	Main	Radical	Regional and local business network for innovation and investment
CS9	EE	Forestry	Large	Residual wood biomass	Main	Radical	Strategic business alliance and network for innovation
CS3	LV	Food	Small	Berry extrusion biomass	Side	Incremental	Business to business in upstream value chain

Findings

In this section we characterise how mainstreaming of circular by-product use happens in four case study companies operating in agricultural, forestry and food sectors. Short company profiles are provided to highlight the by-product type and flows, ratio between the main products and by-products, the by-product processing technologies and new products offered, the markets for circular products, and business models supportive to commercialisation.

CS11 is a prominent groats producer in the Baltics specializing in the production of barley, wheat, pearl barley, pea groats, flakes and flour. The primary focus is on producing buckwheat groats. A part of production is organically certified. The company positions wholegrain products that advocate for healthy nutrition and wellness-oriented lifestyles. The market includes Baltic and other European countries and recently Asia (Bartkiene, 2023). CS11 represents an example of a traditional agricultural company engaging in by-product valorisation as a logical side activity. Approximately 30 % of buckwheat grains consist of hulls. Most of these by-products are utilised as a fuel source to produce steam for the subsequent production of buckwheat groats. Recently the company started to use buckwheat hulls also to produce pillows, mattresses, toys, mulch, and fertiliser to appeal to new markets and customers. However, these side activities appear to be unprofitable, and the company retains them to improve the assortment variety and communication with environmentally conscious consumers. While circular practices are integral to CS11 operations, they do not take a central place in the company's business model. The outcomes of rather proactive endeavour to offer new products produced from hull and enter new markets remain uncertain.

CS4 is a company specializing in larvae production from food waste. It is the largest company of its kind in Norway. The input bioresource is 100% food waste. CS4 is upscaling proteins from food waste in the Bergen city region to products ready for human consumption, animal feed, and organic fertilizer (bio-fertilizer). Products for human consumption include dried larvae snacks and grounded larvae as protein enrichment for baking flour. Feed products include ingredients in pet food. The production processes and products are approved and certified by the Norwegian National Food Safety Board (Brobakk, 2023). CS4 describes their production process as "no-waste" since residuals from the insect production is sold as organic fertilizer. The business model rests

upon three elements: valorization of food waste; efficient and automized production to reduce production cost; and a long-term strategy of making products for sectors and actors who are willing to pay a premium for circular goods with a low environmental footprint. These customers are both individual consumers and industrial actors. The innovation can be described as radical and the strategy towards valorisation of food waste – proactive. A comparative success of CS4 has been relying on a web of supportive arrangements – a rather diverse shareholder structure, positive attitude from local municipalities, use of funding to invest in automated production line, a strategic orientation toward and partnership with actors in emerging consumer and industrial markets of alternative proteins.

CS9 is a cutting-edge company specialising in valorisation of by-products originating from wood processing (Hiir and Värnik, 2023). It is a spin-off of one of the biggest pellet producer in Europe. A strategic decision was made by company founders to switch from pellet production for energy purposes to production of high value-added new types of biomaterials. In 2023 CS9 opened a demo plant and introduced a patented "Sunburst TM" wood fractioning technology which uses heat, pressure, and mechanical power to liquidise wood. This technology is environmentally friendlier comparing to traditional *Kraft pulping* technology. It allows to convert 90% of hardwood residues into high value bioproducts, such as lignin, wood sugars and micro-cellulose. These are intermediate biomaterials aimed for further use by industrial clients in packaging, construction, food, feed, pharmaceutical and cosmetics industries worldwide. For example, lignin can be used for production of textiles, degradable bio-packaging, 'green asphalt' to replace oil-based bitumen products, etc. The company also sells its patented technology. Promoting new bioproducts in value chains requires a lot of collaboration. CS9 collaborative arrangements include participation in Horizon Europe projects, a membership in Bio-based Industries Consortium, contracts with engineering companies and consultancies for technology development, commissioned research by universities and extensive business to business collaboration for securing investment, finance, input provision, and product marketing.

CS3 represents a company in fruit sector which practices by-product valorisation as a side activity (Žabko and Tisenkopfs, 2023). The business model is built for successful production and commercialization of main products berry juices and drinks which constitute up to 95% of total sales. By-product circulation is not at CS3 core focus. Nevertheless, the residual by-products – berry pulp and extrusion constitute approximately 10% of material output and contributes to 5% of income. The company is sensitive even to this smallest part of its output. The berry by-products are rich in minerals, vitamins, nutrients, enzymes, and other active compounds. Therefore, this biomaterial is highly demanded on global markets by pharmaceutical, cosmetics and nutraceutical industries which produce food supplements, drugs, cosmetic items, and other high value products. The company has no capacity nor plans to maximise value capture from by-products inhouse. Most of by-products are sold to pharmaceutical companies in China and there are five main buyers there. The company is operating also as an intermediary in global berry by-product supply chains as it collects, stores, and exports the extrusion from other fruit processors in Latvia too. The domestic buyers are several food companies which use the by-product ingredients as food additives and colourants. The minor part of by-products is composted for reuse in the farm or is fed to forest animals to support the local ecosystem. CS3 example suggests that there are financial, knowledge and operational barriers to start production of higher value-added products from by-products at a single company level even if such options are possible and piloted as industrial demonstrators. Therefore, CS3 opts to retain a more traditional role and reactive position

and act as supplier of by-products for more advanced markets and industries who are the main value-takers.

Practical implications

From a local community and landscape perspective our study identified several opportunities and challenges that circular companies in agriculture, forestry and food sectors experience while trying to mainstream by-product use. Territorial collaboration was observed in all four cases: CS11 as a grain processor collaborates with cereal farmers from nearby regions for input supplies; CS4 has a long term contract with municipal waste companies and offers a novel food waste utilisation option for the community; CS9 offers an outlet for residual wood utilisation for forestry companies in the region; CS3 acts as an intermediary in by-product marketing for a regional cluster of berry growers and processors.

The opportunities and challenges relate also regulative and market conditions of by-product use. The governance challenges involve the absence of official certificates recognizing circularly produced products (CS11). There are more regulations in place dealing with biowaste that with industrial by-products. Radically innovating companies may use this situation to develop their own standards and product brands in collaboration with other market partners and national certification bodies (CS4). However, it is difficult to sell circular products developed by individual companies as the consumer market is not used to branding of circular products and most consumers prioritise affordability over premium priced circularly produced organic items (CS11). The consumer markets for alternative protein products (e.g. larvae flour) are limited for social acceptance reasons (CS4). At the same time there is a rising interest among industrial buyers to switch to novel biomaterials produced from by-products to substitute fossil-based materials (CS9). In most cases we observe an increasing local and global competition for bio-residuals as more innovative circular businesses are established.

Theoretical implications

Circular companies operate in an economic, political and social context. The drivers for circular bioeconomy include not only technology, but also awareness, public and industrial acceptance, systems thinking, policy framework, sustainable production and consumption (Venkata et al., 2020). Expanding the circular by-product use in agri-food sectors is driven not only by profit or cost saving motivation. In the background of companies' decisions there are various technological, economic, social, environmental, and political drivers that inform business decisions.

Companies can have two options in their reorientation towards more considered and strategic approach towards by-product use, and both options involve reconsideration, adjustment or even change of a business model. One option is to stay within the limits of existing technological and market conditions, to continue 'business as usual', remain a 'low profile' by-product operator. For example – to continue by-product valorisation intra-business according to traditional agro-ecological practices; to engage in inter-business by-product exchange at territorial level; to enter renewable energy production from by-products; to become a supplier of raw by-products to other companies in upstream value chains who are the value creators and value takers from innovate products. The other option is to reorient a company's behaviour proactively and strategically towards production of high value-added products from by-products. This is a radical innovation path which involves further dilemmas and choices as it requires investment, technological changes, and market reorientation. This path is easier for companies who have access to financial,

intellectual, and human resources and engage in wider collaborations, such as company consortia, knowledge partnerships, and similar types of arrangements between businesses, research organisations and other parties.

The examples illustrate that in the background of companies in AFF sectors who strive to become more circular and choose a radical innovation path we can observe a complex reframing of essential things (or components of a business model): (i) a by-product which can be processed in new biomaterials; (ii) a circular technology needed for that; (iii) a market for circular products which can expand geographically, extend across sectors of bioeconomy and tap into adjacent sectors, such as construction, packaging, pharmaceutical, textile, cosmetics, nutraceutical and other industries; (iv) a business model which has to translate circularity in value proposition; (v) a relationship with customers who are still fuzzy in attitudes and behaviours towards circular products but nurture strong environmental ideals. To make such transformation happen companies do collaborate with different partners. The examples suggest that in by-product valorisation an increasing role is played by strategic alliances, business-research, and business-research-public collaboration. In addition, companies seek to embrace ethics in their business model in terms of ethicising the circular business practices and proactively disclosing good environmental intent in communication with wider society and specific customer groups.

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MIXED FARMING MODELS AND INTEGRATIVE RURAL LAND CARE

Combining metabolic and landscape approaches for agroecological transitions in cattle farming consistent with the challenges of territorial transition

Valérie Viaud[a], Claudine Thenail[b], Denis Follet[c], Olivier Godinot[a], Anne-Isabelle Graux[d] and Souhil Harchaoui[a]

[a] UMR 1069 SAS, INRAE, Institut Agro Rennes Angers 35000 Rennes, France, valerie.viaud@inrae.fr

[b] UMR 0980 BAGAP, INRAE, 35000 Rennes, France, claudine.thenail@inrae.fr

[c] Chambre Régionale d'Agriculture de Bretagne, 35000 Rennes, France, denis.follet@bretagne.chambagri.fr

[d] UMR 1348 PEGASE, INRAE, 35590 Saint-Gilles France, anne-isabelle.graux@inrae.fr

Abstract: The societal and environmental changes that have been underway for several years have recently become even more pronounced, requiring major transitions. Agriculture is challenged by this context. The demand for more sustainable agricultural systems, which reconcile natural resource management, food production and ecosystem services in the long term and under climate uncertainty is increasing. In addition, the agroecological transition of farming systems may require mobilizing several organizational or technical levers, the functional synergy of which is not obvious, and the combined implications of which at farm and territorial levels are still poorly understood. In this context, we sought to design an innovative framework for the collective co-construction, sharing and appropriation of knowledge - with farmers, planners and territorial stakeholders. Our approach is based on the combination of two complementary viewpoints on agroecology: (1) a metabolic viewpoint of farming systems based on the role of agroecological systems on nutrient, energy and matter flows; (2) a landscape viewpoint based on ecosystem services associated with the mosaic of land uses emerging from the aggregation of agroecological systems at the landscape scale. This approach is applied circularité des flux, multi-échelles, bovins, territoire, transition to the agroecological transition of cattle farming systems in Brittany (western France), and their territorial integration.
Keywords: agroecology, circularity, biodiversity, natural resources, sustainability, multiscale

1. Purpose

Today, we face fundamental sustainability challenges in a number of areas, which are particularly relevant to be addressed on a territorial scale: renewable energy production, saving non-renewable resources, relocating food production, and managing landscapes. There is also a growing demand for agriculture transition towards more sustainability, especially in livestock production. Agricultural transition can contribute to meeting the multi-dimensional and interdependent challenges of sustainability in rural territories. It requires the mobilization of several organizational or technical levers, whose functional synergy is not obvious, and whose combined implications at farm and territorial scales are still poorly understood. To achieve this, methods for assessing multi-performance of agroecological systems at the farm and territorial scales are needed, and they must be actionable by the diversity of stakeholders operating at these different scales. However, issues relating to food and biomass production and the reduction of environmental impacts (e.g. increased nutrient cycling), as well as those related to the protection of natural resources, biodiversity and the services provided by agricultural landscapes, are still mainly dealt with separately by scientists, public decision-makers, and territorial services, and on a sectoral basis.

Our research aims to design a systemic, multi-scale framework for assessing the multi-performance of agroecological systems, from the farm to the territory scale, and the possible trade-offs between the different dimensions and scales of performance. This framework should also facilitate the collective co-construction, sharing and appropriation of knowledge on agroecology - with farmers, agricultural and territorial stakeholders. This research is ongoing: in this paper, we present the principles underlying the framework and a case study.

2. Methodology

2.1 What way towards systemic and multi-scale approach to the agroecological transition?

2.1.1 Metabolic and landscape functions of agroecological systems, from the farm to the landscape and territorial scales

Agroecology takes many different forms (Doré and Besson, 2019). Two main transition pathways have been identified, and sometimes opposed both in the literature and in practice, depending on the degree of break with non-agroecological systems, the level of production, and of integration of other functions (Therond et al. 2017): (1) transition based on substitution of non-renewable resources, optimization of recycling and reuse, reduction of greenhouse gas emissions, and enhanced climate change mitigation; (2) transition based on enhancement of biological and ecosystem processes and the de-intensification of agricultural production. These transition pathways coexist in agricultural areas, and result in a diversity of agroecological systems. Taking account of the multiple functions and objectives of agroecological farming systems is an important issue, but remains a challenge, since synergies and trade-offs between production and environmental outcomes from agroecological systems are still poorly understood and largely unquantified. We hypothesize that recognizing and analyzing farming systems through the interplay between metabolic flows (nutrient, biomass, energy), land use patterns designed by farming activities, and the ecological functionality of agroecosystems, is crucial (Marrull et al., 2016).

In addition to producing agricultural goods and benefits for farmers, agroecological systems are expected to provide a wide range of functions and services for the society, which include protecting natural resources, maintaining biodiversity, protecting against risks, maintaining amenities and the quality of life (Cairol et al., 2009). Larger scales than the farm have thus to be considered for design and evaluation of agricultural systems (Caquet et al., 2020). Indeed, these ecosystem services are produced at the landscape scale (Forman 1995), where agricultural activities interact with their local environment and natural resources, and where patterns of landscape elements (e.g., arrangement and composition of land uses, of cultivated and uncultivated areas) interact with processes (e.g., nutrient cycling, hydrologic flow, ecological connectivity). This means dealing with the multidimensional and multi-scalar emergent properties of agroecosystems, when the analysis goes up from the farm to the landscape scale (Padro et al., 2020). Secondly, these services can contribute significantly to the sustainability objectives of the territory in which they are located. It requires designing high-performance, adaptive systems on a farm scale, and managing the combination of individual farming strategies to meet multiple needs and objectives on a territorial scale (Arnauld de Sartre et al., 2019). Addressing agroecological transitions over the long term calls thus for adopting multiscale approaches, specifically the scales of individual and collective management, namely the farm and territory, and the scale of the ecological and environmental processes. We suggest combining two complementary and cross-scale viewpoints on agroecology: a metabolic viewpoint of farming systems based on the role of agroecological systems on nutrient, energy and matter flows; and a landscape viewpoint based on ecosystem services associated with the landscape pattern. Such combined approach should enable identifying what agroecological synergies can be activated at the different scales, what trade-off must be addressed, and what lever must be unlocked.

2.1.2 Open-innovation research process

The need to consider farmers and local actors' knowledge in research on agroecology has long been advocated by certain authors (Lamine, 2018), in particular, the need for greater stakeholders' involvement in the development of indicators and methods for assessing the multi-performance of agricultural systems (Chopin et al., 2021).

Facing the complexity and the range of scales and processes requires the development of new systemic knowledge and sharing among the multiple stakeholders involved (e.g. farmers, local authorities, environmental managers), and calls for open innovation action-research process. Our research hypotheses are that the various stakeholders, including scientists, have very solid, knowledge and resources regarding agroecological systems. But they are heterogeneous and insufficiently integrative – e.g nutrient cycling versus connectivity for biological regulation, waste recycling and energy production versus biogeochemical cycles or landscape composition; ecological infrastructures versus cultivated plots – and often at a single scale (e.g. plot-farm versus local territory, plot versus landscape, landscape versus local territory).

2.2 Application to cattle farming in two case studies in Brittany

In a context of socio-environmental crisis and mistrust of animal products, livestock farming systems crystallize a number of criticisms (degradation of water, air and soil quality; biodiversity losses) (Herrero et al., 2015; Dumont et al., 2019). Today, maintaining livestock farming is questioned,

as well as the possibilities of moving towards more multi-performant livestock farming systems that reduces pressure on ecosystems, particularly in specialized regions. Cattle farms are particularly concerned by these issues, given their impact on GHG emissions (Martin et al., 2018); on the other hand, the agronomic and environmental benefits of these systems are also recognized when combined with adapted cropping systems (Rodriguez-Ortega et al., 2014).

Agroecological transition of livestock farming systems and their territorial integration is an acute issue in Brittany (western France). Since the 1950s, agriculture has been based on intensifying livestock, forage and vegetable production, especially dairy cattle, with farming systems embedded in industrial, globalized, and commodity-based food systems (Canevet, 1992). It produces the most livestock in France: in particular 23% of national milk production (DRAAF Bretagne, 2018). The concentration of livestock production in Brittany has resulted in strong economic and social development, but has also raised public concern about human health hazards, food security, environmental issues and the uneven distribution of the benefits of agricultural modernization and intensification.

Our research is implemented in 2 local communities in Brittany: Fougères urban area (545 km² among which 73% of agricultural area; 56000 inhabitants) and De l'Oust à Brocéliande Communauté (642 km² among which 55% of agricultural area; 39240 inhabitants). The two local communities are contrasted in terms of the importance and dynamics of cattle farming. Fougères urban area is highly specialized in dairy cattle breeding (750 farms, 42% of dairy cattle farms), and is characterized by dynamic livestock production. De l'Oust à Brocéliande is a mixed livestock production area, where cattle breeding is declining (581 farms, 26% of dairy cattle farms). In both territories, agriculture is concerned by a set of local planning instruments: Territorial Food plans for the relocation of food production, Energy-Climate territorial plans regarding energy sobriety, renewable energy production and climate change mitigation, water quality management plans, green and blue networks management plans.

At the farm scale, we review the tools developed and used by scientists and non-academic stakeholders to assess nutrient and biomass cycling, ecosystem services associated with land use and landscape features in farms. We will analyse the linkages required for a systemic approach to the metabolic and landscape functions of cattle farming systems. For the production function, indicators of yield, income, time and quality of work will be used. We will test this systemic approach on a panel of farms, which present different forage systems and mobilize a diversity of agroecological levers. Issues related to land structure and ownership play a key role in the study.

At the landscape scale, we use the concept of territorial metabolism (Barles, 2017). Indicators and forms of representation of metabolism of nutrients and biomass will be co-designed with the farmers and the other stakeholders. We will also analyse the interactions between cattle farming systems and the land, through their contribution to landscape patterns and landscape functions. To this end, changes in land management of farms (spatial and functional organization of activities) with agroecological transitions, and their impacts on landscape patterns, will be analysed (Puech et al, 2020). We will review and re-design existing indicators of landscape structure and functions to grasp causal relationships between farming system changes and ecosystems services. Knowledge and experiences of stakeholders will be expressed qualitatively, into participatory representation approaches, in order to gain a better understanding of the driving forces at play in changes in landscape and ecosystem services, from different points of view.

To identify step-by-step the potential for reconciling and complementing points of view (farm-centric vs. territory-centric, metabolism-centric vs. landscape-centric), we rely on interdisciplinary

and cross-sectoral workshops (Voinov and Bousquet, 2010). The scientific disciplines involved are agronomy, animal science, geography, environmental sciences, and ecology. These workshops will serve two purposes (Lynam et al., 2007): (1) the extraction of knowledge, values and preferences, and (2) co-learning based on a common diagnosis and synthesis.

3. Expected findings

The expected outcomes are new systemic and co-produced knowledge to enable stakeholders at different levels to apprehend the complexity of the challenges of agroecological transition, and to identify the levers and bottleneck towards interfacing the different transition objectives, from the farm to the landscape and territorial scales.

4. Practical and theoretical implications

This study will contribute to the development of farmers, agricultural and territorial stakeholders' skill with regard to complex interactions and feedbacks between farming activities, landscape spatial patterns and ecological and metabolical processes taking place over time with agroecological transition. Our research is developed and applied to cattle farming systems, but the approach is intended to be generic and applicable to other farming systems. It will contribute to the dissemination of agroecological practices, by making available a cross-sectional analysis of experiences, benchmarks on the multi-performance of agroecological systems and their contribution to territorial issues.

A major theoretical contribution of this research will be an updated, systemic and multiscale approach of the performance of agroecological systems, in a context of open innovation action-research. New assemblies of transdisciplinary knowledge, and new ways of representing them, are expected to (1) explicit the multi-level dimensions of agroecological systems, such as feedback loops across scales (farm, landscape, territory), non-linearity and emergent properties; (2) contribute to defining the conditions for multi-performance at the territorial scale; and (3) support action of the stakeholders involved in the agroecological transition and the long-term integration of agrocecological systems into multifunctional territories.

The frameworks mobilized and their interfacing are envisaged as support for dialogue that should stimulate discussion between stakeholders involved in agroecological transition or concerned by the services expected from transition. Such approach should contribute to better grasp and manage the complexities involved in transition pathways towards sustainability, in particular farmers in the design and adaptation of their systems, other agricultural stakeholders, and territorial stakeholders in the design and monitoring of transition plans. This could ultimately prefigure a multi-stakeholder organization for open innovation, and contribute to long-term support for agroecological transitions in farming and their territorial integration, based on shared steering and management methods.

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Biodistricts as a tool for facilitating agroecology through territorial rural development: a case study from a constitution process in Sicily

Martina Maurer[a], Guido Bissanti[a], Giovanni Dara Guccione[b], Giorgio Schifani[c], Giuseppina Migliore[c]

[a]*Independent researcher, Agrigento, Italy,* martinamaurer@azzalorabio.it, gubissa@gmail.com
[b]*CREA Research Centre for Agricultural Policies and Bioeconomy, Rome, Italy,* giovanni.daraguccione@crea.gov.it
[c]*Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy,* giorgio.schifani@unipa.it, giuseppina.migliore@unipa.it

Abstract: The international community recognizes the challenges facing agriculture and rural development, advocating for transformative change towards sustainable agriculture to achieve the Sustainable Development Goals. Biodistricts (BDs) offer context-specific pathways for sustainable resource management and are rooted in organic farming and agroecological practices. They represent integrated approaches to rural development, foster socio-economic regeneration, and are seen as forerunners of agroecological transition. While BDs have proliferated, legal recognition has lagged, with Italy recently passing legislation to officially recognize them. This study analyses the establishing *Valle dei Templi* Biodistrict in Sicily and its early-stage participation process. The investigation of drivers and barriers to stakeholder engagement in BD governance, together with stakeholders' perception of farm resilience and expectations regarding BD outcomes for territorial development, may inform participatory BD action plans and enhance facilitation processes. Nine main drivers and four barriers together with underlying goals and seven context-specific qualitative indicators for rural development were identified. The findings confirm the importance of investigating the BD's participation process at an early stage, suggesting the direction to follow for a community-shared sustainable development strategy and improved facilitation. This research sets the stage for broader investigations into BDs' potential to promote agroecology, organic farming, and territorial development.

Keywords: Agroecology, territorial rural management, facilitating organic farming, participative approach, multi-stakeholder network, innovative model

Purpose

The international community has recognized that agriculture and rural development are facing a series of challenges and that transformative change towards sustainable agriculture and food systems is necessary to meet the Sustainable Development Goals. Innovative approaches that protect and enhance the natural resource base are needed, for which agroecology is one example (FAO, 2017a; HLPE, 2019). Biodistricts (BDs)[6] as defined by the European Commission (2021) represent context-specific transition pathways towards sustainable management of local

[6] Action Plan for the Development of Organic Production {Swd(2021) 65 Final}, Brussels, 19.4.2021 COM(2021) 141 final/2 and the Italian Law on organic production "*Legge 9 marzo 2022, n. 23, Art. 13.*"

resources. They are an innovative example of integrated territorial development approaches and are based on a formal agreement between local stakeholders. BDs build on organic farming and agroecological best practices, contributing to the socio-economic regeneration of the territory (FAO, 2017b; Guareschi et al., 2020; Stotten et al., 2017). Indeed, BDs provide the local community with better living conditions, increase attractiveness and quality of life, and help counter rural exodus (Dias et al. 2021; Stefanovic and Agbolosoo-Mensah, 2023). The specific form of aggregation picture BDs as suitable model for scaling from practice to movement, as required by agroecology. Considering their bottom-up and holistic approach to sustainability, BDs are described as forerunners of the agroecological transition to local food systems (Dara Guccione and Sturla, 2021; FAO, 2017a; Sturla, 2019).

The first two BDs developed in Italy and France in the early 2000s. Since then, their number grew quickly, especially in Italy, but without legal recognition. The first international guidelines developed in 2015 and were redefined in 2021 by the IN.N.E.R. network (Basile et al., 2021; Sturla, 2019). In 2021 the Communication from the European Commission encouraged member states to promote BDs. This led finally to the national recognition of BDs by the Italian law on organic production (Law No. 23/2022, art. 13). Currently, Italy counts 81 registered BDs, of which six are located in Sicily region (Sturla et al., 2023). Only two studies have been carried out so far analyzing Sicilian BDs' characteristics and management (Dara Guccione and Sturla, 2021; Sturla, 2019), while little knowledge is available on drivers and barriers involving BDs' constitution process.

To overcome this gap, the current study explores the establishing *Valle dei Templi* BD in Sicily and its agroecological approach as an innovative model to foster rural development, before its legal recognition. Specifically, it reflects the participation process at its beginning stage, identifying drivers and barriers affecting the stakeholders' participation in the BD governance. This research investigates the stakeholders' perception of local farms' resilience and their expectations of possible BD services and outcomes in terms of territorial development, helping identify underlying goals. The investigation of drivers, barriers, expectations, needs, and goals at an early stage of BDs' constitution may help indicate the direction to follow for a sustainable development strategy shared within the community, as well as the participatory design of the BD's local action plan, and the improvement of the BD's facilitation process. In addition, the study seeks to generate a set of local qualitative indicators, useful for broader research, promoted by the BD's Promotion Committee to examine whether and to what extent the implementation of the BD facilitates agroecology, organic farming and the socio-economic development of the territory, for which this study is propaedeutic.

Design/Methodology/Approach

To allow a better understanding of the BD's participation process, an interdisciplinary case study approach was used combining qualitative, quantitative, and participatory methods. After a literature review on the state of the art of BD characteristics and governance in Europe, primary data was gathered during two semistructured interviews with key informants, involved in the Valle dei Templi BD creation, to understand the specific context in which the BD will operate and its priorities. After, a focus group (Krueger and Casey, 2002) discussion with six key actors of the Promotion Committee was performed to collect information on the main motivations for taking part in the BD and perceived barriers regarding the performance. The data that emerged from the focus group was integrated into the design of a structured questionnaire with 30 questions. The questionnaire, inspired by the cultural domain analysis (Bernard, 2002), was used for 19 structured

interviews. The respondents were named by the Promotion Committee through purposive sampling method representing the entire range of possible BD stakeholder groups and favoring organic farmers as main components of the BD: ten farmers, two agronomists, one tourism expert, one engineer, two representatives of food system associations and three of public institutions.
Interviews were conducted between November 2023 and January 2024 collecting qualitative and quantitative information on stakeholders' awareness of agroecology, perception of local farm resilience and opportunities of the BD, as well as data on participants' expectations regarding possible BD services, the probability of participating personally in the BD and the main interests and resistances for joining or not. The interviews were fully transcribed and then coded inductively to identify drivers, barriers, and goals. The participatory rank order method was used for quantitative data collection (Weller, 1988; Bernard, 2002) on participants' expectations regarding the BD's outcomes in terms of local territorial improvement. Participants were asked to rank order 12 possible BD outcomes from most to least favorite. Additional data on organic and agroecological farm management was gathered only from farmers with a second questionnaire. This questionnaire will be useful to have a following ex-ante evaluation of the BD governance and also to be compared to an ex-post scenario.

Findings

The BD's territory around the *Valle dei Templi* in Agrigento is characterized by traditional agriculture and covers 13 municipalities with 724 km^2. Apart from the town Agrigento, it is identified as "rural area D with development problems" (CAP Strategic Plan, 2023). Semistructured interviews revealed background information on the BD's establishment, and its set priorities which emphasize the improvement of organic farming, and in particular, the enhancement of agroecological awareness and culture as suggested by Dara Guccione and Sturla (2021) and the Sicilian law on agroecology "*Legge Regionale* n. 21/2021".
To identify the *main drivers for stakeholders' participation* we combined datasets on motivations, opportunities and resilience perception collected with the group discussion and structured interviews. Nine main drivers could be identified *(table 1*), highlighting stakeholders' need of (1) networking *(I would like to interact with other farmers and come out of my isolation, bring farmers together and share experiences, P4* (participant 4 of group discussion); *Cooperation also helps a lot in terms of time. And I suggest to involve a nursey for organic seedlings in the BD, ID1* (respondent 1 of structured questionnaire); *We should share farm workers through a network to face labor shortage*, *ID18)*, (2) environmental awareness *(I would like to produce in synergy with the environment and protect biodiversity, ID3; Improve anti-erosion measures and invest in organic matter*, *ID2)*, (3) improvement of farm economy *(With a BD maybe we could sell better and explore new markets. We need to increase selling opportunities*, *ID4)*, (4) information sharing *(Communicate the difficulties of today's agriculture, create a dialogue and let's overcome disinformation, P5; Everything starts with information, the rest develops around, like school campaigns*, *ID16)* and (5) the need of extension service *(I am looking for technical support, especially for pistachio, ID6)*. Other identified drivers are (6) territorial development *(This new model promises collective impact. It should help to protect our territory and promote cultural cohesion, P6)*, (7) innovations *(I am interested in innovative projects like renewable energy and sustainable building, ID17; innovative tourism could attract people from outside and open new markets, ID7)*, (8) farm diversification, and (9) quality of life *(Improving life quality is the most important, because only then young people will stay in our villages, ID7)*.

According to the local perception, *improving farm resilience* requires technical and commercial support, crop and farm diversification, collaboration and improvement of soil fertility *(Increase soil organic matter to combat draught, ID7; Improve soil life and organic matter to reduce hydrogeological risk*, ID8).

Furthermore, four main barriers to stakeholders' participation emerged (listed by number of mentions): conflicts through individualism, doubts on efficient structure of the BD including lack of funds and lack of people, doubts on the local collaborative capacity (Another flop, P16) and lack of personal time to invest. Our conclusion, that drivers overweigh barriers, is also reflected by respondents' assessed probability of participating personally in the BD which is 91% (mean of 19 respondents). The favorites, chosen by more than 50% respondents out of 25 possible BD services with multiple choice, are summarized in three goals (table 2).

Table 1. Drivers for stakeholders' participation with number of mentions in three datasets

Drivers	**Motivations**	**BD's opportunities**	**Improvement of farm resilience**	**Total nominations**
Networking / collaboration	14	17	6	37
Environmental awareness, soil fertility and agroecology	13	9	6	28
Improvement of farm economy	9	10		19
Information	9	9	1	19
Availability of extension service and training	7	3	9	19
Innovations	9	3	4	16
Farm diversification	3	4	6	13
Development of territory and community	5	4		9
Quality of life	6	2		8

Source: Our elaborations from direct interviews

Table 2. Respondents' favorite services to be implemented by the BD

Goals	**Favorite BD services**
Increase income through	Promotion of organic food consumption Promotion of networking Promotion of short chains (solidarity purchasing groups and canteens) Promotion of farm diversification (ecotourism, etc.) Creation of a territorial BD quality label Implementation of a cooperative processing plant for members e.g. for almond processing

Improve cropping systems through	Extension service and training on organic farming and agroecology
Increase environmental information for the public through	Training and meetings on organics and sustainable lifestyle, both in schools and with adults

Source: Our elaborations from direct interviews

Several *suggestions* on technical support and training were revealed during the interviews, emphasizing three categories: *agroecological management* like mixed cropping and soil fertility improvement, *farm diversification* like language courses for tourist accommodation and sensory analysis of extra virgin olive oil, and *marketing* like sales policies.
The five highest ranks from the rank order activity highlight *participants' expectations* regarding the BD's outcome in terms of territorial development in the next years (rank mean of 17 participants): a triple first place for "An ecological lifestyle has been promoted" together with "Quality of life has improved" and "Socio-economic conditions have improved", followed by forth "A healthy lifestyle has been promoted" and fifth place "Farms have become more resilient and more efficient".
The first three ranks describe the three dimensions of sustainability as underlying goals and hence shed light on the local sustainability perception. Combining some of the results (drivers, expectations, needs, and goals), the authors propose seven local and context-specific indicators for rural development, generated in a participatory manner: (1) quality of life, (2) ecological and healthy lifestyle, (3) enhancement of environmental awareness, (4) adoption of agroecology and innovative farming techniques, (5) improvement of socio-economic conditions, of (6) farm economy, and (7) farm resilience and efficiency.

Practical Implications

The study confirms the importance of investigating the BD's participation process at an early stage suggesting the direction to follow for a sustainable development through the identified community-based indicators for rural development. The main drivers, networking, environmental awareness and improvement of farm economy, stand for the BD's vision inspiring the strategic planning. The findings revealed a wide range of key components that can be presented to the BD's community for the integration into a participatory action plan. Picking out a few targets, the BD could start network stimulation to overcome shortage of labour and of organic seedlings, promote organic food consumption and facilitate extension service including agroecological training. Also, a territorial quality label, welcomed in this study and confirmed in other territorial contexts as characteristic feature (Triantafyllidis et al., 2019), should be implemented. This participatory planning will help to overcome the lack of strategic planning skills on the side of organic farmers which, according to Schermer and Kirchengast (2008), might impede territorial development actions and multi-sectoral cooperation. The findings on the local perception of sustainability based on underlying goals together with the insights on drivers and barriers can help improve the BD's facilitation process. Considering that facilitating collective change requires awareness of underlying goals (Will, 2023) and that agreeing collectively on what local sustainability means is halfway of getting there (Röling, 1998), these findings set the stage for a possible local agreement on sustainability to be facilitated.

The barriers identified in this study, like a missing efficient structure, lack of funds, and lack of personal time to invest in the BD's activities, are reported as well in governance research on BDs by Triantafyllidis et al. (2019), mentioning organization and fundraising as the most important snag. In addition to European funds, the recent Italian legislation on BDs introduces new possibilities of funding, explained in detail by Sturla et al. (2023), which can help to overcome these difficulties.

Theoretical Implications

Given that this research concentrates on an establishing BD, the diverse findings illustrate its possible positioning between the numerous sustainable goals. The suggestions of farmers revealed in this study show that the Valle dei Templi BD can stand up for collecting the training needs of farms advocating a more participatory approach to knowledge creation (Dara Guccione and Sturla, 2021). The BD's goal of improving organic farming in combination with agroecology, promises this BD to be a capable tool for scaling up towards agroecology as suggested by Guareschi et al. (2020). In addition, the authors expect that thanks to the initial facilitation process, the BD will be suitable as a laboratory for the agroecological transition and the transfer of refined knowledge to other territories (Vanni and Viganò, 2020). Finally, we reassume that the Valle dei Templi BD will contribute both to the territorial rural development and the agroecological transition, hence to a context-specific and adapted systemic transformation of the local food system (HLPE, 2019). In particular, through the investigation of drivers, barriers, expectations, needs, and goals, and the BD's participatory multi-stakeholder approach and facilitation process together with a community-shared local agreement on sustainability, the BD will set out the basis for balancing different interests of stakeholder groups, which is essential for harmonizing agriculture and local communities. However, good governance of the process and dialogue (Guareschi et al., 2020) are necessary to align the entire local community and to support and catalyse this ambitious transition.

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Can a community-based intervention approach support scaling at regional level? - A case study of Science and Technology Backyards in rural China

Jinghan Li[a], Nico Heerink[b], Weifeng Zhang[c] and Cees Leeuwis[d]

[a]Knowledge, technology, and innovation group, Wageningen university and research, Jinghan.li@wur.nl

[b] Development economics group, Wageningen university and research, nico.heerink@wur.nl

[c]Resource and environment management academy, China Agriculture University, wfzhang@cau.edu.cn

[d]Knowledge, technology, and innovation group, Wageningen university and research, cees.leeuwis@wur.nl

Abstract: Agricultural green transformation demands a tailored innovation intervention strategy to scale optimized technologies effectively. Science and Technology Backyards (STBs) have pioneered community-based interventions to drive farming practice changes in rural China. However, the extent to which these interventions support regional scaling remains uncertain. This study investigates a typical STB in the North China Plain to explore if and how the STB supports scaling core innovations to the regional level, and the possible factors that contribute to or constrain the scaling outcomes. Focusing on the optimized wheat nitrogen management practices in productivity-oriented (2011-2016) and greening-oriented phases (2016-2021), we employ historical event analysis to explore innovation and scaling processes. We analyse innovation packages using category and comparison analyses and illustrate support networks using network analysis. Findings indicate that the STB effectively scales innovations within the community by developing complementary packages, supported by adapted internal and well-connected external networks. However, regional scaling outcomes are suboptimal due to simplified packages and weakened networks. The study underscores the importance of enhancing supporting networks for scaling out farming practice changes, particularly green technologies, at a larger scale, emphasizing the active involvement of multiple stakeholders.

Keywords: Agricultural innovations, scaling, community-based innovation intervention, Science and Technology Backyard

1 Purpose

Excessive use of chemical fertilizers, particularly nitrogen (N) fertilizers in wheat production, poses a significant challenge to the sustainable agriculture transformation in China (Xin, 2022). Addressing this issue requires promoting site-specific N management approaches to reduce fertilizer overuse (Miao et al., 2011). However, China's top-down agricultural extension system limits the implementation of such strategies, lacking bottom-up engagement and hindering the scaling of site-specific approaches (Hu et al., 2024). Meanwhile, a community-based and locally-led approach has gained traction, emphasizing the importance of integrating local communities' priorities, knowledge, and capacities (Ayers and Forsyth, 2009). While previous studies have highlighted the benefits of community-based approaches (Forsyth, 2013), their potential for large-scale agricultural transformation remains understudied. Our research aims to assess the role and

limitations of community-based innovation in scaling farming practices from an Agricultural Innovation Systems (AIS) perspective.

To our knowledge, no study has applied an AIS perspective to the scaling potential and limitations of an innovative community-based agricultural innovation approach developed in rural China in recent years. The so-called Science and Technology Backyard (STB) approach, developed by China Agriculture University since 2009, combines traditional top-down interventions with bottom-up approaches to promote farming practices change (Zhang et al., 2016). It differs from traditional intervention tools in China in particular by site-specific customization, integration of multiple innovations, and involvement of multiple stakeholders in the innovation and scaling process (Yang et al., 2021). A recent study explored the progressive scaling out of technological innovations from pilot farms within STBs to a regional level by adapting strategies at different level (Li and Huang, 2022). It does not discuss how STBs aim to achieve large-scale scaling by considering local realities and effectively addressing the obstacles encountered during the expansion process. Scaling is inherently site-specific, making it challenging to replicate STB practices in their entirety or achieve the same outcomes even if replication is successful. Gaining insight into the dynamic processes and challenges associated with scaling the innovations developed by STB is essential.

This study aims to understand if and how the STB supports scaling core innovations from a specific community to a regional level, and the possible factors that contribute to or constrain the scaling outcomes. This understanding not only enriches our knowledge of scaling processes for community-based interventions but also equips us with the tools to refine and enhance community-based approaches for effectively supporting large-scale scaling initiatives.

2 Conceptual framework

AIS studies conceptualize innovation as the results of interactions among networks of interdependent actors and stakeholders within a socio-technical context, influenced by the rules and institutions governing their interactions (Klerkx et al., 2010). Firstly, it emphasizes that scaling is contingent upon context, defined as specific spatial and temporal context (Sartas et al., 2020), and broad policy contexts. Additionally, scaling encompasses not only individual innovations but also sets of innovations or innovation packages (Wieczorek and Hekkert, 2012; Wigboldus et al., 2016). Specifically, innovation packages comprise a combination of the core innovation and its complementary technological and non-technological innovations. To elucidate non-technological innovations, we categorize them as follows: 1) providing enabling support services (e.g., mechanical services), 2) offering economic incentives (e.g., subsidies), and 3) conducting technology extension services (e.g., lecture training or participatory learning).

Finally, the success of scaling out is contingent not only on scaling the innovation packages but also on scaling the supporting networks behind them. This supporting network encompasses i) actors (e.g., government, farmers), ii) institutions (e.g., laws, organizational methods), iii) interactions (e.g., interaction networks, individual connections), iv) infrastructure (e.g., roads, financial programs) (Wieczorek and Hekkert, 2012). These actors, institutions, and infrastructure elements are interconnected within the supporting network through interactions or linkages (Wigboldus et al., 2016). Building upon the preceding discussion, scaling initiative can be conceptualized as a continual process of developing innovation packages tailored to specific social contexts, along with the establishment of a robust supporting network to underpin them. When scaling out from a community to a broader region, it is likely that adaptation will be made to the

localized innovation packages, and this might influence scaling outcomes. Based on the conceptual framework, we reformulated the specific research question as:
How were the innovation packages developed by STB tailored to community-specific social contexts?
What elements were included in the innovation packages at community level? How have these innovation packages been adapted as they scaled from the community level to the regional level?
What changes can be observed in the underpinning supporting networks during the scaling?
What were the scaling outcomes from the community level to the regional level?

3 Methodology

This study adopt case study as the major approach. A combined dataset of qualitative data and quantitative data is applied, and then mixed approaches are employed to analyze the data.

3.1 Case introduction

A case study approach, commonly used in agricultural innovation systems research (Klerkx et al., 2010), was adopted for this study. Here, STB is defined as a community-based innovation support approach. STB staff, residing within the community for over 300 days annually, provide timely responses to farmers' needs and organize various extension services such as farmer field schools and night schools (Li and Huang, 2022). Each STB typically comprises a backyard, professionals, leading farmers, training facilities, and experimental plots (Jiao et al., 2019). By the end of 2023, China had 1183 operational STBs. This study focused on Quzhou County, a representative agricultural region located in the center of the North China Plain and the birthplace of the STB concept. Between 2009 and 2013, seven STBs were established in Quzhou County, concentrating on wheat-maize rotational farming systems. These STBs shared similar operational principles across seven communities, collaborating on agricultural knowledge sharing, farming practice optimization, and regional-level technology extension activities.
We chose Wangzhuang (WZ) STB as the focused STB to be examined for this study, since it is one of the earliest established STBs and has been continuously operating in the wheat-maize cropping system since its establishment in February 2011. WZ village also represents a typical smallholder farming community with a population of around 800 people and a cultivated area of about 200 hectares, primarily dedicated to wheat and maize cultivation. WZ STB has focused on improving local farmers' wheat nitrogen management practices in two phases: Phase I (2011-2016) aimed at enhancing yield and fertilizer use efficiency, while Phase II (2016-2021) targeted reducing fertilizer use without compromising income.

3.2 Data collection and analysis

We utilized qualitative data to extracted information about STB's scaling efforts during the period 2011-2021. Those data included first-hand interviews, and second hand materials (STB daily work documentation, MSc and PhD theses, scientific articles and online news reports). We applied historical events analysis, commonly used to describe the innovation process (Klerkx et al., 2010), to describe the development of the innovation packages, and then demonstrated the elements of the innovation packages and its adaptation from community level to regional level by qualitative category analysis and comparison analysis. Network analysis was applied to examine the differences in underpinned supporting networks from community level to regional level. Then we

use quantitative data, mainly adoption rates of different groups, to evaluate the difference in scaling outcomes. Those data included second data from STB students thesis and publications, and first hand questionnaire survey.

4. Findings

Our findings indicate that innovation packages localized for the community level undergo an adaptation when scaling out to the regional level, observed in both Phase I and Phase II (Fig.2). This adaptation is mainly manifested in the simplification of complete innovation packages, which is reflected in the reduction of the number and the loss of diversity of elements. The absent of participatory learning and interactive communication tools at the regional level in both phases was obviously in two phases. As innovation packages have been simplified from STB experimental farmers to the entire county, the scaling outcomes have also weakened, evident in the decreasing trend of technology adoption rates for STB's optimized nitrogen strategies in both Phase I and Phase II.

The further network analysis showed that STB communities were supported by well-organized supporting networks in both phases. These networks facilitated the implementation of complete innovation packages within the STB community, allowing STB farmers to easily access information, knowledge, services, and infrastructures related to optimized N strategies and finally facilitating the adoption of optimized N strategies by STB farmers. However, these supporting networks beyond the STB communities weakened in both phases, hindering the scaling of innovation packages and ultimately resulting in inefficient scaling outcomes at the regional level. The weakened networks can also be perceived as a lack of participation from stakeholders (both human and non-human) beyond the community level. In addition, the weakened supporting networks were further linked with the absence of the 1) effective interaction networks for non-STB communities, 2) strong intermediation actors at non-STB communities, and 3) formal institutions at the regional level. These issues entwined together, hindering the complete scaling of the innovation packages developed by STB.

Figure 1. Community-level innovation packages developed by STB in two phases.

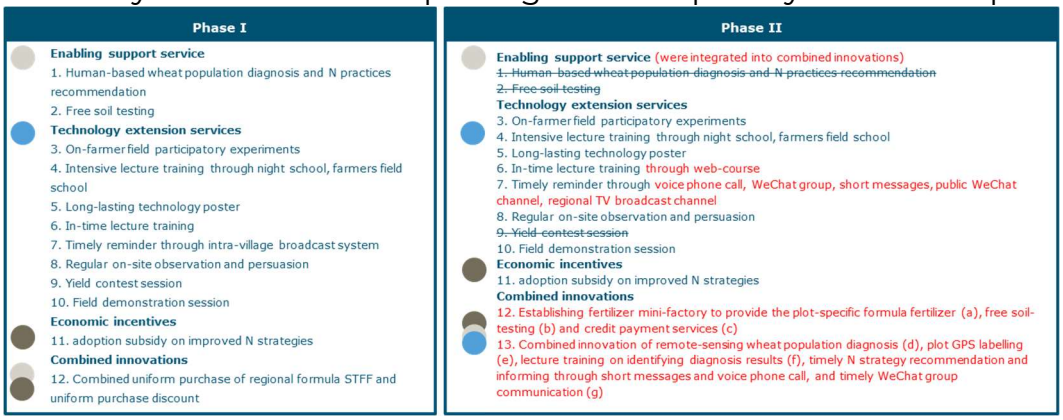
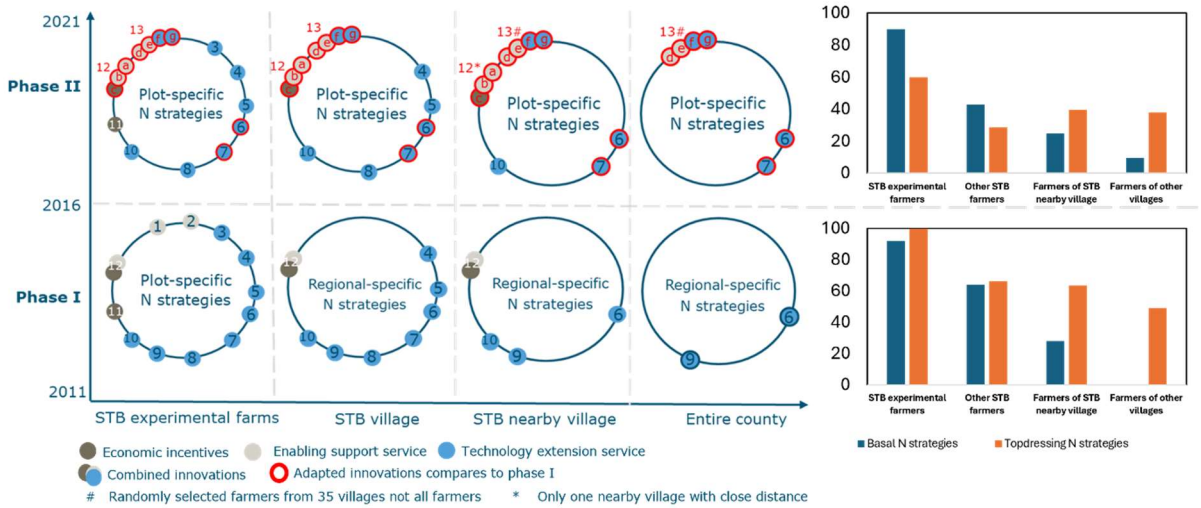


Figure 2. The scaling of innovation packages from the STB community to entire region, and the adoption rate of recommended N strategies from the community level to regional level in two phases.



5. Implications

5.1 Practical implications

Our study contributes to existing literature by exploring the potential of community-based innovation interventions to facilitate scaling to the regional level in rural China. While Science and Technology Backyards (STBs) are instrumental in scaling innovations within communities, their impact beyond this sphere is constrained. Establishing inclusive support networks at the regional level could bolster STB effectiveness beyond the community. It's noteworthy that supporting networks for various agronomic issues and communities may vary, underscoring the importance of adapting innovation packages and their support networks. This adaptation highlights the necessity of nurturing effective intermediaries within each village. Moreover, collaboration among different STBs to influence institutional change at the regional level presents a promising avenue for engaging more farmers in sustainable transitions.

5.2 Theoretical implications

Our research underscores the significance of adapting community networks and the role of intermediaries in employing community-based approaches to facilitate the scaling of agricultural innovations. Both community-based and landscape approaches prioritize the establishment of collaborative networks involving multiple stakeholders, emphasizing human-centricity, and iterative adjustments (Sayer et al., 2013). While community-based strategies primarily focus on crafting sustainable intervention models tailored to specific locales, landscape approaches prioritize broader scales, inter-level coordination, and overarching sustainable development (Denier et al., 2015). We contend that combining community-based intervention methods with landscape approaches can effectively advance sustainable transformation. For instance, in facilitating climate change adaptation, the landscape approach emphasizes the formulation of agendas spanning multiple levels and facilitating multi-stakeholder interventions for negotiating and implementing actions (FAO, 2013). While it also addresses fostering community engagement and ensuring the livelihood security of vulnerable populations, developing location-specific solutions is not the primary focus. We posit that the community-based approach offers tangible

operational guidelines for the landscape approach, particularly in enhancing community engagement and safeguarding the livelihoods of the most vulnerable groups. This involves identifying and nurturing innovative intermediaries within communities and leveraging their role as conduits to facilitate the reconstruction of internal community networks and bridge internal and external networks.

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Crop-livestock interactions between farms: how and why do they occur? A case-study in Southern France

Myriam Grillot[a], Clémentine Meunier[a], Claire Triolet[a], Julie Ryschawy[b]*

[a] AGIR, Univ Toulouse, INRAE, 31326 Castanet-Tolosan, France ; *myriam.grillot@inrae.fr

[b] AGIR, Univ Toulouse, INPT, INRAE, 31320 Auzeville, France

Abstract:
Whilst interactions between crop and livestock productions can contribute to the agroecological transition, crop-livestock farms are in decline in favour of specialized farms. Interactions between farms can be an alternative through exchanges of fodder, grain, straw, and manure. However, these interactions are rarely documented. We aimed to better understand farmers' perceptions and decision factors when involving in-between farm interactions.
We worked with a group of about 17 farmers in south-western France (Ariège, 2017-2022). The group included crop, livestock and crop-livestock farmers aiming to increase local interactions. We conducted two sets of semi-structured interviews with the participants to understand their perceptions on interactions and study interactions they had.
We highlighted heterogeneous perceptions of the benefits of interactions. Crop farmers were interested in agro-environmental benefits and focused on decreasing logistical costs. Livestock farmers aimed for feed self-sufficiency and self-sufficiency in decision making when involved with cooperatives. Logistics, neighbouring and social dimensions were important decision factors.
We provided an initial insight into interactions between farms. We highlighted the importance to further study farmers' situation in dynamic, over time (e.g. evolving situations, possible positive gradation of interactions) and space, as well as asymmetries in farmers' situations (e.g. offer or demand).

Keywords: crop-livestock system; agroecological transition; motivations; landscape level

Purpose

Interactions between crop and livestock productions and especially circulation of biomass between them can contribute to agroecological transitions. They can help closing nutrient cycles (e.g. carbon, nitrogen) to reduce environmental impacts and improve the use of resources (e.g. co-products); promoting cropping system diversification (e.g. pasture or fodder legume introduction

in crop rotations); and promoting resilience of farms to address unpredictable climate and market events (Bonaudo et al., 2014; Martin et al., 2016; Schut et al., 2021). In Europe, crop-livestock farms are declining in favour of specialized farms, partly due to the limited availability of a workforce and the lack of appropriate skills. Interactions between farms seem a relevant option to address these limiting factors (Martin et al., 2016). These interactions involve exchanges of a diversity of biomasses (grain, fodder, crop by-products, manure, or even live animal). However, whilst these interactions do occur between farms, they remain scarce due to transaction costs (Asai et al., 2018) and implicit aversion to risk and lack of trust between crop and livestock farmers (Garrett et al., 2020). Overall, how and why these interactions occur is rarely documented.

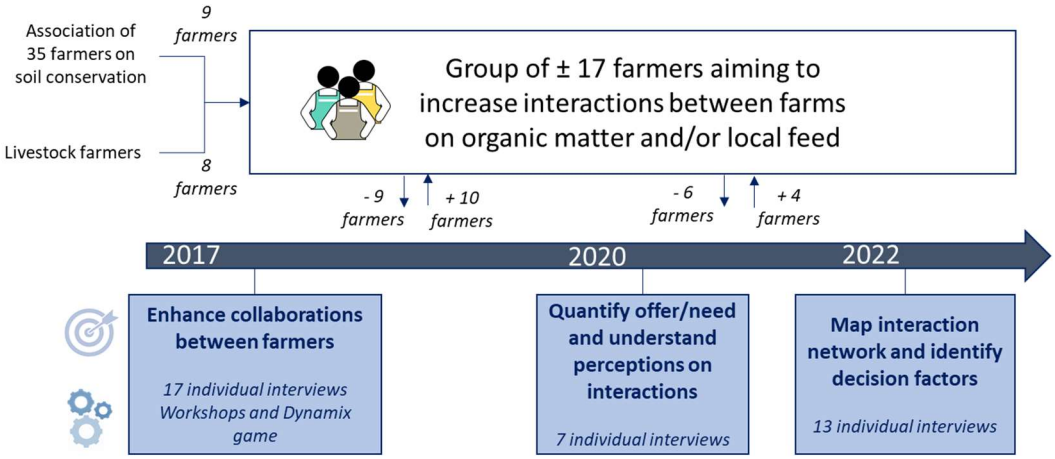
We aimed to better understand farmers' perceptions and decision factors when involving in-between farm interactions. This implied: i) identifying levers and barriers leading to interactions between farms as expressed by farmers; ii) understanding how and why these were translated in practice.

Methodology

In 2017, we started a participative process with extension advisors from the local "Chambre d'agriculture" and a group of 17 farmers aiming to increase local interactions on organic matter (e.g. manure) and/or local feed (Ryschawy et al., 2022). Crop farmers were particularly engaged in soil conservation practices. This group is located in Ariège, a French NUTS 3 region from Southern France. In the region, farms tend to be specialized depending on the geography: specialized crop farms in the northern plains (seed maize production and wheat-sunflower rotations) and specialized livestock farms oriented toward grazing and transhumant systems (beef cattle, sheep) in the southern mountains. Both systems are highly reliant on inputs (fertilizers for the first and feed and straw for the latter). On foothills at the border of plains and mountains, mixed farmers are engaged in both crop and livestock productions, with heterogeneous situations regarding input self-sufficiency.

Throughout the years, we conducted two sets of face-to-face interviews with the participants (Fig. 1). The first set (2017-2020) focused on the farm, agricultural practices and farmers' perception on interactions (i.e. motivations, barriers, and levers). The second set (2022) aimed at mapping with the farmers all the interactions they had for season 2021-2022. We considered one interaction as one triptych including i) two partners, ii) one biomass and iii) one flow type, i.e. sale-purchase, exchange against another type of matter, barter. We considered four types of biomasses: fodder (standing for grazing/mowing, or conditioned), grain related to livestock feed, straw (standing or conditioned) and manure. We asked farmers to describe each interaction with the name of the partner, the type of relationship, the biomass involved, the flow type, and occurrence frequency of the interaction. These interactions occurred within an open network of farmers and were not limited to the farmers interviewed. Farmers were invited to comment on the history of each interaction, particularly on why i) they were involved in these interactions, ii) had stopped previous interactions and iii) had started new interactions. We performed inductive content analysis and open-coded the interviews into key themes that emerged from the interviews (Elo and Kyngäs, 2008) and are highlighted in italic in the findings section. We also performed a descriptive analysis of farm interactions.

Fig. 1. General approach with aims, methods and group constitution over time (2017-2022)



Findings

Expressed levers and barriers for interactions between farms

All farmers mentioned a common desire for *local cohesion and solidarity* which matched, according to them, with interactions between farms. However, we highlighted different perceptions on the levers and barriers of these interactions according to their productions. Crop farmers were looking for *agro-environmental benefits* such as i) cropping system diversification through introduction of crops to feed livestock, or ii) the improvement of soil organic matter content thanks to manure inputs. Growing alfalfa seemed an opportunity to them to improve soil nitrogen content, limit erosion, and for some even a step to organic conversion. However, crop farmers emphasized the *logistical costs* were a barrier to local interactions. Due to geographical segregation and steep roads to collect manure in the mountains, costs were too high. They mentioned how easy it was to deliver grain to local cooperatives compared to a coordination with a livestock farmer ("It's easier than coordinating ourselves with livestock farmers [...] I need things to be simple"). At the cooperative there was always an employee available to take care of their merchandise, they did not have to make an appointment in advance.

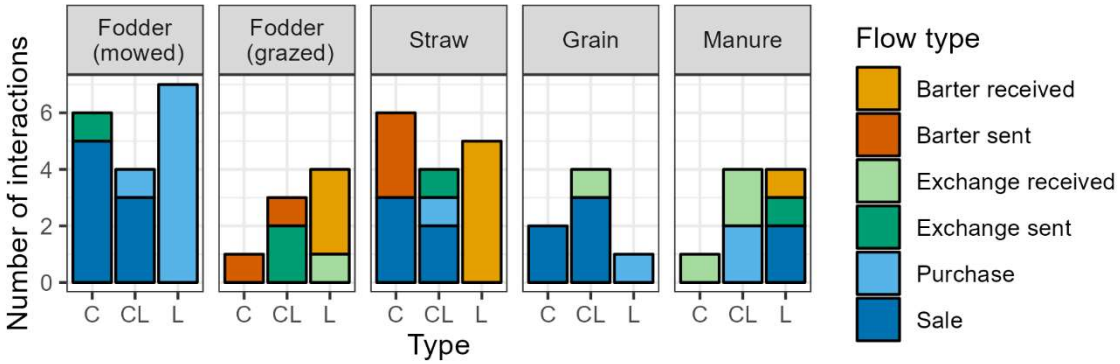
Crop-livestock and livestock farmers aimed for *local feed self-sufficiency* for their animals in order to be less reliant on the global market and large cooperatives (regarding prices and product quality). Indeed, those who bought feed to the cooperative were dubious regarding its quality and composition ("we don't know what's inside [depending on global crop market] [...] and this quality is directly impacting manure quality that goes back to our fields"). Farmers' wish to be *autonomous from cooperatives* in their decision-making was strong. Some farmers mentioned situations where cooperatives invested and provided buildings, livestock and feed and farmer had to apply recipe-like recommendations (systems highly embedded in the value chain) as opposite as their view of their profession ("you are not livestock breeder anymore", "you are not the manager in your house"). Most of these interviewees showed such a profound mistrust in cooperatives that they were producing their feed on-farm or were planning to. This facilitated interactions between farmers. Livestock farmers with few land to produce their fodder and grain interacted with livestock farmers to get it. However, they mentioned they could not work with any crop farmer: as they were looking for *quality feed*, they needed to work with technical crop farmers with "clean fields", or farmers who let them handle grain/fodder production from seeding to harvesting. For those who were buying ready-to-eat feed from the cooperative, the technical cost of changing

their system to produce their own feed were a strong barrier hindering interactions. Indeed, it required sourcing the crop products (access to production, sorting, and storage), as well as equipment and knowledge to formulate rations. They perceived high risks to decrease the herd productivity if quality of the feed and ration formulation were not handled properly. In addition, uncertainty on price volatility was an important barrier for some farmers with livestock production who were still unsure whether sourcing local products would really be an economic advantage in the long run. Others were less hesitating ("when we limit intermediaries there is always less cost [economically].").

Interactions between farms in practice

For season 2021-2022, over 13 farms, two farms were not involved into any interaction: a crop farmer sold all his grain to the cooperative and kept his straw as mulch and a mixed farmer was fully autonomous. For the 11 other farms, we recorded 51 interactions in total. On average, there were four interactions per farm (range: 1 to 8 interactions) and three different partners per farm (range: 1 to 6 partners). Nine pairs of farms interacted for more than one type of biomass. Most of the interactions occurred between farmers with a spatial proximity (45% with neighbours), or social proximity (31% with friends or family), while 23% occurred with an acquaintance from the professional network. Farmers sealed an oral contract in 75%, none in 23% and a formal contract in 2% (1 case) of the interactions. The formal contract concerned a crop farmer and a livestock farmer who met through their professional network. They mainly established it to cover for insurance as the interaction involved sheep grazing within the crop farmer's farm. Oral contracts varied in substance but specific terms could be agreed upon, such as date of removal (e.g. take away the straw from the field as soon as it is packed and ready).

Fig 2. Interactions from 2021 to 2022 by biomass, flow type and type of farmer (C = crop farmer, CL = crop-livestock farmer, L = livestock farmer). Exchange flows were recorded twice (received and sent)



Interactions involving fodder were the most common (25 interactions, or 44%, Fig. 2). They involved both crop farmers who supplied the biomass and livestock farmers who sought it. Mixed farmers were buyers when their own production was insufficient and sellers when they produced surplus. Overall, 64% of fodder-related interactions involved buying and selling. Over the years, new interactions with cover crop and cereal grazing were tested and adopted. Fifteen interactions involved straw (27%, Fig. 2). They were mainly bartering (53%), followed by buying and selling (40%) and exchange for manure (7%). As with fodder, mixed farmers were both buyers and sellers. Nine interactions involved manure (17%, Fig. 2). There was as much buying and selling (45%) as ex-

changes for straw or grazing (45%) and one donation (10%). Seven interactions involved grain (12%), of which 86% were buying and selling, and 14% were exchanged (Fig. 2). In terms of quantity, these interactions represented a small amount of crop total production, most of the grain was sold to cooperatives.

We highlighted tensions around straw and manure. Most farmers had stopped straw-manure exchanges due to high logistic costs and straw sales without manure in return left a feeling to downgrade from a win-win to a loose-win situation (in favour for the livestock owner). Crop farmers tended to keep straw in the fields to improve or maintain soil quality ("if I sell my straw [without manure in return], I need mineral fertilizer to compensate and this is not my wish"). Main factor to maintain straw-manure exchanges was solidarity, related to trust and friendship. This was the same for straw sales ("In solidarity with a livestock farmer, I give him straw. Actually I don't give it, I sell it but at a reasonable price").

As a confirmation to what the farmers had expressed when mentioning important barriers to interactions between farms, logistics and costs were important decision factors for all biomasses. However, their perceived level of importance on the choice to whether or not involve into interaction depended on whom was in charge of it. Most of the straw and mowed fodder were handled by the receiver (livestock owner) and did not affect the crop farmers, as long as it was collected right after the harvest to let them time to prepare for the next crop. It was more heterogeneous for interactions involving grain (even though even availability of storage was important factor in the arrangement).

Even though farmers did not seal written contracts with each other, they agreed upon modalities and rules for their collaboration. They wanted to keep these collaborations based on trust and flexibility through the years. Infinite debates came at hand when mentioning the possibility to prepare a contract with fixed prices in order to cope with price volatility. One crop farmer even mentioned the need for a neutral institution to help set up mechanisms to decide prices with a fair adjustment through years.

Practical implications

This study started from a need from this group of farmers and their adviser. Farmers explicitly aimed to increase local interactions between farms. Far from representing the dominant regime in the study region, they remained within a niche with a high propensity to take risks and implement innovative farming systems. Understanding these farmers' perceptions and decision factors to get involved into interactions was and remains a necessary first step in supporting the development of those interactions. Despite an expressed mistrust towards cooperatives, further research could be undertaken on their role as innovation intermediaries; e.g. as conducted in China by Yang et al. (2014). We confirmed the importance to emphasize on trust and social capital, as highlighted by King et al. (2019).

The group composition evolved throughout the years. The number of farmers remained quite stable but only six farmers were involved during the whole process. The most spatially isolated livestock farmers left the group and more farmers located in the piedmont joined it. This evolution highlighted how difficult it is to maintain a group which is too spatially spread in the long run. Also, some participants changed priorities (e.g. investments) or faced personal issues and paused their involvement for a time. Overall, independently of the case study, we highlighted the importance to work in the long run with farmers. It allows to take a step back from focusing on specific practices, and to recontextualize them regarding farmers' objectives. Those objectives may be

reached through many paths depending on hindering factors, and lead to innovative change of practices (e.g. here, focus progressively switched from straw-manure exchanges to cover crop grazing in interactions

Theoretical Implications

In the study region, but most likely also in most other European regions, farms do interact with other farms (through biomass, workers, machinery, etc.). However whilst they often benefit from local coexistence, they are more rarely involved in a stronger level of integration leading to more spatial, temporal and organization coordination (Martin et al., 2016). We showed that interactions between farms is not only a question of offer and demand, there is more at hand. Bouttes et al. (2019) emphasised that farmers do not only focus on profit maximization and/or optimized productivity. Each farmer has his own objectives depending not only on farm structure but also on individual values. We showed that his perceptions and decision factors for being involved into interactions may even differ according to the biomass considered and farmers' position (i.e. offer or demand). We showed the importance of trust, solidarity, and spatial and social proximity in involving into interactions. Many interactions with neighbours relied on informal help, which is key element but rarely documented in studies. Also, there was a gradation in the interactions, as after many interactions with acquaintances from the professional network, friendships developed. They could also lead to more subsequent changes in the cropping systems (e.g. choice of the crop composition for fodder) and to more integration, contributing then more to the agroecological transition. These dynamic and individual elements should be thought through when developing models on farmers' decision-making, especially regarding farm interactions.

Acknowledgments

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Analysing farmer biomass, product, labour and land exchanges in a range of European landscapes.

Francesco Accatino[a], Claire Triolet[b], Tommy Dalgaard[c], Camelia Anisoara Gavrilescu[d], Jacqueline Leonte[e], Miranda P.M. Meuwissen[f], Carolina Ramos[g], Asbjørn Mølmer Sahlholdt[h], Marie Trydeman Knudsen[i], Kairsty Topp[j], Monica Mihaela Tudor[k], Christine Watson[l], Fergus Younger[m] and Myriam Grillot[n]

[a]UMR SADAPT, INRAE, AgroParisTech, Université Paris Saclay, France. francesco.accatino@inrae.fr

[b]UMR AGIR, Univ Toulouse, INPT, INRAE, France. claire.triolet@inrae.fr

[c]Aarhus University, Department of Agroecology, Denmark tommy.dalgaard@agro.au.dk

[d]Romanian Academy, Institute of Agricultural Economics, Romania. cami_gavrilescu@yahoo.com

[e]Romanian Academy, Institute of Agricultural Economics, Romania. jacqueline.leonte@gmail.com

[f]Business Economics, Wageningen University, the Netherlands. Miranda.meuwissen@wur.nl

[g]CONSULAI, Portugal. cramos@consulai.com

[h]Aarhus University, Department of Agroecology, Denmark ams@agro.au.dk

[i]SRUC, UK Kairsty.topp@sruc.ac.uk

[j]Aahrus University, Department of Agroecology, Denmark. mariet.knudsen@agro.au.dk

[k]Romanian Academy, Institute of Agricultural Economics, Romania. monik_sena@yahoo.com

[l]SRUC, UK christine.watson@sruc.ac.uk

[m]SAOS, UK Fergus.Younger@saos.coop

[n]UMR AGIR, Univ Toulouse, INPT, INRAE, France. myriam.grillot@inrae.fr

In landscapes, interactions between farmers, i.e., coordinated actions (e.g., exchanges of biomass, livestock, labour, or land), can lead to agronomic benefits, ecosystem services and close the nutrient cycles. We aimed at exploring the types of interactions among farmers and their effect on landscapes, identifying, among them, those leading to improved circularity. We analysed interactions in six farmer networks: crop-livestock landscape in France (FR); Montado in Portugal (PT); small-scale mixed farms in Romania (RO); farms and biogas plant in Denmark (DK); sheep and arable farms in Scotland (UK); arable and dairy farmers in the Netherlands (NL). Interactions were manure-feed/straw exchanges between crop and livestock farmers (FR, UK, NL); livestock transfer for grazing to other farms (PT, RO, UK); biogas-plant mediated nitrogen redistribution (DK); land parcel exchanges for optimizes rotations (NL); product exchanges between farmers and agrotourism facilities (RO). Most explored interactions require mutual trust as they were often informal and not regulated by contracts. Advisors play (FR, DK) or are advocated to play (NL) a (stronger) role in mediating. Not all interactions promote landscape-level nutrient recycling; land exchange aims for optimization (NL); in RO, interactions focus on economic mutual aid. Manure-for-feed/straw and livestock transfer enhance circularity.

Keywords: farmer interactions, ecosystem services, circularity, biomass exchange

Purpose

Mixed agricultural landscapes integrate different interacting agricultural components (for example crops, livestock and trees) in a way that they can recycle nutrients at different levels and provide ecosystem services (e.g., biological control for reducing the need of pesticides) (Martin et al., 2016). In some cases, individual farms might be specialised or might not be able to close the nutrient cycle within the farm. In this case, in order to achieve integration and nutrient recycling at the landscape level, it is fundamental to have interactions among farmers or between farmers and other actors (Martin et al., 2016). However, interactions occur in many different types and formats (Asai et al., 2018), especially given the diversity in European mixed farming systems and *the interaction does not necessarily result in integration of components in the landscape and nutrient circularity*. In this study, we addressed the following questions: what are the main types of materials exchanged among farmers? In what way do these exchanges occur? Finally, we reflect on whether there are some interactions are more important than others in developing integration and interaction of components and nutrient recycling in landscapes.

Design/Methodology/Approach

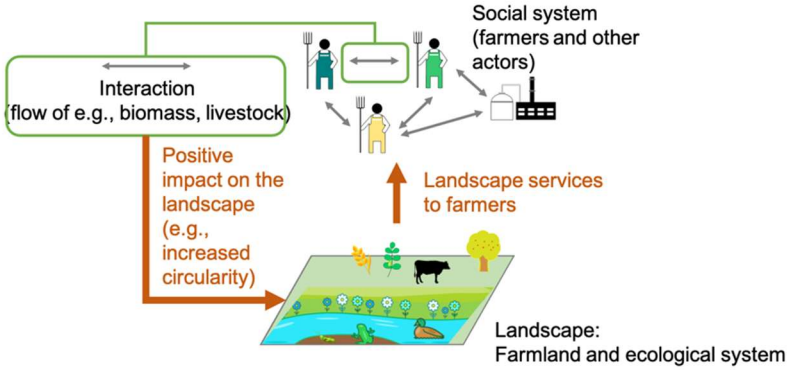
We considered six European farmer networks (Table 1) extending over an area of a NUTS3 or smaller and characterized by different agricultural activities. All the networks include farmers that are either interacting directly with other farmers or with other actors in the landscape. The number of farmers in each of the networks varies. Some networks have been in existence for many years, while in others, the interactions have only occurred relatively recently.

Table 1 – Description of the networks

Country	**Short name**	**Description**
France	FR	13 farms located in uplands (ruminants) and in lowlands (cereals) in Ariège
Portugal	PT	15 farms in the montado (tree-grass) system in Alentejo
Romania	RO	8 small-scale farms combining mixed agricultural activities (fruit, dairy cattle, sheep) and agrotourism
Denmark	DK	11 specialised farms (pigs, dairy cattle, other cattle, stockless) and a biogas plant
UK	UK	Farms involving sheep coming to graze winter cereals
The Netherlands	NL1	Four farms (2 mixed (dairy-arable), 1 dairy, 1 arable farm)
	NL2	Two farms (1 arable, 1 dairy)

The network facilitators were asked to describe the coordinated direct or indirect (e.g., via intermediaries) interactions action between two or more actors (at least one is a farmer) that leads to exchange of resources or animals having some landscape services (e.g., improved soil conditions, animal welfare, increased nutrient recycling) (Fig.1). This excludes pure buying or selling of products or services without agronomic consequences for both parties. In order to analyse interactions within the networks, the idea was that each network could identify farmers interactions and describe them among pre-defined axes, in order to allow cross-network comparability.

Figure 1. Within a landscape, actors (forming the social system) interact within an ecological systems. An interactions among two actors (actor 1 and actor 2) is defined as an exchange of resources (from actor 1 and actor 2 and vice versa, excluding money). This exchange leads to landscape benefits, including ecosystem services, decreased imports, nutrient recycling.



In each of the networks, a common set of over-arching questions were addressed, which were aimed at identifying the resources exchanged in farmers interactions and the benefits these exchanges provide to the landscape. Questions were addressed with focus groups (PT, RO), with focus groups integrated with expert knowledge (UK, NL), with data analysis and expert knowledge (DK), or with a series of in-depth farmers interviews (FR). Because of the heterogeneity of the protocols implemented and of the type of information collected across case studies, network facilitators were asked to fill a common table (Table 2) in which interactions could be described homogeneously across common, standardised, dimensions: 1) actors involved (in this sense it was important to distinguish the type of farmer (e.g., cereal, cattle), so that we could make considerations about complementarities among farmer types), 2) resources or livestock exchanged, 3) perceived benefits to the landscape, including ecosystem services, reduced need for importations, increased nutrient circularity. Interactions could involve some monetary flow, however we excluded pure purchases without non-monetary resources flows in both directions. The benefits to the network (point 3) were either identified through discussion with actors in the focus group or inferred by researchers. Further discussions between the actors and the researchers allowed insights to be gained about relevant strategies for facilitating interactions and on whether these interactions led to increased nutrient recycling at the landscape level.

Findings

The focus groups revealed a diversity of interactions with different modalities, involving farmers, and in some cases other actors. The intensity and frequency of interactions could not be quantified consistently among case studies; therefore, we have only compared the types of interactions according to the dimensions of Table 2.

Table 2 - Interactions observed in the case study networks. Each interaction, assigned an ID, is associated to two types of actors interacting ("Actors"), which deliver certain resources ("Resources delivered in the interaction"), giving rise to the specified benefits to the two actors and/or to the network as a whole ("Benefits in the network").

ID	Actors	Resources delivered in the interaction	Landscape benefit
IntFR1	Cattle farmer	Manure	Feed self-sufficiency; reduced synthetic fertilizer
	Cereal farmer	Feed	
IntPT1	Pig farmer (outside)	Pigs	Good quality feed and welfare for pigs; soil improvement through manure
	Montado farmer	Acorns, grazing area	
IntPT2	Sheep farmer	Sheep (goats)	Feed and welfare for sheep, weed control and decreased need for machinery, reduced synthetic fertilizer
	Orchard/vineyard farmer	Graze feed and area	
IntRO1	Mixed farmer	Sheep, dairy products	Pasture maintenance; feed for sheep in spring/summer months, employment creation
	Shepherd	Specialised labour	
IntRO2	Farmer	Dairy products, fruit, manure, calves	Manure for fertilization in orchard, employment creation, agro-tourism development in the region
	Agro-tourism facility	Products	
IntDK1	Mixed farmer	Manure	Nitrogen redistribution; reduced synthetic fertilizer, higher nutrient efficiency and gross margins.
	Biogas plant	Digestate	
IntUK1	Beef/sheep Farmer	Ruminants	Pasture maintenance, feed for sheep over the winter months
	Arable farmer	winter cereals	
IntUK2	Beef/sheep Farmer	Manure	Feed self-sufficiency; reduced synthetic fertilizer
	Arable farmer	Straw	
IntNL1	Arable farmer	Land	Improved rotation; increased production
	Arable farmer	Land	
IntNL2	Dairy farmer	Manure	Feed self-sufficiency; reduced synthetic fertilizer
	Arable farmer	Feed	

One set of interactions reflected exchanges of manure and feed/straw among specialized crop and specialised livestock farmers (IntFR1, IntUK2, IntNL2), taking advantage of their complementarity, and therefore allowing the increase of regional feed/bedding self-sufficiency and decreasing the need for synthetic fertilizer. A second set of interactions regarded the transfer of livestock from one place to another for a certain period in order to satisfy livestock needs for certain types of feed, increasing the carrying capacity on the livestock farm and pasture maintenance on the other: in IntPT1 pigs come from outside the region to spend time in the Montado feeding on acorns bringing benefits to Montado soils; in IntPT2 sheep come from farms with olive orchards or vineyards (outside the network) to graze, therefore helping to control weeds; in IntRO1 sheep are sent to mountain pastures with a shepherd in the spring and summer months (traditional transhumance practice) and calves are grazing in orchard; in IntUK1 sheep, from livestock farms, are grazed on winter cover crops or winter cereals on arable farms. In IntDK1, IntNL1, the interactions do not involve the transfer of goods between livestock and arable farms. In IntDK1, the

farmers send their manure to the biogas plant and receive digestate. Some farms pay for receiving more digestate than equivalent to the manure they sent: this leads to indirect interactions among farmers mediated by the biogas plant, leading to a nitrogen re-distribution in the region, reducing the need for synthetic fertilizer. In IntNL1, the arable farmers exchange land parcels in order to optimize rotation and therefore increase their productivity. In IntRO2, dairy products are exchanged between farmers and farmers with agro-tourism facility, therefore helping each other economically and developing agro-tourism in the region, which creates as well jobs locally. The negotiations between the farmers may also involve bartering and include the sharing of labour and resources. In case money transfer is involved, the interaction has a higher benefit to one of the two actors involved. Interactions occur mostly on a bilateral basis on the principle of a (more or less consolidated) mutual trust and do not typically involve legal agreements. However, in France (IntFR1), it is legally required that cooperatives play a role of mediation and facilitation for exchanges involving the exchange of feed. The other exception is DK1, where the biogas plant plays the role of mediator in the network.

Practical Implications

Many of the interactions are agreed upon informally, which may be why they are often not included in policies. It would benefit farmers if policies were implemented that not only focused on the individual farmers, but valued the interactions among farmers. This would help to facilitate the emergence of good relationship between farmers. This can also be achieved by means of intermediary agents or cooperatives. Considering the DK network, the integration with a cooperative facilitates farmer (indirect) interaction, so the intermediary role of the biogas plant is beneficial for interactions. In FR and the UK, advisors are already playing a role (organisation of training for crop-livestock interactions, playing an intermediary role). NL farmers advocated for advisors who are not experts in specialised farms (crop or dairy) but have expertise in facilitating interactions among farmers. Formal agreements between the farmers and the other actors would help to protect these bilateral relationships.

Theoretical Implications

Not all the interactions explored led to nutrient recycling in the landscape. For example, IntNL1 is focused on optimising the production of the cooperant farmers; however, this interaction does not lead to integration of components and nutrient recycling. IntRO2 interactions are focused on economic mutual aid, while nutrient circularity is limited. IntPT1, IntPT2 and IntUK2 involve farmers outside the network. The exchange of manure and feed (IntFR1, IntUK1, IntNL2, IntRO1) will promote nutrient recycling.

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SPECIAL SESSION "MEDITERRANEAN SOCIO-TECHNICAL SYSTEMS I - WATER AND SOIL"

Supporting the dynamic conservation of water management in the Globally Important Agricultural Heritage Systems (GIAHS) site - L'Horta de València, using the Institutional Analysis and Development (IAD) framework.

Clelia Maria Puzzo[a], Itzel Inti Maria Donati[b], Filiberto Altobelli[c], José-María García-Alvarez-Coque[d].

[a] Food and Agriculture Organization of the United Nations (FAO), Viale delle Terme di Caracalla, 00153 Rome, Italy, cleliamaria.puzzo@fao.org.

[b] Department of Architecture and Design Landscape and Environment Sapienza, University of Rome, Piazza Borghese 9, 00186 Rome, Italy, itzelinti.donati@uniroma1.it.

[c] Council of Research in Agriculture and Analysis of Agricultural Economics, Research Centre for Agricultural Policies and Bio-Economy, Via Barberini 36, 00187 Rome, Italy, filiberto.altobelli@crea.gov.it.

[d] Department of Economics and Social Sciences, Universitat Politècnica de València (UPV), Camino de Vera, 46022 Valencia, Spain, jmgarcia@upvnet.upv.es.

Corresponding author: Itzel Inti Maria Donati, itzelinti.donati@uniroma1.it

Abstract: The agricultural system of *L'Horta of Valencia* has a history of over 1,200 years, during which time it has evolved in response to the interaction between local communities and the natural environment. The earliest ditches and irrigation networks that shaped the hydraulic landscape of *L'Horta* and the *Albufera* lagoon were the result of the experience and ingenuity of the Islamic civilization. Currently, given the relevant role that institutional arrangements or governance play in the management of the agricultural system, this contribution proposes the application of the conceptual and methodological tools of the Institutional Analysis and Development (IAD) framework, to identify factors that support the dynamic conservation of the case study. This paper examines the historical irrigation system of Valencian *Horta* as part of the Globally Important Agricultural Heritage Systems (GIAHS), with an emphasis on the dynamic conservation actions needed to support the agro-ecosystem. The key objective of the GIAHS programme, "*dynamic conservation*", guided the research questions: "*How do farmers and decision-makers interpret this concept?*" And "*How can policies, strategies and actions help promote dynamic conservation in the case study?*"

Keywords: water governance, IAD framework, irrigation system, agricultural heritage, dynamic conservation.

Purpose

The Globally Important Agricultural Heritage Systems (GIAHS) and their governance are often considered under the framework of the integrated landscape management approach (Ramakrishnan, 2001). Indeed, integrated landscape approaches are viewed from different

perspectives, as observed by Reed et al., (2020) and governance is a crucial aspect in all definitions. Integrated landscape management is a governance strategy that aims to reconcile the multiple and conflicting demands of land use and the environment. The aim is to achieve more multifunctional, sustainable and equitable landscapes. Agricultural landscapes harbor complex synergies and are governed by multiple stakeholder interests (Rizzo, 2022); (Rizzo et al., 2012). The complexity of agricultural landscape systems is increasing due to the emergence of new stakeholders seeking to use the land not only for agriculture, but also for housing, wildlife habitats and drinking water supply (Carmona et al., 2010). These complex structures characterize traditional farming systems, including those recognised as GIAHS, which continue to provide multiple services and face a number of challenges in an attempt to achieve conservation while pursuing rural development. The historical ability of the traditional irrigation system of *L'Horta* to maintain its activity for centuries, while remaining strongly linked to the traditional form of water management, has stimulated the interest in studying the dynamics that determine the resilience of this efficient productive system. This is particularly relevant in a strongly evolving global agricultural production context, which is looking towards the modernization of irrigation practices. Added to this context is the current water crisis, in the face of which *L'Horta*'s flood irrigation system might seem to be completely against modern techniques (e.g. micro-irrigation). However, as emerged from the consultation with the farming community of *L'Horta*, water scarcity is not perceived as a risk. Not only secular cultural practices but context-specific environmental reasons are behind the maintenance of this traditional irrigation method.

Figure 1 Historical Irrigation System at l'Horta: the irrigation network and the land structure divided into very small plots. Source: ©PAT de L'Horta - Generalitat Valenciana
https://www.flickr.com/photos/giahs/albums/72157715520444098

1.2 The concept of Globally Important Agricultural Heritage Systems (GIAHS)

GIAHS is a programme of the Food and Agriculture Organization of the United Nations (FAO) aiming at identifying and safeguarding traditional agricultural systems together with their associated landscapes, agricultural biodiversity and traditional knowledge systems (Ramakrishnan, 2001). These unique agroecosystems are living examples of the co-evolution of human communities with their territory, agricultural landscape or biophysical and wider social environment (Koohafkan & Altieri, 2011).

1.3 The concept of Dynamic Conservation in the context of GIAHS

Through the GIAHS approach, the FAO aims at supporting local communities in their efforts to adapt to the several changes that undermine their future sustainability. The central concept behind all actions implemented in the framework of GIAHS is the one of *dynamic conservation*. Despite the lack of an official definition of dynamic conservation, with this concept FAO highlights the importance of avoiding static representations of traditional farming systems. In other words, recognizing their intrinsic dynamicity allows for a conservation that foresees innovative actions in

support of the needs of local communities, being far from a pure conservation approach (Ramakrishnan, 2001).

1.4 The Institutional Analysis and Development (IAD) framework

The IAD framework facilitates the investigation of the influence of rules on the behavior of actors, the dynamics of cooperation and decision-making in communities sharing common resources. Due to the central role of local communities in the context of GIAHS (He et al., 2020), the IAD framework can be a useful tool to evaluate the interactions among GIAHS-relevant stakeholders in a specific site (Sai Dinesh et al., 2024).

1.5 The case study area: the Historical Irrigation System at l'Horta of València, Spain

The designated GIAHS consists of a gravity irrigation system with channels that allow the cultivation of crops in the periurban area of Valencia, and that flow towards the South forming the *Albufera* - a freshwater lagoon in which rice cultivation and traditional fishing activities are carried out (Miralles i Garcia, 2015) . The site represents a historical peri-urban agricultural area situated on the periphery of the City of Valencia and 44 municipalities within the *Comarcas de l'Horta Nord*, *Horta Sud*, *Horta Oest* and the *Albufera* lake. The main crops cultivated by the agricultural community in the study area are presented in Fig. 4. The social management of the irrigation system is the feature that together with the channels has stood the test of time, being maintained through centuries and still active in our days. Examples are the community of irrigators (*comunidad de regantes*), in which farmers interact daily to ensure an equitable distribution of water among the fields (Otega-reig et al., 2015). Despite the high fragmentation of land in small plots and small-scale owners, the perception of water as a common good is still alive (García-Mollá et al., 2020). The century-old *Tribunal de las Aguas* (traditional water court), recognized by UNESCO as intangible cultural heritage, and the water governance customary institution, the *Real Acequia de Moncada*, together with their “water guards” are the expressions of the sophisticated social interaction system that guarantees a sustainable management of water in *L´Horta* (Miralles i Garcia, 2015).

2. Methodology

In this study, two main exercises are used to understand the social context of l’Horta: participatory workshops and the overlaying of the IAD framework with the key actors of the case study. This did not only helped analyze the composition and the existing interactions between the stakeholders involved in the GIAHS of *L‘Horta,* but supported a clearer definition of the entire governance rules of this agricultural heritage system in the light of the IAD framework.

2.1 Data collection and analysis

2.1.1 Participatory Workshops

A qualitative research study was conducted involving thirty-seven stakeholders operating in the Horta and in the Albufera of Valencia. The stakeholders consisted of farmers (4), local administrations (2), civil society organizations (8), sellers of local products (8), tourist operators (7), academia (6), and NGOs (2). A pre-session with a focus group of four experts and two representatives from farmer’s associations was organized to define the structure of the workshops and the topics to be selected and submitted to the participants. The research study consisted of two participatory workshops held between April and November 2022. The first workshop consisted of breakout groups ensuring a good representation of different stakeholders in each group. The groups were requested to identify the needs of the GIAHS site based on four main topics: conservation, innovation, economic opportunities, and landscape.Given the central role of

innovation which resulted from the first workshop, the second activity focused on the innovative actions needed for the conservation of the Agricultural Heritage System. It consisted of a poster session in which stakeholders presented innovative projects that they were implementing or planning to ensure dynamic, people-centered, and bottom-up conservation actions.

2.1.2 Overlaying the institutional framework of the case study with the IAD

Biophysical characteristics - As previously discussed, the main biophysical characteristics of the system are the Turia River, the irrigation network that originates from it, the cultivated land, the Albufera lake and its rice cultivations (Fig.3B) and the traditional fish catching techniques (Fig. 2). It is worth highlighting the social management of irrigation, which makes the system resilient and efficient. As mentioned in paragraph 1, the irrigation practices are specific to the context and designed to avoid water waste and to maintain good levels of groundwater, preventing saltwater intrusion from the sea.

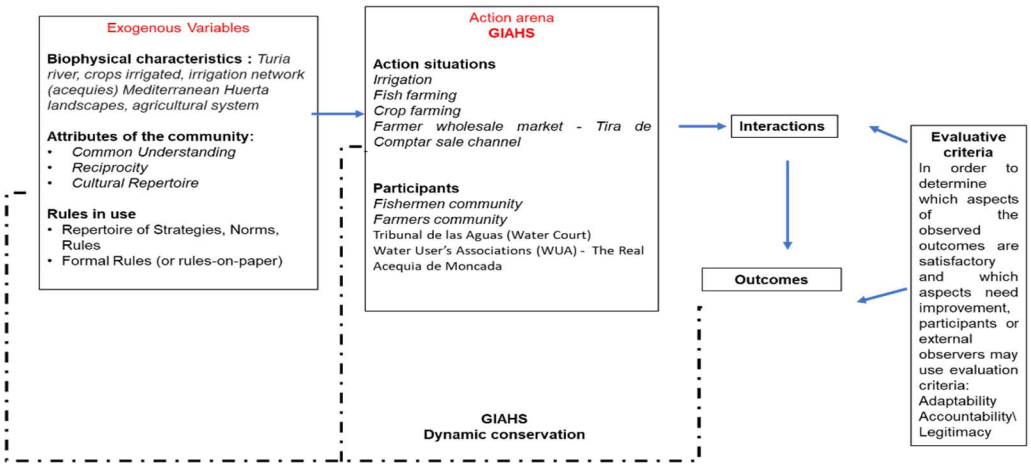

Figure 2. The Institutional analysis and development framework adapted to the case study

Attributes of the community - The relevant aspects of the social and cultural context that emergedfrom the discussion with stakeholders in the first phase of the survey are collected in Figure 2: Common Understanding (or shared understanding), Reciprocity and Cultural Repertoire.

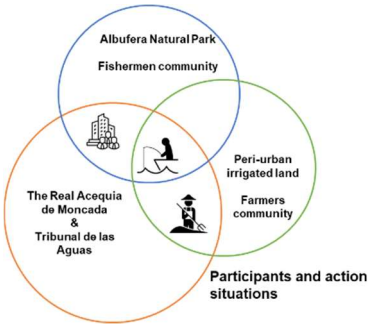

Figure 3A. La Horta Action arena between three Agro-Ecological Zones: Albufera Natural Park, Peri urban irrigated land.

Figure 3B. Structure of the farming community

The action arena and actors - The action situation is the key component of the IAD framework, in which individuals (acting on their own or as agents of organizations) observe information, select actions, engage in patterns of interaction. The main actors of this system are listed in Figure 3A.

Rules in use - The customary rules applied to the management of water resources represent a sophisticated governance system. Irrigation takes place in a strict calendar of turns ('turnos'). In times of drought, the trustees or representatives of the irrigators have the power to distribute water according to criteria that allow for fair compensation and that have been handed down from generation to generation. As far as the fishing community is concerned, it is worth mentioning the regulation of the fishing community of El Palmar, through which fishing is protected and managed. ***Evaluation criteria -*** The evaluation criteria are a component of the IAD framework used by the participants or external observers to determine which aspects of the observed results are considered satisfactory and which need special attention (Cole et al., 2019). Most IAD evaluation criteria were deemed satisfactory in this case study. Among the eight criteria, the one regarding adaptability, resilience, robustness or sustainability proved to be the most appropriate to be used as a performance criterion for human-designed systems, including GIAHS**.** The *Horta of Valencia* responds adequately and efficiently to the needs of its communities. Furthermore, the selected criterion focuses on the promotion of learning and institutional innovation. These aspects are still central to the governance of *L'Horta* nowadays, as demonstrated by the presence and active involvement of all its actors (Fig. 3).

3. Results

The workshops and the matching exercise with the IAD framework addressed the research questions by identifying an idea of dynamic conservation that is translated into the specific context of the GIAHS site. The local stakeholders expressed the idea of dynamic conservation being the chance to put their concerns on the table and discuss jointly the necessary actions needed to secure a sustainable future for their GIAHS site. Based on the Action Plan submitted to FAO together with the application dossier, the considerations made during the discussions resulted in an interesting new set of actions concerning conservation, innovation, economic opportunities, and environmental protection. The analysis of the intricate social management system and the way the actors are interlinked and its overlaying with the IAD framework, provided relevant elements in the perspective of the creation of a methodology to assess the social framework in GIAHS sites (being the GIAHS criterion n. 4 established by FAO).

4. Theoretical implications

What makes the Horta irrigation system globally important is that it provides an interesting foundation for solutions to modern problems. The emphasis on community control and ownership is especially significant in light of the data that suggests that community involvement is a direct pathway to success for water systems. (Hudson-Richards & Gonzales, (2013) observe the water governance as a way that can allow people across the world facing the worst consequences of water shortages to exercise agency solving their local problems in ways that answer their direct needs and procure resilience.

5. Practical implications

The practical implication is that participatory processes are essential due to the variety of actors that make up these systems, as each GIAHS is very different from the other. IAD proves to be a suitable methodology for analysing key aspects of the dynamic conservation of an agri-food system, with a two-pronged approach: investigating the basis of a concept or extracting aspects from the framework to be used for the identification of a dynamic conservation strategy in other sites comparable to the chosen case study.

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Analysis of the drivers of practices in the irrigated farming systems: a multi-level spatial explicit approach in northern Tunisia during the past 15 years

Intissar Ferchichi[a], Insaf Mekki[a], Nesrine Taoujouti[a], Fatma Abdelwahed[a], Davide Rizzo[b], Abdelaziz Zairi[a], Rim Zitouna-Chebbi[a]

[a] National Research Institute for Rural Engineering, Water and Forestry (INRGREF), Carthage University, Ariana, Tunisia

[b] LISAH, Univ. Montpellier, AgroParisTech, INRAE, IRD, Institut Agro, Montpellier, France

Abstract: The southern Mediterranean region displays remarkable diversity and heterogeneity, reflected in the dynamic mosaic of farms and farming systems that have evolved to adapt to the frequent scarcity and irregularity of water availability. Using the Echraf irrigated area in northern Tunisia as a case study, this paper addresses the decision-making process of farmers regarding crop choice and management practices. Drawing from 15 years of real land use data and interviews with experts from the local administration and farmers' associations, we identified the main cropping systems and analysed the determinants of farmers' decision-making, with a focus on tomato production system. The results highlight the nuanced influence of different factors on farmers' decision-making processes. The regional distribution of processing facilities underscores the broader decision-making dynamics and competitive pressures faced by farmers.
Keywords: Farming practices; Determinant factors; Cropping systems; Southern Mediterranean; Tunisia.

Purpose

Agricultural systems in the Mediterranean basin are expected to undergo rapid transitions over the next decade, as they appear to be more vulnerable to current changes, occurring at different scales and under various forms (Blondel, 2006; Cramer et al., 2018; Nieto-Romero et al., 2014). The latest IPCC report (2023, p. 48) identifies the Mediterranean agricultural systems among the most vulnerable to drought originated by climate change. However, in the Southern Mediterranean, the technical and financial capacities to implement large-scale adaptation measures are insufficient to cope with the problem (Djellouli-Tabet, 2010; Schilling et al., 2020). The high level of heterogeneity and complexity of these areas increases the farming system vulnerability, as it hampers the capacity of farmers to adapt their agricultural practices to the changes in the technical, social, and economic framework conditions (Ferchichi et al., 2020).
Several studies have focused on characterising the dynamics of cropping systems and interpreting the farmers' decision-making logic and systems in order to understand the adaptation of farming practices and how they can simultaneously address the challenges related to the environment, resource use efficiency and the economic sustainability of farms (Biarnès et al., 2021). Cropping system choices result from a decision-making process in which farmers weigh various objectives and constraints that are embedded in different spatial and temporal dynamics. Because production decisions are almost always made under uncertainty and multiple crops can follow within the same agricultural year, cropping system decision-making is a continuous process

occurring throughout the year rather than a single simple choice (Dury et al., 2012). Explaining the coherence of the cropping system in relation to the objectives of the stakeholders, the constraints to which they are subject, and the existence of various interactions between techniques, is an essential step, both for assessing agricultural practices and for improving their economic or environmental efficiency.

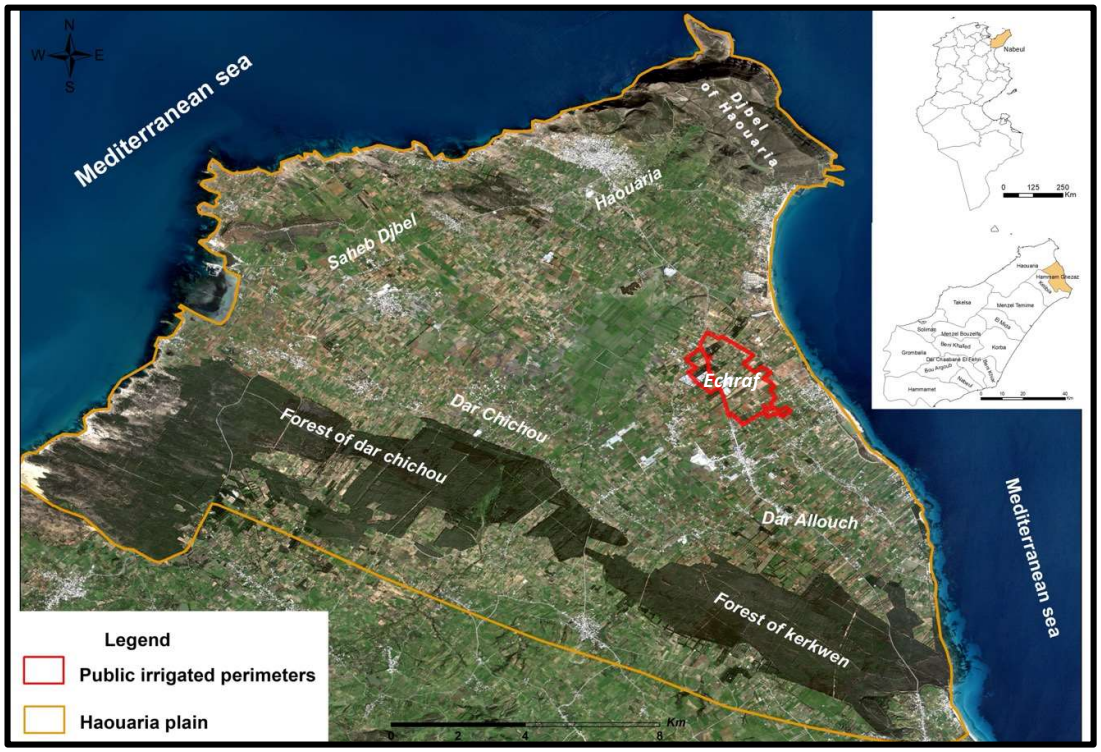
Analyzing the spatio-temporal dynamics of cropping systems and their underlying drivers is especially challenging in the context of Southern Mediterranean systems for two main reasons: (1) the significant knowledge gap when it comes to characterizing and assessing the nature and causes of ongoing dynamics in the Southern Mediterranean systems (Debolini et al., 2018), and (2) the lack of available local and even generic datasets to track crop sequences and crop management practices, qualified as a major obstacle in describing dynamic cropping systems due to the high spatial and temporal heterogeneity of farmers' decision making (Rizzo et al., 2019). This study aims to describe farmers' decision-making process regarding crop choice and management practices, and to identify the determining factors of these decisions, based on 15 years of real data on land use occupation in the Echraf irrigated area, and on interviews with managers and technicians from agricultural public administration and farmers' association. This study case is a representative of irrigated farming systems in the northeastern part of Tunisia. It comprises small and scattered farms that are characterized by a high heterogeneity of crops, making it challenging to analyze cropping systems, particularly when it comes to understanding the dynamic distribution of crop sequences and their driving factors.

Material and Method

2.1. Case study

The Echraf public irrigation scheme is located on the Haouaria plain in Cap Bon and is administratively attached to the Nabeul governorate (Fig. 1). The cultivated area covers 305 ha and is irrigated from groundwater, from a collective irrigation network and from private and individual wells. The collective irrigation network is managed by the farmers' association called GDA Echraf.

Figure 1. Localisation of the study area of Echraf (Source: image SPOT6_2022_CHF-ORTHO)



The agricultural sector is managed by the regional administration (CRDA Nabeul) at the level of the Cap Bon region and by the CTV at the level of the Haouaria region. Farming systems are diversified: some are specialised in perennial crops (citrus, olive, etc), others in a mix of vegetables and fodder crops and others in livestock.

2.2. Method

For the study of the spatio-temporal distribution of cropping systems in the irrigated area of Echraf, we created a georeferenced database in 2018. This spatial database specifies for each farm, the location of their plots, its geometric shape and area and land use occupation, as well as its irrigation water resource. We gave each plot a unique identifier and attributes to describe its general characteristics (area, type of land tenure, etc). Since then, this database has been updated for each season of the year. To create this database, we collected and spatialised different forms of data that the GDA generated from 2008 to 2017: (1) paper maps and plans (plot maps, land use maps, irrigation network plans, etc.) and (2) electronic datasheets containing data for each farm (cultivated area, irrigated area, seasonal water consumption, etc.). Using the spatial database, we were able to analyze the cropping systems and identify the most frequent crop sequences in the studied area. Data on the different crops and the evolution of their cultivated areas and production at the level of Haouaria region were also collected from various public agricultural administrations and its local offices to compare the territorial and the local dynamics of cropping systems distribution.

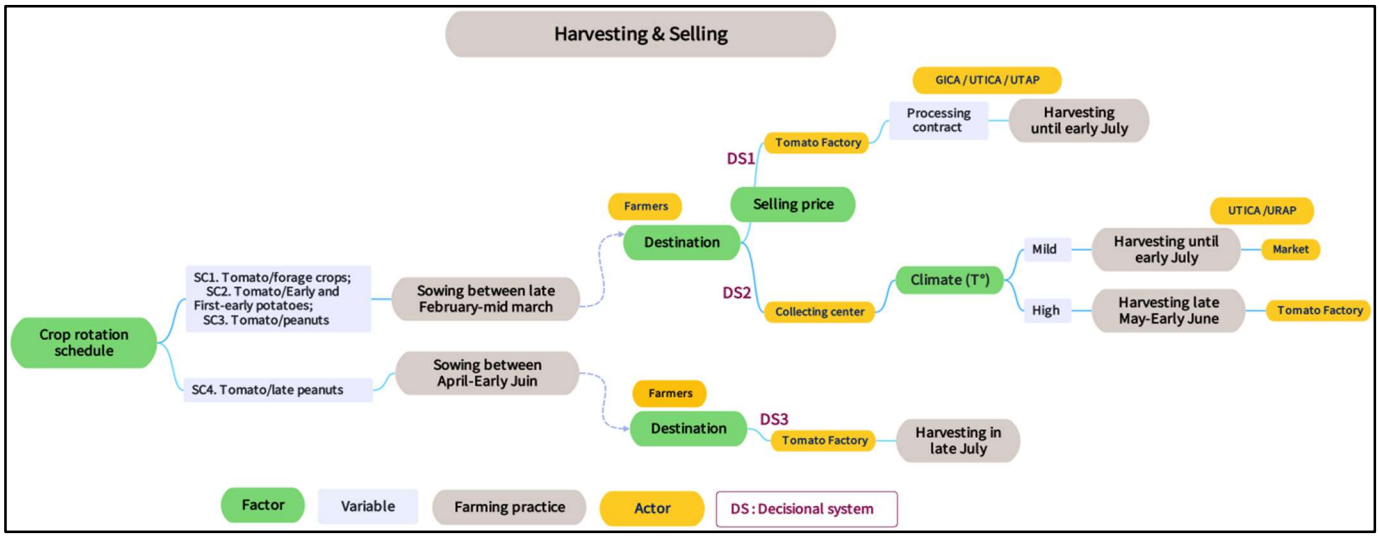
Between July and October 2023, face-to-face interviews were conducted with 11 managers from the CRDA, the CTV and the GDA. Interviewees were asked to: (1) identify the main crops in the area, (2) explain the determinant drivers for the choice of these crop types; (3) identify the three most important factors from the farmers' point of view and (4) describe the cropping calendar and

management practices for each main crop. Maps of land use occupation from 2018 to 2023 were used during these interviews to facilitate the discussion on the cropping systems change in the Echraf area. These data were meant to help the interviewees remember events that may have affected the farmers' decisions. For the main crops, we retraced the agricultural practices, the farmers' decisional system and the actors that can affect these decisions for each crop.
In this paper, we are focusing on the determinants of farmers' decisions related to tomato crop production. Since 2010, the tomato area has decreased significantly, mainly due to water scarcity and the development of tomato production in other areas, leading to the increasing of farmers' vulnerability (Arfa and Elloumi, 2021). In order to better assess this vulnerability, we analysed the influence of different factors on farmers' decisions, particularly during the harvesting and selling of tomato crops.

Findings

Tomato is the second most frequent crop in the area; it is mainly cultivated in farms where the cultivated area exceeds 5 ha (large farms), located downstream of the irrigated area. In 2023, tomato was cultivated in 36% of the large farms. The conducted interviews revealed that the most important factors driving the farmers' choice of tomato crop are agro-economic, such as the selling price, the water security, the farmers' experience and mastery of agricultural practices, and the labour costs, regardless of the spatial level of analysis: the territory or the irrigated system.
We analysed in this paper the farmer's decision-making system during the harvesting and marketing phases of the tomato crop, when the farmer faces the greatest uncertainties, linked in particular to the socio-economic context of the region and to the climate. In this example, we consider a typical year where we have considered only the uncertainty related to the climatic conditions (temperature). The availability of irrigation water is not considered as a determinant factor because the farm water needs can easily be satisfied by the collective network of the GDA or the private wells.
For the tomato crop, the most frequent crop sequence in the study area is fodder crop/tomato/fodder crop. In this case, the farmer has to plant his tomatoes between the end of February and mid-June. If the selling price is attractive and the farmer wants to ensure the sale of his production, he will sign in advance a contract with the tomato processing plant, specifying the choice of variety, the selling price and the quality required. Regardless of what happens (any hazardous events, climatic or financial, etc.), the farmer must honor this contract. In this paper, we refer to this decision system as DS1. If the farmer has chosen to go through a collection center, the date of harvest in this case depends mainly on the weather conditions (DS2). The collection center will proceed with the sale according to the date of harvest. If the temperature is mild, the crop can be harvested and sold on the market by the end of July. If the temperature is high, the farmer is obliged to harvest by the beginning of June at the latest, the production will be sold to tomato plants (DS3). Some farmers choose to sell directly to the market if farm labour is not available (Fig. 2).

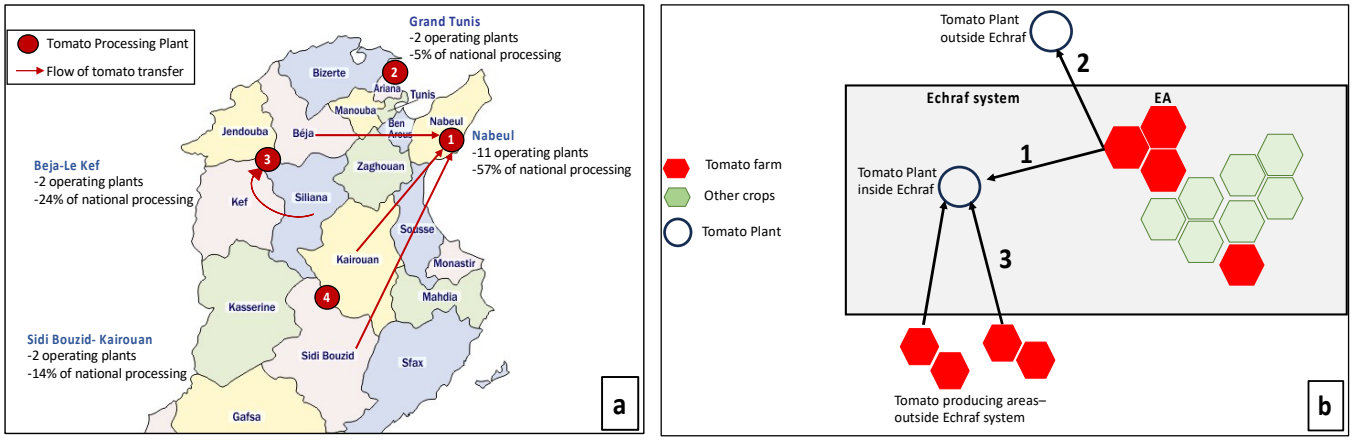
Figure 2. Decisional system-choice of tomato crop-Stage: Harvesting and selling (GICA-Union of Food Canning Industries; UTICA-Tunisian Union of Industry, Trade and Handicraft; UTAP-Tunisian Union Of Agriculture and Fisheries)



Several actors can directly or indirectly influence farmers' decisions. For example, even though the CRDA is more involved in controlling the areas of tomatoes irrigated by surface water than by groundwater, it can still indirectly influence farmers' decisions. When the CRDA restricts water-intensive cropping in public areas irrigated from the surface water, farmers in groundwater irrigation systems like Echraf, are encouraged to cultivate tomatoes. The UTAP is another example of an actor directly affecting farmers' decisions. A national committee to prepare and monitor the industrial sector is made up of representatives of GICA, UTICA and UTAP. At the start of each tomato growing season, this committee decides on the areas to be cultivated, based on the Tunisian market's requirements for canned tomato (the dominant processed form), export forecasts and the level of canned tomato stocks. This committee also sets the selling price of tomatoes to processing plants. UTAP's regional structure in Nabeul can influence the decisions of farmers in Echraf, by informing them in advance of possible increases in tomato selling prices, and restrictions imposed on other tomato-producing regions. For example, at the end of 2022, farmers were informed of the increase in the selling price for the summer of 2023. Between 2022 and 2023, the price of 1kg has risen from 230 millimes to 280 millimes (1 Tunisian dinar = 1000 millimes = 0,34 euro in 2023), the tomato cultivated area in the El Haouaria region has increased by 12% and has doubled in the Echraf system.

Another key actor is the industrial processor, which controls and coordinates the production chain for processed tomatoes and imposes its conditions on the farmers. The written contract between the producer and the processor helps to reduce price volatility, and UTAP plans to amend it to include more specific requirements, such as payment according to the quality. Figure 3 shows that farms in Nabeul produce 57% of the country's processed tomatoes from production areas that are not limited to Cap Bon but also include other regions such as Sidi-Bouzid, Beja and Kairouan. In 2022, 11 of the 17 factories operating in Tunisia are located in Cap Bon, making it the leading tomato processing area in the country (GICA, 2022). In the Echraf region, 4 factories are operating (Somocap, Socodal, Brima and STICA). During times of oversupply, farmers often consent to sell their yield at prevailing prices to avoid the risk of spoilage and unsellable produce.

Figure 3. (a) Localisation of industrial tomato processing areas, their contribution to national processing and flow of tomatoes transfers between producing areas and processing plants in 2022-(b) Illustrative diagram of potential directions of industrial tomato production in Echraf system (Producers in Echraf may sell their yield to (1) one of four local plants within the Echraf region or (2) to external plants (typically in Cap Bon and occasionally in distant areas). They compete with (3) other tomato producers from outside the Echraf region which can influence the selling price).



Practical implications

The results of this study present an example of a farmer's decision-making system concerning a structural crop, the industrial tomato. Through rapid interviews with managers at different scales (regional and local), we tried to identify the main factors and actors influencing farmers' decision-making in light of possible changes in the social and economic system. This work will make it possible to develop realistic scenarios for the evolution of cultivated landscapes and, secondly, to jointly develop sustainable agricultural production alternatives that take into account significant changes in the political and social context. These rules will be used to build models of cropping system plans based on real data on the spatio-temporal evolution of cropping systems over the last 15 years. The development of such a model will enable policymakers to assess landscape changes, formulate policy strategies and anticipate their long-term impacts.

Theoretical implications

Farmers' decision-making involves several nested levels at different temporal and spatial scales. The analysis of farming practices in the case of industrial crops revealed the complexity of interdependencies between multiple factors within and outside the decision unit. This study highlights the need for multidisciplinary research that considers actors' logic and the socio-economic system they operate in, based on a mosaic of interdependent theories to elucidate farmers' decision-making processes. In addition to analyzing farmers' rational choices in the face of biophysical change or resource dependence, it has become crucial to analyze farmers' decisions in situations where outcomes depend on the actions of other actors, considering strategic interactions and mutual incentives. These actors may be internal or external to the level being analysed and may influence farmers' decisions directly or indirectly. The study also highlights the importance of considering the influence of institutional actors, such as the regional farmers' association or the public administration, emphasizing their indirect but significant impact on farmers' decisions.

Acknowledgements

This work was carried out under a research and development convention between the INRGREF and the CRDA of Nabeul. The fieldwork benefited from the support of the Laboratoire Mixt International LMI Naila funded by the MESRS, the MARHP via IRESA, and the IRD. D.Rizzo activities are funded by ANR (project n. ANR-22-CPJ1-0050-01), IRD and the University of Montpellier via the I-SITE MUSE excellence program in the framework of the junior professorship tenure track in landscape agronomy.

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Mapping and analyzing farmers' perception of challenges and opportunities of Agriculture: evidence from Upper-Litani, Bekaa valley, Lebanon

Safa Baydoun[a], Fatima Fawaz[b], Roudaina Khalil[b], Joseph Bechara[c], Marco Heredia[d], Vincent Bijon[e], Lamis Chalak[b], Mehdi Saqalli[f]

[a] Research Centre for Environment and Development, Beirut Arab University, Lebanon, safaa.baydoun@bau.edu.lb

[b] Department of Plant Production, Faculty of Agronomy, The Lebanese University, Dekwaneh, Beirut, Lebanon, fatimafawaz888@gmail.com, khalilroudaina@gmail.com, lamis.chalak@gmail.com

[c] Lebanon Reforestation Initiative, Jdeideh, Lebanon, jbechara@lri-lb.org

[d] Universidad of Quevedo, Av. Carlos J. Arosemena 38, Quevedo, Ecuador

[e] Université de Paris Cité /INALCO, 13e arrondissement, Paris, France

[f] UMR 5602 GEODE Géographie de l'Environnement, Maison de la Recherche, Université Toulouse 2 Jean Jaurès, Toulouse, France, mehdi.saqalli@univ-tlse2.fr

Abstract: Rural population perception may help to understand the rationality on which the various uses of a territory are implemented and by then the agriculture and food security challenges over a territory and its population. Investigating these perceptions, meaning collecting criteria of local territory discrimination and spatial coverage could be assessed, among other approaches, by exploring farmers' perception on spatial territory, for the first time in the Upper Litani Basin (ULB), Lebanon. It combines (1) semi-structured individual interviews using qualitative and quantitative indicators with 120 local farmers and (2) perception-based regional mapping (PBRM) developed on 36 farmers displaying a 1,395 km2 coverage (90%) of ULB. First method shows that economic constraints, weak institutional support, market constraints, the occasional closure of Syrian borders during severe hostilities and finally climatic conditions are perceived as the most damaging challenges on agriculture. The second tool provided ten criteria discriminating the investigated territory: cultivated crops, water availability, water origin, water quality, crop irrigation type, soil type, soil fertility, landform, arable cover and agricultural productivity. The mapped units reflected considerable spatial variations in dimensions and characteristics, reflecting the need to consider farmers' perceptions in decision-making and interventions to mitigate agricultural challenges.

Keywords: Perception mapping, indicators, agriculture, Lebanon

Purpose

Uniquely positioned in the convergence of human society and the environment, investigating local communities' perceptions in relation to their environment and natural resources has been widly used as a powerful tool in formulating management and development strategies, especially in the NGO sector (Duong et al., 2019; Courage Shereni & Saarinen, 2021; Lalani et al. 2021; Saqalli et

al. 2023). Perception is defined as “the way an individual observes, understands, interprets, and evaluates a referent object, action, experience, individual, policy, or outcome” (Bennett, 2016). Various community perception-based approaches were conceived since the Participatory Research Assessment of Chambers (1994) to collect qualitative and quantitative data and identify priorities from specific groups or a whole population living on a territory by different research or operational groups in various contexts (Hayden et al. 2018; Courage Shereni & Saarinen, 2021; Lalani et al. 2021; Saqalli et al. 2023). Despite that, following Arnstein and his ladder of participation, acknowledging the value of community perceptions and rationalities in rural management and development plans is still scarce in many regions and this has a direct connection to political power. This study aims to understand how farmers perceive agriculture structural constraints and factors, both economically and environmentally and spatially. It is assessed in Lebanon and more specifically in the plain of Bekaa in the Upper Litani Basin (ULB) (Fig. 1). The approach used is called Perception-based Regional Mapping (PBRM) that considers spatial visualization of multiple criteria identified by community members and mapping them as geographic units or polygons within the space of the study territory (Saqalli et al. 2009; 2023). This approach is proposed to provide relevant multiple scale information for a more developed local based context for decision-making and development actions.

Case study

Despite the considerable efforts invested by the Lebanese government and its international partners, Lebanese agriculture has been shattered by an accumulation of crises (rapid population growth mostly due to the Syrian refugee crisis, recurring political conflicts, armed hostilities and wars exacerbated by current economic and financial crisis, which started in 2019), features major uncertainties and inefficiencies, and had to adapt to different economic, political and social contexts, progressively becoming more extreme (Dal et al., 2021). Recent reports show that Lebanese agriculture can only satisfy 20% of local food demands and food prices persist to increase causing many Lebanese and Syrian refugees to be food insecure (FAO, 2020; 2023). The ULB Bekaa region is recognized as the hub of agriculture in the country accounting for 43% of total cultivated land (Fig. 1). In such rural settings, agriculture is stated as a main driver of up to 80% of the local GDP (Dal et al., 2021).

Methodology

The study employes low-cost approaches of 1) face to face interviews with 122 farmers (1 female and 121 males) by a semi- structured questionnaire that has open and closed-ended questions on challenges and potential opportunities of agriculture in study area and 2) PBRMs based on the perception of 36 community participants. The study was conducted during summer 2023 and followed a non-probability sampling method with purposive sampling technique for the selection criteria of participants. Of the interviewed farmers, 64 (52.5%) operated at a large-scale level, while 52 farmers (42.62%) were operating at a medium-scale level, with average land area of 62,06 ha and 3.44 ha, respectively. The remaining small-scale proportion was comprised of only six farmers (5%) with an average land area of 0.36 ha. More than half of the farmers (n= 63, 51.64%) rented their lands, 42 farmers (34.43%) reported their personal tenureship, and the remaining 17 farmers (13.93%) had shares of both personally owned and rented lands. The cultivated crops consisted of a high diversity (Fig. 2) with wheat, potato, and vegetables being the main crops (Fig. 2). The

farming systems were mostly conventional, with one farmer only practicing organic farming. Both groundwater and rain were the main sources for irrigation water. Several crop rotations involving the cultivation of two or three crops of potato, wheat and legumes over multiple growing seasons and mechanized tillage, seed sowing, and harvesting mostly with wheat, lentils, and potato were common.

For the PBRM, delineated zones on a geographical A2-sized map from the database of the Lebano-French Environmental Observatory (O-LiFE) were created based on participants' perception they draw on a tracing paper, overlapping the map, allowing participants to draw polygons based on individually identified differentiation criteria. These polygons and their corresponding units were sequenced according to their presentation during the mapping session and were then digitized using a GIS software for further analysis. A detailed description of the PBRM method is documented by Saqalli et al. (2023). The digitized maps were integrated into a GIS, facilitating the linkage of information related to criteria and their order of importance. The resultant shapefile, initially lacking defined shapes, was combined with a 100m grid file to enable the statistical representation of each criterion per cell. This integration helps in accurately representing the spatial distribution and significance of the identified criteria.

Findings

Table 1 presents the challenges and opportunities perceived by farmers. According to the frequency of farmers perceiving a specific challenge, economic constraints such as the limited or even absence of access to financial credit and collapse of Lebanese currency and fluctuation of exchange rate, represented the main challenges. These are inevitable consequences of the poor political and economic governance and the multiple crises Lebanon has been facing in recent years (Dal et al., 2021). Addressing these priorities should facilitate an effective recovery and development of Lebanese agriculture. According to farmers, the introduction of new financing instruments, enhancing access to credit, institutional support, improved agricultural extension services adequate and developing appropriate trade and marketing plans among others (Table 1). The current Lebanese agricultural strategy 2020-2025 identifies eight strategic priorities that display a mismatch with those perceived by farmers (MoA, 2020). While farmers identify enhancing access to financial credit and extension services as top priority opportunities, the national strategy places less importance on them despite the recognition of the major financial constraints and that technical development is mostly led by the private sector.

Table 1. Challenges and opportunities of agriculture, Upper Litani Basin, Bekaa, Lebanon

Challenges	Opportunities
Economic	**Economic**
– Limited (absence) access to financial credit – Collapse of Lebanese currency & fluctuation of exchange rate – High cost of energy, agrochemicals and trading	– Enhancing access to financial credit – Addressing high energy costs
Institutional	**Institutional**
– Inadequate agricultural subsidy programs – Limited agricultural extension services	– Enhancing extension services
Marketing	**Marketing**
– Lack of effective marketing policies – Closed Syrian borders/High passage facilitation fees through Syrian trade route	– Emphasis on Trade and Market Related Issues – Promoting Marketing and Trade Routes

– Illegal import (competition of Syrian product)	
Environmental aspects – Climate conditions – Scarcity of water (quality and quantity)	
Limited availability of labor	**Utilizing Syrian Refugees as labor**
Low quality of agrochemicals and adulteration	
Limited organizational capacity and agricultural cooperates	
Limited support from international programs	**Enhancing support from international development programs & funding agencies**

The PBRMs covered an area of 1,395 km^2 representing about 90% of the area of ULB (1,500 km2) (Fig. 1). Participants identified 10 criteria for the differentiation of the units/polygons. The criteria included: crops cultivated, water availability, type of water resources, water quality, crop irrigation, soil type, soil fertility, landform, area of arable land, agricultural productive and, listed in order of their presentation during the mapping process. Figure 3 illustrates the spatial differentiation in water availability as indicated by community percepation. The territory features four levels of water availability ranging between low and very high with the latter being generally dominant.

Figure 1. Upper Litani Basin and area covered by the perception mapping survey using PBRM.

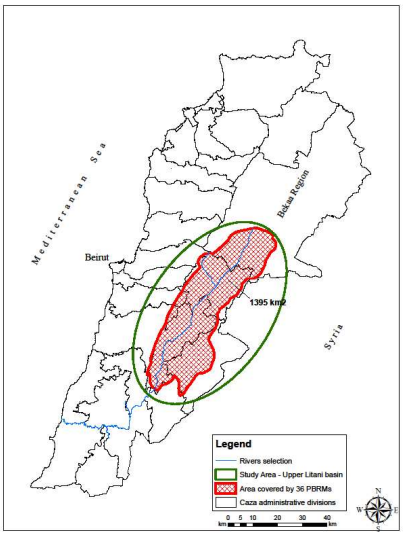


Figure 2. Types (left) and area (right) of crops cultivated by farmers who participated in the perception field survey.

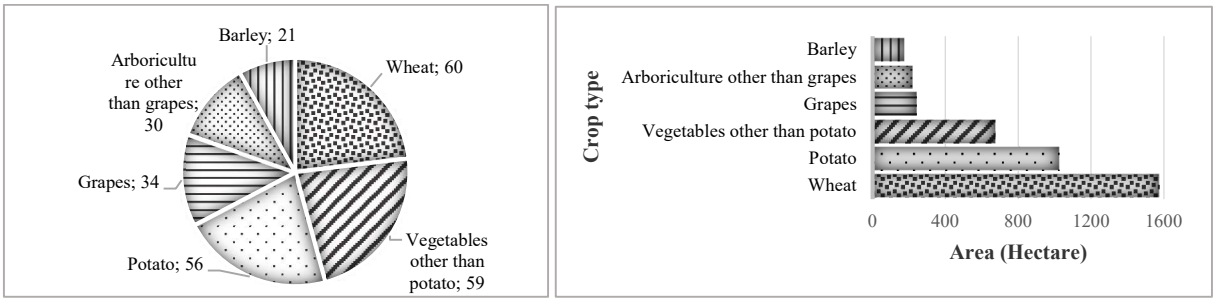
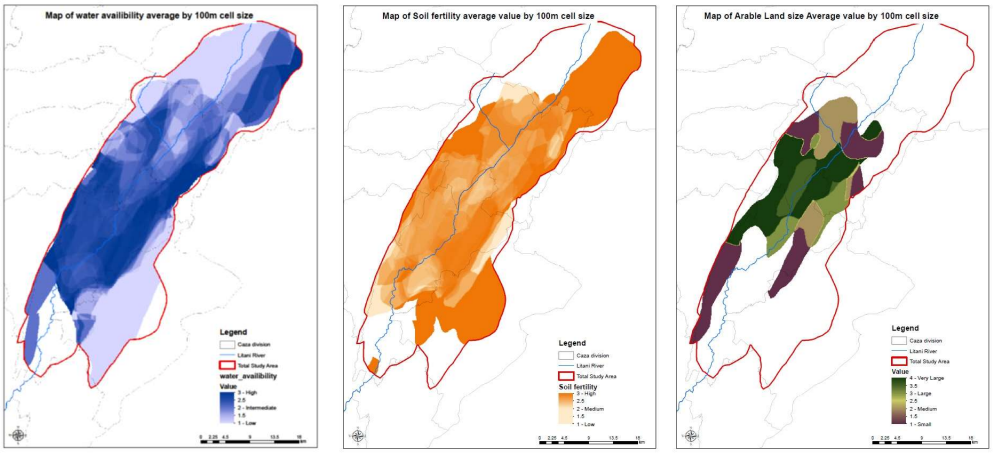


Figure 3. PBRM of water availability, soil fertility and farm size in the study area as perceived by local participants.



Practical Implications

This study provides insightful information of Lebanese farmers perception related to challenges and opportunities of agriculture. Farmers perceived many challenges undermining agriculture in ULB and potential opportunities to address them. Nevertheless, the mismatch indicated between farmers‘ perceived priorities and those identified in current national strategy 2020-2025 indicate the need for the recognition of the voice of farmers and local realities to inform appropriate management decisions and intervention actions to foster agricultural production sustainably and efficiently meet food security needs. It is apparent that limiting strategic priorities and management options to only "top-down" approaches leads to unsatisfactory results (Duong et al., 2019). Nevertheless, exploring socio-economic contextual factors that influence farmers' perceptions could enable national programs to better target farmers at both local and national levels who are more likely to be amenable to particular programs (Duong et al., 2019).

The PBRM of water vailabilty (Fig. 3) can provide a rich of place-specific information to water resouces mangment and agricultural planning. This reflects considerable spatial variations in the crops cultivated. A better understanding of multiple spatial scale patterns, covering other regions in Lebanon, can support the development a more relevant context for decision-making and interventions in agriculture at country scale and beyond. Although it is too hastily to draw any practical implications, findings still highlight the importance of PBRMs in cartographic communication and visualization in the natural resources management.

Theoretical Implications

This study provides empirical evidence on the importance of PBRMs in deepening knowledge in cartographic communication and the process of information transfer as well as the design of participatory solutions. Issues related to the efficiency of BPRMs reading, interpretation and use remain of particular importance for future research.

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Perception of local stakeholders and biophysical assessment of water erosion control in a Tunisian semi-arid catchment

Amri Samar[a,b], Ben Slimane Abir[b], Rebaï Houda[c], Fehri Noômène[d], Rizzo Davide[e], Raclot Damien[e]

[a] Faculté des Sciences Humaines et Sociales de Tunis (FSHST), University of Tunis, elaamri.samar@gmail.com

[b] National Research Institute of Rural Engineering, Water and Forests (INRGREF), University of Carthage, abir.ben.slimane@gmail.com

[c] Institut Supérieur des Sciences Humaines Jendouba (ISSH), University of Jendouba, houdarebai@gmail.com

[d] Faculté des Lettres, des Arts et des Humanités de la Manouba (FLAHM), University of Manouba, fehri_n@yahoo.fr

[e] LISAH, Univ Montpellier, AgroParisTech, INRAE, Institut Agro, IRD, Montpellier, France, davide.rizzo@ird.fr /damien.raclot@ird.fr

Abstract: In Tunisia, water erosion affects more than half of the agricultural land area. To combat the degradation it causes, over a million hectares of farmland have been managed through contour benches since 1960. However, many of these areas still encounter issues with water erosion processes, and the reasons behind these poor outcomes remain unclear. This study aimed to provide feedback from a case study where contour benches have been extensively implemented as a water and erosion control measure. It consisted in comparing a biophysical assessment based on the identification and mapping of erosion issues and contour benches degradation with an analysis of local stakeholders' perceptions obtained by survey. The study area is the Sbaihia catchment (3.57 km², northern Tunisia), which is representative of semi-arid hilly farmland and is characterised by a 42% contour bench surface. Our results show discrepancies between the perceptions of local stakeholders and the findings of the biophysical assessment. In particular, they highlight a lack of knowledge and awareness of local stakeholders who were not involved in the land management program, resulting in inappropriate practices and modifications of the contour bench sequence by them.

Keywords: contour bench, erosion control, stakeholders' perception, biophysical assessment, Tunisia.

1. Purpose

The Mediterranean region is naturally vulnerable to erosion, further enhanced by the long history of anthropic pressure (García-Ruiz *et al*., 2013). Nevertheless, the societies in this region have taken measures to control this form of degradation, such as terracing hilly areas, with varying degrees of success depending on the environmental and societal contexts (Raclot *et al*., 2016). In Tunisia, water erosion affects more than half of the agricultural land area, with major negative on-site (e.g., reduction or alteration of soil properties) and off-site (e.g. reservoir siltation) impacts. This has justified the use of various soil and water conservation measures, among which contour benches are the most widespread on the hillslopes (Fehri, 2003).

However, many of these areas still encounter issues with water erosion processes, and the reasons behind these poor performances remain unclear. In the academic field, soil and water conservation measures have been studied either from a biophysical assessment perspective (Baccari et al., 2008; Fourati et al., 2015) or focusing on a socio-economic aspect (Dangiso and

Wolka, 2023; Gennai-Schott et al., 2020). Only a few studies have considered these two perspectives (Fehri, 2003). In this context, the present study aimed at evaluating the performance of the water erosion control system by comparing local stakeholders' perceptions of the soil and water conservation measures with a biophysical assessment of their (dys)functioning. To this end, the methodology combined field surveys, socio-economic surveys, and cartographic analysis.

2. Methodology

2.1. Study area

The study area is a small rural catchment called Sbaihia. It is located in north-eastern Tunisia (Fig. 1A). It belongs to the Imada of Oued Sbaihia, where 2000 inhabitants reside in the form of 9 *Douars* (small dwellings nodes), facing various development problems such as water shortages, unemployment, and poverty in general (Ounalli et al. 2021). The catchment is situated in a hilly and semi-arid environment typical of the southern Mediterranean. Its area is affected by water erosion, which still has on-site and off-site negative effects whilst 42 % of its surface is currently managed by mechanical contour benches with total water retention (Fig. 1B).

A mechanical contour bench is an earth embankment built along a contour line, perpendicular to the slope, to intercept and store runoff water and thus protect agricultural lands, as well as limit the siltation of the outlet reservoir (Fig. 1C). Its outlet is composed of a small reservoir built in 1993. It rises to 473 metres above sea level in its northern part belonging to Jebel *Bou Khouf*. Its surface is 3.57 km² and 60% of it has slopes greater than 15%. The lithology is dominated by alternating hard and soft rock, the latter covering around 57% of the catchment area. The climate is Mediterranean semi-arid, with an average annual rainfall of 413 mm, and the hydrological and erosional regime is very intermittent.

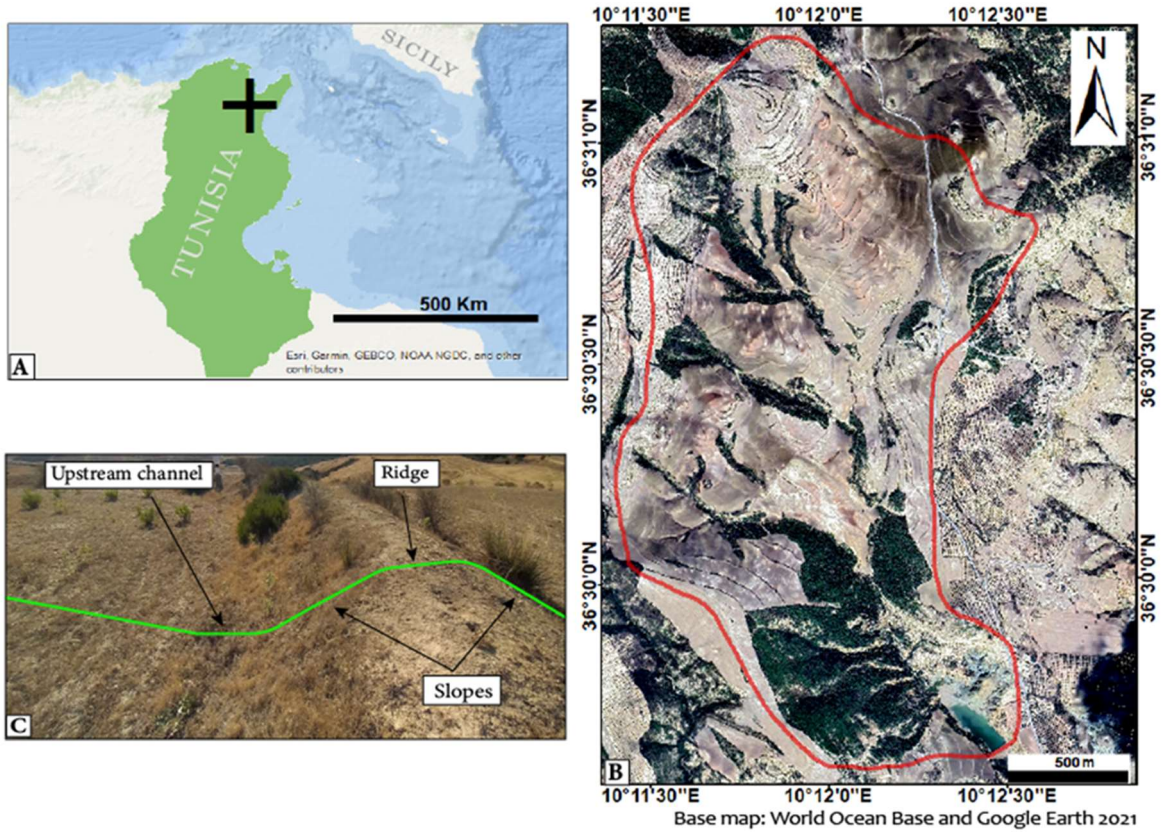
The catchment surface is mainly dedicated to agricultural land belonging to a single farmer. It includes crops, mainly cereals and some perennials, forests, and pastures that occupy 50%, 28% and 18% of the catchment area, respectively, while the remaining area is for the lake reservoir. The construction of most of the benches took place under the leadership and supervision of the national authorities, via two implementation phases first in 1981-1982, then around 1990 (Rebai, 2017). Between and especially after these two construction phases, the landowner of the Sbaihia catchment made several adjustments by removing some benches or building new ones.

2.2. Biophysical assessment

A comprehensive biophysical evaluation of the functional state of contour benches was carried out in 2022. This involved several field surveys in the Sbaihia catchment area to document the geometry (location, shape, dimension, continuity) of each contour bench and to locate any dysfunctions. Here, a contour bench dysfunction defines a local anomaly in terms of geometry or misuse that may compromise the overall coherence and efficiency of the contour bench system. The present work has consisted in an inventory of them based on expertise. The information was systematically localised by a GPS and digitised using a geographic information system software. These field surveys also documented basic information on land use or erosion evidence on the upstream and downstream inter-benches areas.

Figure 1. Localisation (A), aerial view (B) illustrating the contour benches system and the main land use of the Sbaihia catchment, and schematic view showing the upstream

channel, the ridge, and the slopes of a typical contour bench in Sbaihia (C).



2.3. Survey approach

The survey of local stakeholders aimed to explore their link to the studied area, their perception of water erosion phenomena and of the role of contour benches. It was based on a detailed directive questionnaire composed of close-ended questions, mostly categorical to ease the treatment and comparison of the answers. It was structured into four main parts to address: (1) the socio-demographic profile of the respondent, (2) the farm characteristics, (3) the relation with soil management activities and structures and the perception of soil erosion and functional state of contour benches, (4) the role and degradation of the forest. The questionnaire addressed witnesses of the changes that have occurred in the catchment over the years. To this end, the sample included the main land owner and one participant for each of the closest households living in or near the study area.

3. Results

3.1. Identification of contour bench dysfunctions

In the Sbaihia catchment, we have identified and mapped three main types of contour bench dysfunction in 2022:

Disappearance or significant attenuation of the upstream channel. It corresponds to a partially or completely filled upstream channel, which considerably limits the retention of runoff water and leads to a high risk of ridge overflow.

Weakening of the contour bench slopes. It corresponds to natural or anthropogenic ablation or excavation of the bench slopes which may lead to local contour benches breaches. It includes tunnels crossing the bench, leaving the ridge overhanging.

Removal or break of a contour bench section. It corresponds to the partial or complete removal or break of a short section of the contour bench (both slopes and ridge), either in its central part or at one of its extremities. This is the riskiest type of dysfunction because it promotes local overflow, stimulating water concentration and downstream gullying.

3.2. Local stakeholders survey

The 30 respondents reported four types of direct links with the catchment area, namely: (i) farmers working in the catchment on a permanent or seasonal basis, including the only one owner of the catchment; (ii) herders conducting their livestock in the catchment; (iii) water users from the reservoir in the catchment outlet; (iv) forest users frequenting the area for the collection of wood, Aleppo pine nuts or aromatic plants. Among them, 14 declared being landowners in or near the study area and half of them were also concerned by the construction of benches during the national implementation phases.

Concerning soil management, 80% of the respondents stated that the region is threatened by water erosion and mainly mentioned natural drivers, namely extreme rainfall events (70 %), steep slopes (7%) or type of vegetation cover (3%). Accordingly, for 80% of the respondents, the main role of the contour benches is to store runoff or protect soil. Only one respondent mentioned a negative impact of contour bench related to the asphyxia of young tree crops planted in the upstream channel.

Globally, the perception of the impact of the contour benches system is positive. Nevertheless, all the respondents stated that they have not been included in the diagnosis step to design the contour benches management and 70% of respondents said they have no idea about the criteria used for choosing the areas managed by the national authorities. The weak involvement in the decision-making process relative to implementation led to a negative perception of the process, which remained rather unclear for them.

Finally, 63% of the respondents answered that the main factor explaining the dysfunction of contour benches is extreme rainfall events. Only 7% considered that low maintenance is the main reason for contour bench dysfunctions, and for all of them, maintenance is the responsibility of national authorities.

3.3. Comparison between the perception of local stakeholders and the biophysical evaluation of dysfunctions

The discrepancy between the perception of local stakeholders and the biophysical evaluation of dysfunctions revealed two main misuses of the managed area by local actors: the first related to contour bench maintenance, and the second to contour bench modification.

Lack of maintenance of the contour benches: Surveys and field observations have shown that the owner of the Sbaihia land was trying to correct a few of the contour benches' dysfunctions using traditional methods but without necessarily fully controlling the techniques. Generally, there is a lack of regular maintenance which highlights an unsustainable use of contour benches. This involves the gradual elimination of the upstream channel, and sometimes part of the bench slopes, by tilling and cultivation. In addition, as livestock farmers graze their ruminants (mainly goats and sheep) in the studied catchment, the contour benches serve as cattle paths and are therefore frequently trampled by the herds. The repeated passage of livestock can, in some cases, weaken the slopes of the bench and cause the ridge to collapse. Moreover, grazing prevents the bank from being stabilised by the installation of vegetation.

Modification of the contour bench system: A main negative practice observed was to increase the cultivated area between contour benches by removing some contour benches. This practice was also identified by Roose (2002) in several Tunisian governorates. Indeed, the enlargement of the inter-bench distance may generate a runoff volume that exceeds the retention ability of the downstream contour bench, promoting failure by overflow. The second damaging practice was splitting contour benches to open access roads for agricultural machinery, which is one of the main reasons for the local removal of a contour bench section. The most severe consequences did not appear on the divided contour bench but mostly on the downstream areas receiving the concentrated runoff. The third harmful practice identified in the Sbaihia catchment was the installation by the landowner of a contour bench inappropriately, i.e. not on a contour line, leading the contour bench to be quickly degraded. This improper planning reveals that the farmer is not fully aware of the interaction between the sequence of contour benches.

4. Practical and theoretical implications

Research often focuses on the natural or biophysical factors that determine erosion processes and the longevity of soil and water conservation measures. However, the comparison between the perception of local stakeholders and the biophysical evaluation of dysfunctions in the Sbaihia catchment has highlighted that, anthropogenic factors can amplify the natural factors involved in soil degradation and undermine the anti-erosion measures put in place to control it. Therefore, there is a need for a greater focus on anthropogenic factors.

The identification and mapping of existing dysfunctions on contour benches can be used to plan maintenance and correction strategies. Our results also support the importance of taking into account the skills and concerns of local stakeholders in the definition and design of the water and soil conservation structures, as well as their long-term maintenance. Indeed, involving local stakeholders through a participatory approach can be particularly effective in ensuring the maintenance and the correct functioning of soil and land protection programs.

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Sustainable groundwater-based date palm farming: Lessons from a multi-stakeholder dialogue in Kebili Region, southern Tunisia

Insaf MEKKI[1], Nesrine TAOUAJOUTI[1], Nicolas FAYSSE[2], Abdelaziz ZAIRI[1], Hedi BEN ALI[3], Maher SGHAIROUN[3], Amar IMACHE[4], Audrey BARBE[4], Intissar FERCHICHI[1]*

[1]National Research Institute for Rural Engineering, Water and Forestry (INRGREF), University of Carthage, Ariana 2080, Tunisia;

[2]CIRAD, UMR G-EAU, 01800 Tunis, Tunisia; G-EAU, Univ Montpellier, AgroParisTech, CIRAD, INRAE, Institut Agro, IRD, Montpellier, France; National Institute of Agronomy, Tunisia (INAT), Tunisia

[3]Aride Region Institute (IRA), Medenine, Tunisia

[4]Lisode, 2512 Route de Mende, 34090 Montpellier, France

*Corresponding author: Insaf Mekki (insaf.mekki.im@gmail.com)

Abstract
The sustainability of groundwater-based date palm systems in Kebili Region, southern Tunisia, is challenged by the continuous increase of farmed areas under private initiatives called “extensions”, irrigated from illegal boreholes and the development of photovoltaic panels used for pumping the underlying aquifers. Actors have identified the overexploitation of groundwater resources as the main threat, but there has been no discussion on how to respond to this concern. This is resulting from the complexity of interactions between different actors’ strategies, diverse decision-making processes across sectors and spatial levels. Therefore, a common representation of the issues and of actors’ interventions at different scale, is a prerequisite to facilitate the emergence of more collaborative and sustained groundwater use. This study investigates an integrated approach that helps the creation of conditions for dialogue between groundwater actors. The developed approach integrates a spatial analysis tool, surveys and a multi-actor participatory process. The main output of the multi-actor participatory process is the initiation of a dialogue including stakeholders representing the diversity of farming situations, public sectors, and spatial level. The study underlines that combining spatial analysis knowledge and a participatory process catalysed stakeholder dialogue and enabled the identification of measures and the creation of policy-based knowledge towards sustainable groundwater management.

Keywords: Groundwater Governance, Participatory Mapping, Multi-actor Process, Palm Date, Sustainability.

Purpose

Global groundwater resources are under pressure, with effects on producers, food and fibre production systems, communities and ecosystems (Molle & Closas, 2016). Groundwater-based agriculture sustainability cannot be answered by just one actor but rather using a multi-actor approach perspective. Indeed, it involves different actors such as researchers, farmers, entrepreneurs, regional and national organisations and results from their complex “systemic interactions” (Belmans, 2018). Biophysical research has

clarified the challenges and proposed a series of technological solutions. However, achieving a sustainable use of groundwater is fundamentally a governance challenge, that spreads over a continuum from local- to global-scale. Many knowledge gaps exist to assess change drivers and their consequences that compromise the development of both optimal local adaptations and national, regional, and global mitigation objectives (Berger et al., 2019). The real challenge is dealing with systems that are not only cross-scale but also dynamic, creating important uncertainties about stakeholders' responsibilities. Despite all these difficulties, the adaptive governance literature reports evidence that well-structured dialogue involving policy makers, scientists, and the concerned public can lead to improved natural resource management (Folke et al. 2005, Olsson et al. 2006). However, questions about how to organize and what methods and tools can support the adaptation decision-making process still remain open in the literature. This paper contributes to the existing literature, expands the frontier of socio-technical analysis on the transition to sustainable agriculture. The aim of this paper is to investigate an integrated approach that helps to motivate participation of relevant groundwater actors and to encourage their interactions and dialogue.

Methodology

Case study

The groundwater considered in this study provides water supply mainly from two confined aquifers: the Continental Intercalaire (CI) and the Terminal Complex (CT). The southwest region constitutes the area which took 40% of the volume of water pumped in Tunisia during the year 2021. In the governorate of Kebili more than 765 Mm3 of which 47% is extracted by illegal pumping (DGRE, 2021) due to the expansion of irrigated palm groves. These private initiatives, called "extensions", developed on uncultivated collective lands, outside the old palm groves (Mekki et al., 2022). The total surface area of these extensions increased from 7,000 ha in 1996 to 32,700 ha in 2020, while that of the old palm groves, called Public Irrigated Perimeters, did not exceed 10,500 ha in 2018 (Mekki et al., 2021).

Implementation of an integrated framework

This study follows an integrated approach with the stepwise process developed by Wieczorek and Hekkert (2012) including complementary quantitative and qualitative methods to account for the complex multi-level nature of the analysis: 1) stakeholders' analysis of key actors to involve, 2) a quantitative spatial analysis approach, in-situ measurements and a data collection from interviews and surveys with territorial actors, and 3) a series of multi-actor participatory workshops that allowed to collectively identify prevailing dynamics and future scenarios (Figure 1).

Stakeholders' analysis

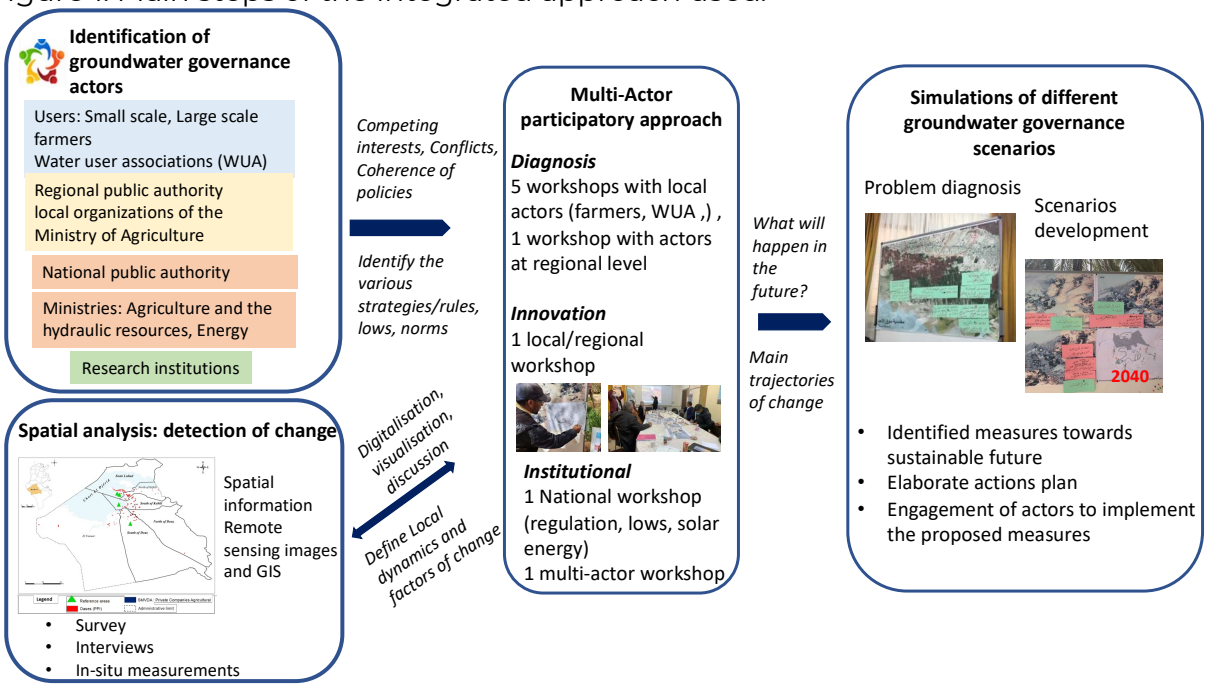
The identification of the relevant stakeholders to be involved was an iterative process, where stakeholders are added along the process. Semi-structured interviews, expert opinion, focus group or a combination of all methods were used for stakeholder analysis (Reed 2008). The actors were identified and were considered to have an influence on or to be influenced by the groundwater farming systems. Stakeholders were invited to engage in the study development and activities with different levels of participation based on their roles. These levels ranged from specific

consultations to active involvement in the project (e.g. hosting demonstrations, facilitating meetings, field visits etc.…).

Spatial analysis

Methods included diverse spatial analysis tools, interviews, and participatory workshops to retrace the spatial, social and temporal boundaries of Kebili oases transformation i) surveys, exchange questionnaire- based quantitative tools, where stakeholders are requested to individually answer questions, ii) face-to-face meetings (such as seminars, workshops, focus group, community events, or field visits), iii) participatory monitoring, the engagement of farmers, in the design of water monitoring for the irrigation; (iv) participatory training approach and demonstration farm. We use maps as a tool for peer-to-peer interpretation and dialogue.

Figure 1: Main steps of the integrated approach used.



Multi-actor participatory approach

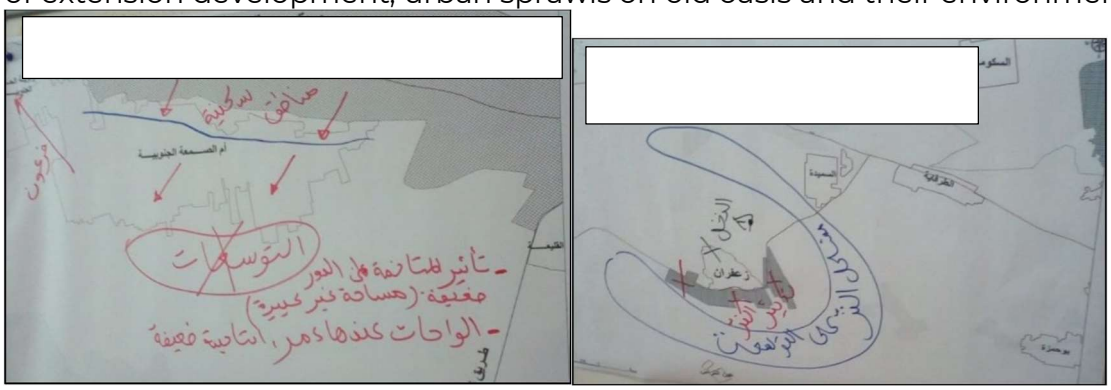
In this study, a multi-actor participatory process was implemented to engage a dialogue and build a joint vision of the on-going overexploitation of groundwater resources that promotes the co-construction of visions for the future and the actions needed to achieve them. As groups worked in separate workshops producing separate results, the fact that their priorities were not compatible was addressed. We mixed subgroup discussion with plenary debates to avoid such problem (Munaretto et al., 2014). A total of nine participatory workshops were organized between March 2021 and May 2022 that aim: (1) to motivate participation of relevant actors to the situation diagnosis (2) to create space for actors' innovations development (3) to provide to actors' institutional information such as regulations, lows, norms and, (4) to encourage actors' interactions and dialogue. Stakeholders' discussions ended with proposed options, which were a compromise that reflected stakeholders' preferences and engagement to implement them. This methodology uses maps for actors to identify and draw the main dynamics of the territory and discuss their

knowledges and the future scenarios. Based on the identified dynamics, the actors imagined and drew a possible spatially explicit scenario for the region. A series of actions towards a sustainable future of farming systems in the area was identified. Identified actions should be feasible and possible to implement at present. Each participatory workshop involved a skilled facilitator to engage participants and encourage dialogue. The constitution of the database and the data processing were carried out with QGIS software and Microsoft Excel.

Findings

Decisions on groundwater governance are influenced by multiple overlapping /nested functions, and redundant centres of power and factors that interact across temporal and spatial scales. The identified relevant stakeholders were categorised into four categories: water users (farmers, associations), regional public entities, national public entities, and research institutions. During the workshops, the actors were really engaged in the process. The main findings of the present research show that the dynamics most often described by actors are not leading to a sustainable future of the Kebili landscape (Figure 2) including the extension development and the impact on the drainage.

Figure 2: Examples of dynamics drawn during the participatory workshops. Generalisation of extension development, urban sprawls on old oasis and their environmental impacts.



The multi-actor participatory process ended with options and measures for a sustainable groundwater, which aimed to achieve a compromise that reflected stakeholders' engagement and preferences with regard to the spatial extension (table 1).

Several responses were proposed: i) revising public policies, ii) setting up adaptive legislations, and iii) implementing regulation measures. Theses responses aim to enable the control of water abstraction, while accounting for tensions between nationwide regulation policies and socio-environmental local contexts. This involves in particular:

Reinforcing the role of water user association (GDAs according to their local acronym in French) to enhance their administration and financial autonomies when relaying governmental measures.

Enhance information flow and collaboration across scales for transformations to sustainability in collective action.

A path of innovation that included promoting innovative irrigation practices an optimising water supply and drainage systems that mitigate soil salinization and waterlogging. A call for creating or improving extension services to better inform and build the capacities of farmers, so that these can implement "good practices" in terms of photovoltaic uses.

Build a regulatory framework that promote cooperation amongst farmers and links short-term agricultural development objectives with long-term water resource preservation objectives.

Table 1. Overview of the main dynamics/issues and measures towards sustainable future explored during the multi-actor participatory process.

Thematic	Dynamics	Factors of change	Measures towards sustainable future	Actors involved	Strategies for engagement/scale
Historical oasis	Water shortage High-cost water pumping Drainage problem	Complex institutional of water management policies Dysfunction of collective water management Over-irrigation situation	Collective water management Enhance performance solar energy irrigation Assess date palm water needs Improving extension services for farmers Reclamation of drainage water	CTV Research CRDA GDA	Informing/ Legislative Organizational National/local National/local demonstration/field visit
Extensions	Overexploitation of the groundwater Degradation of water resources Drainage/salinization problem Solar Energy	Little cooperation between stakeholders' Lack of communication Development of illicit wells Problems of solar irrigation	Participatory workshops Solar energy profitability studies Awareness days for farmers on the use of solar energy Subsidies	Farmers, APIA Research CRDA Ministries	Informing/ Legislative Organizational National/local Organizational/ local

GDA -Group of agricultural development (water users association), CTV-Local agricultural extension units; CRDA-Regional Centres for Agricultural Development; APIA - Agricultural Investments & Promotion Agency.

Practical Implications

Groundwater governance includes the involvement of multiple actors across different institutional and spatial levels. Successful water governance needs the coordination of these actors and their actions. In order to effectively solve conflicts between groundwater users, and to reduce pressures to groundwater sustainability, authorities need tools dynamically coupling social, and physical dimensions that will assist in making more proactive, and evidence-based management decisions. The integration of different kinds of knowledge can be used as a guiding tool to build links between all stakeholders engaged in the transition towards sustainable groundwater "economies" through (i) improving the visibility of farmers' problems, and (ii) informing stakeholders about the spatial impacts of the different activities. Spatial data allow discussions to emerge about

groundwater governance challenges. It also made it possible to identify avenues for improving the dialogue. This is related to the capacity to process information/data and to connect it to the experiences from past changes and responses, and to facilitate adaptive and innovative responses. The final decision in charge of the decision-maker(s) should be based both on the results of participation and of technical and spatial analysis, allowing to assess the feasibility and impacts of the proposed solution.

Theoretical Implications

The analytical proposed framework enabled a) a better understanding of the interactions among actors and between actors and their environment in complex systems and b) contributed to addressing the conceptual gaps in terms of studying the interconnection and interdependence of different governance levels.

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Pre-conditions for multi-stakeholder dialogue towards collaborative groundwater governance

Emeline HASSENFORDER[a], Intissar FERCHICHI[b], Imen DHAHRI[c], Samia CHRII[b], Insaf MEKKI[b], Lassâd ALBOUCHI[d], Nicolas FAYSSE[a]

[a]CIRAD, UMR G-EAU, 01800 Tunis, Tunisia; G-EAU, Univ Montpellier, AgroParisTech, CIRAD, INRAE, Institut Agro, IRD, Montpellier, France; National Institute of Agronomy,

Tunisia (INAT), Tunisia

[b]National Research Institute Of Rural Engineering, Water And Forests (INRGREF),

University of Carthage, Ariana 2080, Tunisia

[c]Higher School of Agriculture of Mograne, Tunisia (ESAM), University of Carthage Mograne, Zaghouane, Tunisia

Abstract: Growing demand for water, exacerbated by climate change, is increasing dependence on groundwater in the southern Mediterranean countries, especially in semi-arid and arid regions. In recent years, collaborative governance was put forward as a solution to manage complex socio-ecological systems such as groundwater systems. In this paper, we argue that collaborative groundwater governance is not a panacea everywhere, and that a number of conditions must be met from the start for this collaborative governance to have more chance to be effective and sustained over time. Through an analysis of literature and after reviewing twenty-five cases of collaborative groundwater governance across different regions in the world, we identified fifteen conditions enabling multi-stakeholder dialogue towards collaborative groundwater governance. These conditions are related to the resource itself, to the actors and their interactions and to institutional frameworks.

Keywords: Collaborative governance; Pre-conditions; Multi-stakeholder dialogue; Groundwater governance; Southern Mediterranean Systems.

1. Purpose

Groundwater is an important water resource for domestic, industrial, and agricultural use. It is central to food security in north Africa countries, where the local development heavily relies on the 'Groundwater Economy' (Kuper et al., 2016). Water management in southern Mediterranean countries is challenged by the growing demand for water coupled with the impacts of climate changes, especially in its semi-arid and arid parts (Faysse et al., 2011). In recent years, collaborative governance has been increasingly put forward as one possible solution to manage complex socio-ecological systems such as groundwater systems. Many scholars argue that there are several key factors enabling the development of collaborative governance and that will often determine the success of the process. In this paper, we aim to identify pre-conditions for initiating multi-stakeholder dialogue to achieve successful collaborative groundwater governance. Pinkerton (1989) identified these factors as 'preconditions' or 'antecedents' that provide 'the impetus for collaborative management'. We seek to propose a list of pre-conditions that is manageable (i.e. clear, not too long) so that it can be used by local stakeholders (managers, administration users,

etc.) who want to set up a collaborative management process for groundwater resources in their area and who are interested in finding out how the collaborative governance was initiated in other contexts. This work is conducted in the frame of BRIDGE-C4S Groundwater project (Climate-Smart System Solutions and Scaling), a part of the ClimBer Initiative (Building Systemic Resilience against Climate Variability and Extremes). It aims to support groundwater governance in Tunisian irrigated systems to co-construct climate and water smart solutions.

2. Design/Methodology/Approach

2.1. Frame of analysis

The establishment of effective collaborative processes remains a major challenge due to the specificities of groundwater ("invisibility", interdependencies between actors, less easily available data, etc.). In this paper, we argue that collaborative groundwater governance is not a panacea everywhere, and that a number of conditions must be met from the start for this collaborative governance to be more effective and sustained over time. We define pre-conditions as the pre-requisite conditions favorable to the start-up of a multi-stakeholders' dialogue or a participatory process aimed at achieving collaborative governance in the end. We also assume that collaborative governance is generally established following a participatory process or a multi-stakeholder dialogue. Participation may be defined as a process where public or stakeholder individuals, groups, and/or organizations are involved in making decisions that affect them, whether passively via consultation or actively via two-way engagement (Reed, 2008). Multi-stakeholder dialogue aims to create and support spaces, in which meaningful conversations can take place among diverse stakeholder groups (Leeuwis and Pyburn, 2002). In 1997, Berkes estimated that the antecedent or precondition was a fundamental component of co-management. He states, "very little scholarly work addresses, in my opinion, the key question: When is co-management feasible?" (Mccay and Jones, 1997). Since then, some authors have looked more closely at certain preconditions (Ansell and Gash, 2008; Plummer and Fitzgibbon, 2004). However, the majority of scholars working on the evaluation of collaborative governance were more interested on the evaluation of outcomes of the collaboration or the process itself (Emerson et al., 2012).

2.2.Methodology

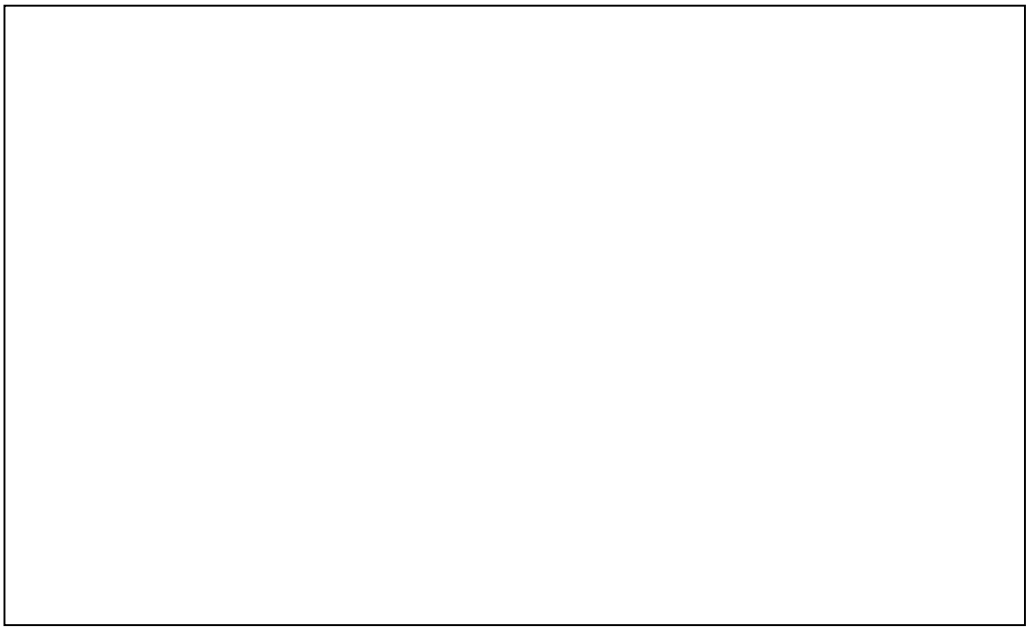
The identification of the pre-conditions is based on a comprehensive review of the conditions necessary for collaboration in different contexts and specific case studies investigating groundwater co-management. We searched several databases (Google Scholar, Scopus, Web of science). We used different combinations of the search terms: "participative governance", "participatory governance", "co-management", "joint management", "collaborative governance", "cooperation", "collective action", "partnership", "multi-stakeholder dialogue", "participatory process", "enabling conditions", "pre-conditions", "antecedents", "starting conditions", "criteria, factors", "initiating", "emergence", "barriers", "variables". Combinations of these search terms and the terms "groundwater" or "aquifer" were used to search to identify preconditions for multi-stakeholder dialogue to achieve successful collaborative governance of groundwater resources. It allowed us to identify 157 papers that mentioned conditions for collaborative governance, among those, 84 paper did not mention "pre- conditions". The pre-conditions related especially to the

context of groundwater systems were completed through the analyze of a database of twenty-five cases of groundwater collaborative governance cases. This database illustrate examples of sites worldwide where groundwater has been managed in a participatory manner and detail the problem of the cases, how and by whom the dialogue among stakeholders was initiated, the governance modalities that have been implemented, the solutions that were identified as well as the obstacles and levers to participatory groundwater management.

3. Findings

In the literature, several pre-conditions have been extensively cited as crucial for initiating multi-stakeholder dialogue to achieve successful collaborative governance (Fig.1). From the C4S database we identified references citing pre-conditions in the specific context of groundwater governance. Additionally, we identified several frameworks to evaluate whether the starting conditions were facilitative or impediment to the collaborative governance. Ansell and Gosh (2008) identified three main pre-conditions for initiating the collaboration across a range of policy sectors: (1) incentives to participate (financial incentives, interdependence, legally mandated), (2) prior history of conflict or cooperation and (3) power and resource imbalances. Plummer and Fitzgibbon (2004) identified 5 pre- conditions for initiating a co-management process of natural resources: (1) Real or imagined crisis; (2) Willingness for local users to contribute; (3) Opportunity for negotiation and incentives; (4) Leadership and (5) Coming vision and existing networks.

Figure 1. Review of preconditions identified in the literature and case studies



Fifteen preconditions were identified and grouped into three families (Table 1): (i) preconditions related to the resource characteristics, (ii) preconditions related to the actors and their interactions and (iii) preconditions related to the institutional context.

Table 1. Resulting list of pre-conditions and associated hypothesis

PRE-CONDITIONS RELATED TO RESOURCE CHARACTERISTICS	
1	***Extent of the aquifer*** Dialogue is more feasible if the aquifer is small, as the number of users is smaller.
2	***The risk of the deterioration and/or the overexploitation of the groundwater*** If the aquifer is critically depleted or degraded, users will find dialogue complex. Conversely, if abstractions are minimal compared to available resources and recharge, or if contamination risks are low, stakeholders may perceive little incentive to participate.
3	***Existence of an alternative water resource*** If users have access to alternative water resources, their dependency level on groundwater is reduced and they will be less inclined to take part in the groundwater dialogue.
PRE-CONDITIONS RELATED TO ACTORS AND THEIR INTERACTIONS	
4	***Local stakeholders' awareness of the problem*** If local stakeholders are unaware of the problem of degradation and/or overexploitation, they will be harder to mobilize. If local stakeholders perceived risks associated with potential and credible threats to groundwater, they will be more motivated to take part in the dialogue.
5	***Sense of responsibility*** If stakeholders have a sense of ownership and responsibility for groundwater resources and management, they will be more inclined to identify sustainable solutions.
6	***Existence of one or more individual or collective leaders among users*** The existence of dynamic individual or collective leaders (associations, groups, etc.) is an enabling condition for dialogue.
7	***Prior history of conflicts and collaboration*** If there is a prehistory of conflict between local stakeholders, dialogue will be more complicated to establish. On the other hand, an history of successful cooperation can increase the willingness of stakeholders to collaborate.
8	***Inequalities between users*** If there are major inequalities between users (particularly in terms of land and water resources), dialogue will be more complicated to establish. If the users form a homogeneous community, it would be easy for them to engage in face-to-face communication.
9	***Interdependence*** If the stakeholders perceive that the achievement of their goals is dependent on the co-operation of other stakeholders, they will have a greater incentive to take part in the dialogue.
PRE-CONDITIONS RELATED TO THE INSTITUTIONAL CONTEXT	
10	***Valorization of groundwater resources*** If the aquifer represents a key resource on a national and/or regional scale (particularly from an economic point of view), stakeholders will be more inclined to identify sustainable solutions.

11	***Political support from actors with decision-making power***
	If no political actor with decision-making power supports the dialogue, then it is more likely to fail. Conversely, an alignment of political interests in favor of the cooperative resolution of the problems associated with the aquifer will facilitate the dialogue.
12	***Resources available to set up such a dialogue***
	If resources (human, financial, time) are available to set up such a dialogue, then it is more likely to take place.
13	***Cooperation between government agencies***
	If there is cooperation between different government departments and/or bodies, this will facilitate multi- stakeholder dialogue and the identification of sustainable solutions.
14	***Enabling institutional environment***
	If the institutional environment (including legal and regulatory framework) encourages collaborative governance, it is easier for stakeholders to engage in dialogue.
15	***Provision of information and feedback***
	Actors will likely engage in a dialogue when information (hydrological conditions, groundwater dynamics, etc.) and feedback (example, lessons learnt in successful or failed attempts to collaborate) are provided. Scientists may provide data and/or modeling results to show the trends over the resource.

4. Practical Implications

The involvement of stakeholders in groundwater management ensures that different interests, knowledge, and perspective are considered, fostering mutual understanding and conflict resolution. The identified pre-conditions will be tested in the context of a multi-stakeholder's dialogue initiated in the Limaoua irrigated area, located in the governorate of Gabés, in north-eastern Tunisia. This dialogue will mainly involve the regional agricultural administration and farmers, who are facing problems of degradation and depletion of groundwater resources. The C4S project is currently supporting this initiative.

5. Theoretical implications

Concerns over groundwater depletion have led to the development of transdisciplinary research approach which connects natural and social science. Groundwater management is embedded within co-evolving biophysical and socio-economic systems, which are difficult to capture. This study contributes to a better understanding of how collaborative governance, seen as a potential solution for ensuring groundwater resource sustainability, can be initiated particularly within the specific context of groundwater resources. We identified preconditions through by insights gleaned from scholars across various disciplines, including analysis of common pool resources and institutions, evaluations of governance arrangements and frameworks, and assessment of public participation processes and methodologies.

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SPECIAL SESSION “MEDITERRANEAN SOCIO-TECHNICAL SYSTEMS II - AGRICULTURAL LANDSCAPES”

A landscape-scale approach to reducing pesticides: how can the analysis of local initiatives and dynamics support the design of territorial transformations?

Myrto Parmantier, Marc Moraineb and Lorène Prostc

aUMR Innovation, INRAE, myrto.parmantier@inrae.fr
bUMR Innovation, INRAE, marc.moraine@inrae.fr
cUMR SADAPT, INRAE, lorene.prost@inrae.fr

Despite attempts to regulate and reduce pesticide use, progress remains limited. This calls for a more systemic approach to address this issue, which can be achieved by using the « pesticide-free » paradigm. With the aim to work on the redesign of a territory towards " zero pesticide ", we analyzed the diversity of initiatives already undertaken by local stakeholders, as first transition steps. To do so, we combined two conceptual frameworks from landscape agronomy and research on collective action. This enabled us to illustrate the interweaving of initiatives at the territory level, but also provided information on their potential role in the transition to a "pesticide-free" territory. We have identified gaps, but also synergies to be built between initiatives, and initiatives with transversal visions of pesticide reduction. These results enable us to gain a better understanding of territorial dynamics, with the aim to build a territorial design strategy with local stakeholders.

Keywords: Pesticide reduction; landscape agronomy; local initiatives; territorial design

Purpose

The use of pesticides in agriculture has been crucial in securing crop yields by mitigating the impact of pests. However, they have adverse effects on both human (Mehrpour et al. 2014); and environmental (Rani et al. 2021; Sánchez-Bayo et Wyckhuys 2019) health. Despite the implementation of various public measures aimed at reducing pesticide use and minimizing diffuse pollutions, the outcomes have been less than satisfactory (Stehle et Schulz 2015).

Within a specific territory, understood here as the sociotechnical dynamics occurring in a landscape perimeter that makes sense for local stakeholders, different initiatives often coexist. They can be individual or collective and raised by diverse stakeholders

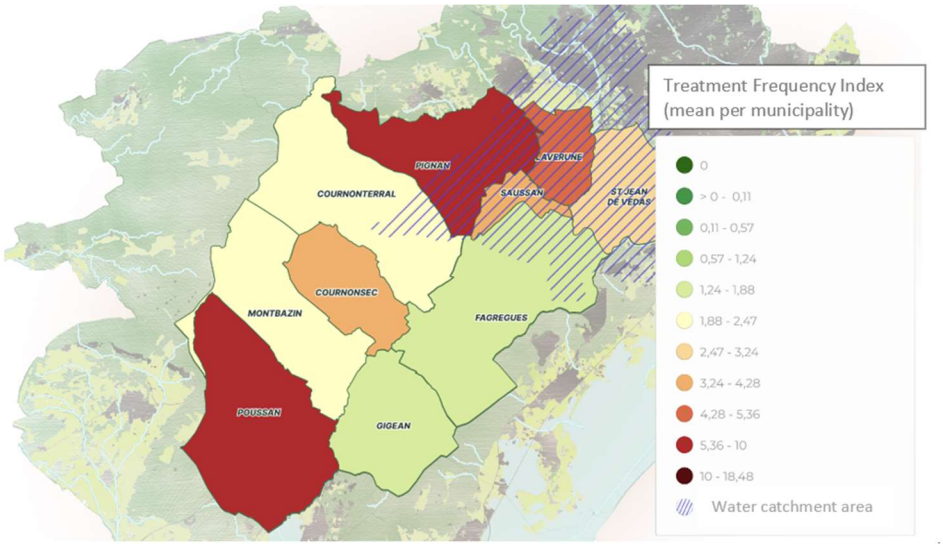
upon targeted motivations: biodiversity conservation, soil regeneration, water protection, etc., that may embrace the question of pesticide reduction in different ways. These initiatives impact and orient farming systems and land management, resulting in an evolutive landscape mosaic associated with various levels of sustainability and resilience.

The aim of this communication is to present part of a doctoral thesis' project on reducing pesticide use in the West plain of Montpellier, a middle-size city in the South of France close to the Mediterranean Sea. The objective is to analyze the diversity, complementarity, redundancy or default of initiatives that can enhance pesticide reduction at the territory level.

Design/methodology/Approach

This research was completed within the BeCreative (Built pEstiCide-free agRoecosystEms At TerrItory leVEl) French research project. This project combines three complementary areas of work: a comprehensive approach for an empirical analysis of socio-technical systems, a co-design approach to support stakeholders in designing innovations and an evaluative approach. Our analysis of local initiatives is part of the comprehensive approach and is the basis to the design approach on one of the 9 territories/case studies of the project.

Figure 1. Treatment Frequency Index on the Western Plain of Montpellier.



The studied territory is the Western Plain of Montpellier (Figure 1), a French territory of around 5,000 ha located between the cities of Montpellier and Sète in Southern France. This peri-urban and Mediterranean territory faces multiple sustainability challenges (climate change, risk of wildfire, biodiversity preservation, water resources and soil fertility). Its links with the city generate both major constraints (access to land, multiple use of natural and agricultural spaces, informal buildings, unauthorized trash dumping) and opportunities (potential for direct sales, high valorization of food products). The use of agricultural surfaces is divided between viticulture, arable crops and grasslands, with some market gardening and arboriculture.

For this research, we combined the analysis of existing reports on the territory with interviews with actors leading initiatives (18), farm visits (5), participation in 7 workshops/meetings of territorial actors and 3 field trips across the territory. We also

organized two workshops: the first one presented a first understanding of the territory to territorial actors (13 participants) and was combined with the identification of local initiatives and the second one was gathering researchers (9 participants) in order to identify innovations in winegrowing practices for the reduction of pesticide use. Finally, we presented those results to territorial actors (2 presentations) in order to validate and complete our results.

Our research is focused on how far local initiatives pave the way, or not, towards achieving a pesticide-free territory, also in regard of other sustainability issues (climate change, soil erosion). To enlighten this, we combined two existing frameworks: Collective Action in Territories (Amblard et al. 2018) and the Agricultural LAndscape Dynamics (ALaDyn) framework (Benoît et al. 2012).

For each of the 22 initiatives we identified, we first studied the material, organizational and symbolic dimensions of the territory, as well as the socio-economic and political context enabling the emergence and development of pesticide reduction initiatives (step 1). We then described the initiatives through their strategic entry according to the ALaDyn criteria : impacts on resources, practices and landscape configurations (step 2). Finally we analyzed the way the diverse initiatives coexist at territory level and their potential contribution to reducing of pesticides on the territory: how are these initiatives synergistic, antagonistic or address different strategies ?

Findings

Step 1: Territorial determinants of collective action

Farming systems in the Western Plain of Montpellier area are influenced by several factors.

The territory's many material constraints, combined with an important presence of land planning and development actors in the area (transport routes, urban development etc), are creating significant pressure on the territory, which seems likely to spur action for these stakeholders. The presence and development of certain production systems are also conditioned by material factors. Pedoclimatic constraints and agronomic potential are linked to the context of a Mediterranean coastal plain (limited space, strong climatic, hydric and technical constraints). They vary across the plain (alluvial zones, early scrubland, etc.) and do not favor the same types of agriculture. Irrigation only concerns part of the plain, and this will certainly evolve in the coming years in line with climate change (water availability) and related adaptation measures (regulations, prioritized water allocation).

The evolution of the area's farming systems can also be determined by the area's symbolic dimensions. Indeed, the ideas of "landscape mosaic" (linked to the presence of hedges, pastures, field crops, scrublands and trees) and the wine cultural identity (many village festivals are linked to viticulture and wine) are very present. It contributes to the formation of initiatives focused on viticulture or biodiversity linked to this dual identity of the territory. Arable crops are seen as having less to do with the identity of the area: crop farmers are less numerous in the area and crop products are not associated with local traditions and *terroir*. However, several factors constrain the wine production: urban development, development of wind turbines, transport infrastructures, projects such as a large-scale cinema studio. As a result, some the wine producers prefer to start cereal farming or leave some fields as fallow land.

From an organizational point of view, land management and planning coping with ecological objectives are reshaping the farming practices, and raised several initiatives: many municipalities support “alternative” farms (permaculture, extensive livestock) on public land. A number of environmental NGOs (Natural Land Conservation, Birdlife-France, etc.) provide technical support and expertise to integrate biodiversity-friendly practices in farms.
This diversity of actors and dynamics set up the scene for a large reconfiguration of local farming, but it results mostly in the coexistence of a large number of diverse initiatives without a collective space for thinking this reconfiguration.

Step 2: Diversity of collective action on the Western Plain of Montpellier

Collective action and initiatives in the territory are either focusing on specific issues or implementing transversal approaches. This part of the analysis is based on the ALaDyn framework (Benoit et al., 2012), which was chosen in order to identify the prominent strategy used by each initiative (do they enter by the farming practices, natural resources and landscape patterns?) and potential transversal initiatives that would combine these three entries.
Most of the initiatives analyzed intend to have an impact on farming practices, with an important focus on viticulture. Some have a targeted strategy for reducing the use of one type of pesticide, and focus mainly on experimentation or technical and financial support (e.g. use of mechanical weeding with financial support to buy adapted equipment; collective monitoring of the development of *flavescence dorée* through observation of the *flavescence* leafhopper, offering winegrowers the right to dispense with certain mandatory insecticides). Some pesticide-reduction initiatives are less targeted, such as the certification processes carried out by cooperative wineries (with a preference for sustainability certifications to enhance a type of “reasoned agriculture”) or outside cooperative wineries (with a preference for organic agriculture certification). Awareness-raising and funding programs (such as agri-environmental-climate measures) support these dynamics. Finally, only one project aims to develop cereal and protein crops with low pesticide use.
Among the initiatives with a resource-oriented approach, the first category is the protection and maintenance of natural areas, mainly supported by the Natura 2000 site on the plain. Secondly, the protection of water resources, both in terms of quality and quantity, is the focus of a large number of initiatives, such as the agri-environment-climate measure schemes run by various actors, which aims to implement agro-ecological infrastructures in viticulture following a farm diagnosis. Several initiatives include aspects of knowledge creation or compilation, as well as surveys carried out by associative actors. Finally, ecological compensation measures are numerous due to the multiplicity of projects impacting natural and agricultural areas.
While all initiatives can ultimately have an impact on the spatial configurations of the territory, some have a strong input on these aspects. For example, a number of initiatives are helping to delimit areas to be protected, but also areas to be pre-empted. Finally, there are initiatives that could have an impact on the landscape in the long term, such as the development of agro-ecological infrastructures (hedges, watering points).

Step 3: What synergies and tensions are identified on the territory's initiatives?

An overall analysis of these initiatives raises several questions about their impact on the region.

The majority of these initiatives focus on a single sector, viticulture, demonstrating the importance - also from a symbolic point of view - of this production in the region. Arable crops are largely under-represented in these initiatives (only 1 initiative is fully focused on arable crops, while 10 focus only on viticulture), which could help reduce the use of pesticides. Moreover, some initiatives seem to "overlap" in their objectives and strategies. For example, two initiatives have very similar objectives and methods, but focus on Protected Designation of Origin and Protected Geographical Indication viticulture respectively. While this situation may be representative of local tensions, it can also be an opportunity to create links between stakeholders. These strategies led by local stakeholders reflect very different visions of what pesticide reduction could look like in the plain. Some initiatives aim for a relatively small reduction in pesticide use at the farm scale, but over large areas (development of resistant grape varieties, certifications supported by cooperative wineries), while others aim for a drastic reconfiguration of farming systems, but on the farm scale. This diversity of visions shows that the issue of pesticide reduction can have a variety of solutions. There is finally an important number of initiatives and stakeholders involved, raising the following question: Why, despite taking these issues into account, are all these initiatives and stakeholders not yet succeeding in building a "pesticide-free" territory? These different approaches can complement each other and reach different types of agricultural practices, but also carry the risk of activating only certain levers, thus leading to a greater or lesser reduction in pesticide use, but without involving a "systemic" reconfiguration of the territory as implied by a "pesticide-free" paradigm.

Three initiatives combine all three entries to landscape agronomy and therefore seem to have a systemic vision of the territory in their strategy. They seem to offer an interesting potential for designing a “pesticide-free territory” at the scale of the Western Plain of Montpellier.

Practical Implications

This research has several practical implications. First, the formalization of this "overview of initiatives" makes it possible to identify the conditions for transforming the area and agricultural practices, and to gain a good understanding of the initial situation. Setting up this analysis enabled us to forge human links with local stakeholders and to calibrate a scenario-building phase in line with discussions with them. Second, the three systemic initiatives on pesticide reduction identified have a potential in redesigning the territory towards a “pesticide-free” territory. At the same time, they are illustrative of different strategies implemented by local stakeholders. In the next months, we will mobilize these different strategies to create scenarios towards a “pesticide-free territory”. The scenarios, co-constructed with local stakeholders, will enable us to explore with them different strategic visions of pesticide reduction and initiate discussions on how to combine these strategies with other initiatives, that may already exist or could be developed at the territory’s scale. Third, this research can have an impact on the field. Understanding farming practices and initiatives is of interest to local stakeholders, and could potentially

feed into some of their projects. For example, it could provide thought for stakeholders on local farming practices and the scope for progress towards a " pesticide-free" territory, in conjunction with biodiversity-focused stakeholders. It can also be used to identify gaps in initiatives, as well as opportunities to improve the governance of agri-food transition issues in the region, which is one of the objectives of certain stakeholders.

Theoretical Implications

From a theoretical point of view, this research contributes to landscape agronomy and to design and transition studies. As the focus of our systemic approach, the territory prompts a reevaluation of the modalities and extent of interdisciplinarity that need to be mobilized (Aude Vialatte et al. 2021; Arts et al. 2017). Because of the spatial extent and complexity of the territorial system, there are many uncertainties and knowledge gaps that are difficult to fill, leading to "a form of vicious circle" between the lack of scientific evidence on large-scale effectiveness and the lack of real landscapes that have implemented solutions for controlling pests (A. Vialatte et al. 2022). Many questions remain unanswered about how to carry out research on a territory, including how to take into account the diversity of issues faced by the territory or the integration of land-use planning stakeholders in territorial participatory processes (Moraine et al., 2018). The first implication of this work is therefore to provide an empirical application of the landscape agronomy framework by illustrating the complexity of giving a consistent vision of the coexisting dynamics and objectives driven by local stakeholders. The second theoretical contribution is a contribution to design sciences and notably the field of territorial design. We hypothesize that this detailed understanding of the territory and its dynamics, taking into account the interweaving of scales, will enable us to work with local stakeholders towards the co-design a "pesticide-free" territory including spatial, technical and social challenges and mobilizing adequate levers to overcome sociotechnical lock-ins. Ultimately, the results of this work could help identify certain conditions for a systemic, agroecological transition of territories, particularly in terms of synergies between initiatives and between stakeholders.

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Mapping stakeholder influence in the agricultural water management: a preliminary study for the Lebna watershed, Tunisia

Davide Rizzo[a], Gabrielle Rudi[a,b], Intissar Ferchichi[c], Loriane Pignard[d], Aymen Ben Ahmed[a,c,e], Jean-Stéphane Bailly[a], Insaf Mekki[c]

[a] LISAH, Univ Montpellier, AgroParisTech, INRAE,Institut Agro, IRD, Montpellier, France, davide.rizzo@ird.fr, bailly@agroparistech.fr

[b] GEau, Univ. Montpellier, AgroParisTech, BRGM, CIRAD, INRAE IRD, Institut Agro, Montpellier, France, gabrielle.rudi@agroparistech.fr

[c] INRGREF - National Research Institute for Rural Engineering, Water and Forestry, Carthage University, Ariana, Tunisia, insaf.mekki.im@gmail.com, ferchichiintissar@hotmail.fr

[d] GEAC, AgroParisTech, Montpellier, France, loriane.pignard@gmail.com

[e] INAT - National Agronomic Institute of Tunisia, Carthage University, Tunis, Tunisia aymenbenahmed03@gmail.com

Abstract: Water management in rural areas is fragmented throughout spatially heterogeneous decision-making processes. This fragmentation is further exacerbated in Mediterranean regions due to the uneven seasonal distribution of rainfall. This study aims to understand the spatially explicit overlap of diverse stakeholders' influence. Focusing on the Lebna watershed, in the Cap-Bon region of northern Tunisia, the research maps stakeholder influences using qualitative methods, revealing a network of actors spanning the academic, public, and private sectors. The stakeholder interest/influence diagram shows that farmers are central players with varying levels of interest and influence. For instance, the influence of downstream irrigated agriculture seems prevalent, potentially at the expense of upstream rainfed systems. Spatial analysis through a chorematic diagram reveals mismatches between national policies and local practices, highlighting the crucial role of intermediary actors. In terms of practical and theoretical implications, the study underlines the importance of incorporating local knowledge and practices into policy frameworks for sustainable agricultural water management and other spatially contextualised land management issues.

Keywords: Landscape agronomy, land systems, local spatial knowledge, chorematic diagrams

1 Purpose

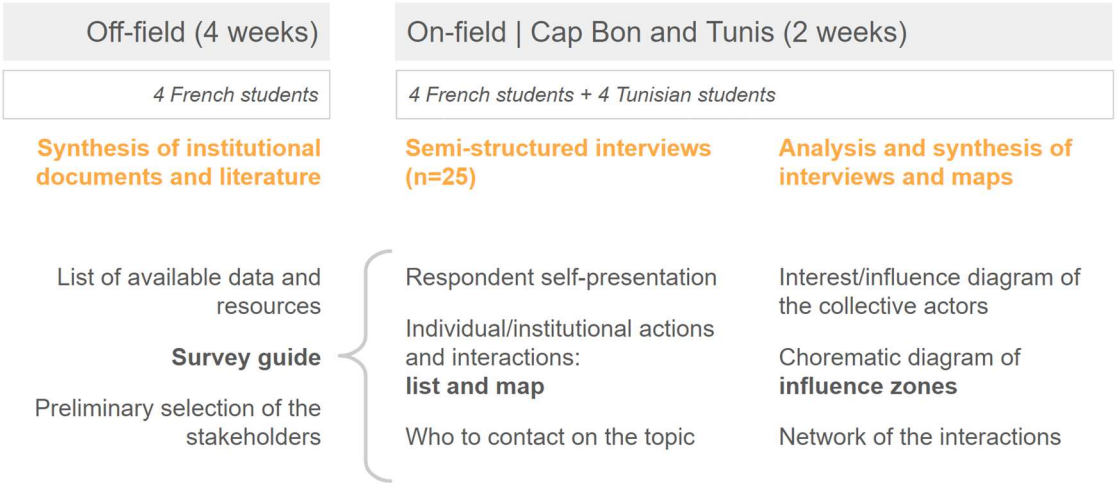
The effective management of natural resources in rural areas requires aligning the goals and practices of various stakeholders. Local actors manage the land defined, yet potentially defined or unclear boundaries. The existing research that focused on the watershed level to improve the spatial governance of water, revealed misfit and polarisation in land management (Borowski et al., 2008). Furthermore, biophysical zoning developed by scientist or decision-makers can create mismatches, particularly in the context of water management (Narcy and Mermet, 2003).

In Mediterranean countries, the concentration of socio-economic development and population growth in coastal areas exacerbates the spatial polarisation in the competition for water resources. This adds to the already uneven recharge of inland watersheds (García-Ruiz et al., 2011). The non-uniform distribution of actions and impacts in different directions reflects the directional nature of water flows, which is amplified by heterogeneous anthropic actions and uses, creating anisotropic patterns" (Barton et al., 2010). For instance, downstream irrigated agriculture often prevail upon upstream rainfed systems, highlighting the mismatch in water management across space.
This study aims to describe the spatial influence of different stakeholders by addressing the "territorialisation" of agricultural water management, which includes the use and governance of water in irrigated and rainfed systems. The study is part of a preliminary spatial survey of stakeholder influence zones in a rural watershed and the contextual region.

2 Methodology and approach

Influence zones describe the spatial extent of stakeholders' actions. They can be officially defined, as in the case of administrative territorial units, or remain implicit, as a result of power balance and interactions. Despite existing knowledge on local and national resource management, the spatial aspects of stakeholder influence remain largely unexplored. The study focused on the Lebna watershed, in the Cap-Bon region of northern Tunisia, as an example of a Mediterranean agricultural zone with long-standing but evolving water management issues. It includes both rainfed and irrigated farming systems (Mekki et al., 2018), dams, groundwater-fed wells, and few runoff management structures. The study involved eight French and Tunisian students from January to February 2023, two professors and three researchers with expertise in the topic and the study area (Béguier et al., 2023).

Figure 1. Scheme of the two phases, main methods (orange), and key results (bold) of the study.



Twenty-five stakeholders from the academic, public and private sectors took part in the survey, selected based on the knowledge of the researchers and local experts, as well as

for their availability during the study. Namely, we included representatives from the main regional and local administrative bodies of the agricultural and water management sector, and French and Tunisian researchers that studied the area. Informal talks with five farmers allowed adding complementary information. For one of the survey questions, we asked respondents to draw their answers on a base map to make explicit the spatial influences of the actions at the personal, institutional, or group level (e.g., farmers' associations, cooperatives), using a local spatial knowledge method (Debolini et al., 2013). For each interview, the local knowledge map was supplemented by a summary report of the information, actions, interactions and contacts mentioned by the respondent.

The responses were processed at the regional level and combined into three types of diagrams. The first diagram represents the network of interactions linking stakeholders in agricultural water management in the Lebna watershed. The second diagram represents stakeholders' positions based on their degree of interest/influence on agricultural water management. The interest/influence diagram is based on the grid proposed by Eden and Ackermann (1998, p. 122) to relate interest in strategy making and the power in strategy implementation onto four quadrants. The lower left quadrant identifies the crowd, which consists of marginal stakeholders with low interest and influence. The upper left quadrant identifies the subjects, who are potentially influential but have little interest or power in the issue. In the lower right quadrant, there are the influencers or strategists who hold significant influence but little interest, such as external consultants. Finally, in the upper right quadrant, there are the key players.

The students placed the stakeholders identified from the literature review and mentioned during the interviews. The position of stakeholders was determined by a qualitative assessment of the strength of their interest and influence on the agricultural water management in the study area. The third and final diagram aimed to map the zones of influence of the stakeholders. The spatially explicit representation of influence was qualitative and based on a synthesis of the maps drawn by the respondents. Due to the exploratory nature of the study, we chose to use a symbolic representation based on the chorematic diagrams developed by Brunet (1993), which are qualitative-descriptive spatial models focused on dynamics.

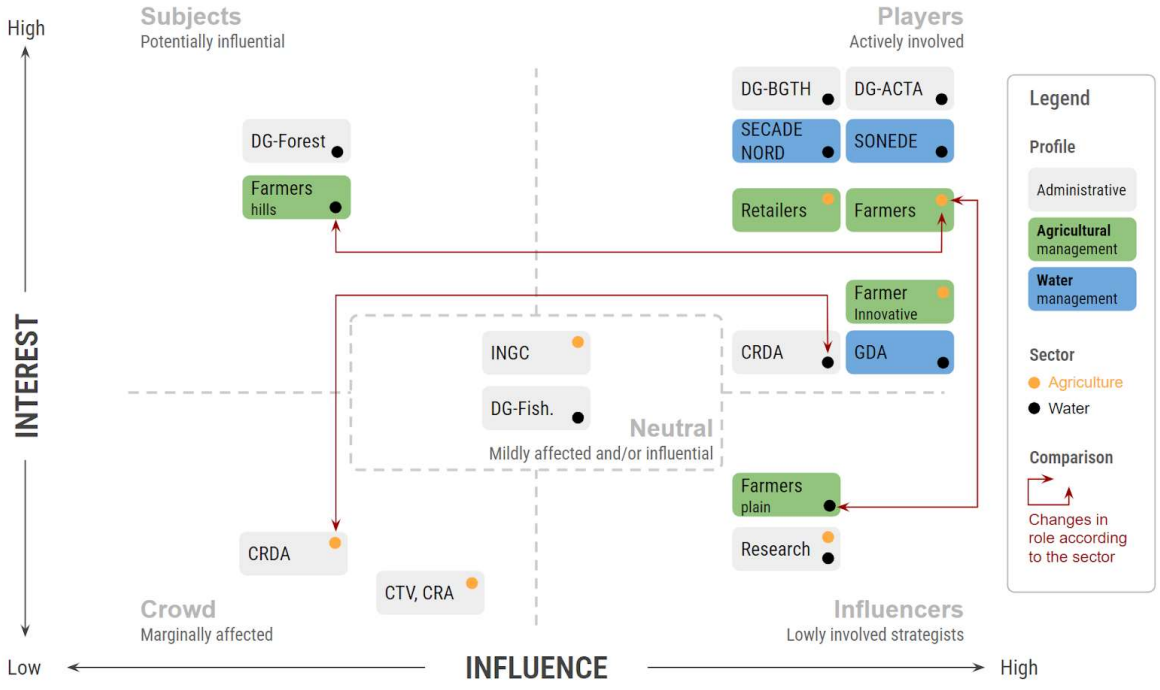
3 Findings

The results are divided into three categories: (1) a partial list of stakeholders and their interaction networks about quantitative water management and agri-food production, (2) the influence/interest diagrams, and (3) a chorematic diagram of the influence zones. Stakeholders were grouped into four roles: agricultural management, water management, administrative entities, and the agri-food industry. Each role exerts its influence and pursues specific interests that significantly shape rainfed agricultural systems and influence agricultural production dynamics. The study suggests that the rainfed agricultural value chain in Lebna comprises three segments: upstream, farm-level operations, and downstream. Each segment involves multiple stakeholders involved in direct and indirect interactions. In particular, respondents noted the growing influence of intermediaries, such as milk collectors and phytochemical retailers, in shaping decisions in upstream rainfed and downstream irrigated farming systems. In contrast, developments in downstream irrigated farming systems appear to be more

influenced by agri-food companies and national policies. However, as we did not have the opportunity to interview any stakeholders from the agri-food industry, this finding cannot be confirmed.

The interest/influence diagram provided a comprehensive overview of the stakeholders with high interest and influence in the agricultural and water sectors (Fig. 2). The respondents only addressed a small number of stakeholders with low influence. It is important to note that the Regional Centres for Agricultural Development (CRDA) appeared to have more influence in the water management sector than in the agricultural sector, probably due to their administrative control over the water users association "groups of agricultural development" (GDA), and the direct control over irrigation infrastructure and pumping stations. Although designed for all types of development, the existing groups in the area are dedicated solely to the management of irrigation zones. Farmers were consistently identified as highly interested and influential stakeholders in the agricultural sector. However, the diagram allowed distinguishing between the lower influence on the water sector of farmers in the hilly areas and the higher influence of a particular innovative farmer in the citrus grove area. Additionally, the farmers in the downstream plain were identified as influencers in the water sector (Fig. 2).

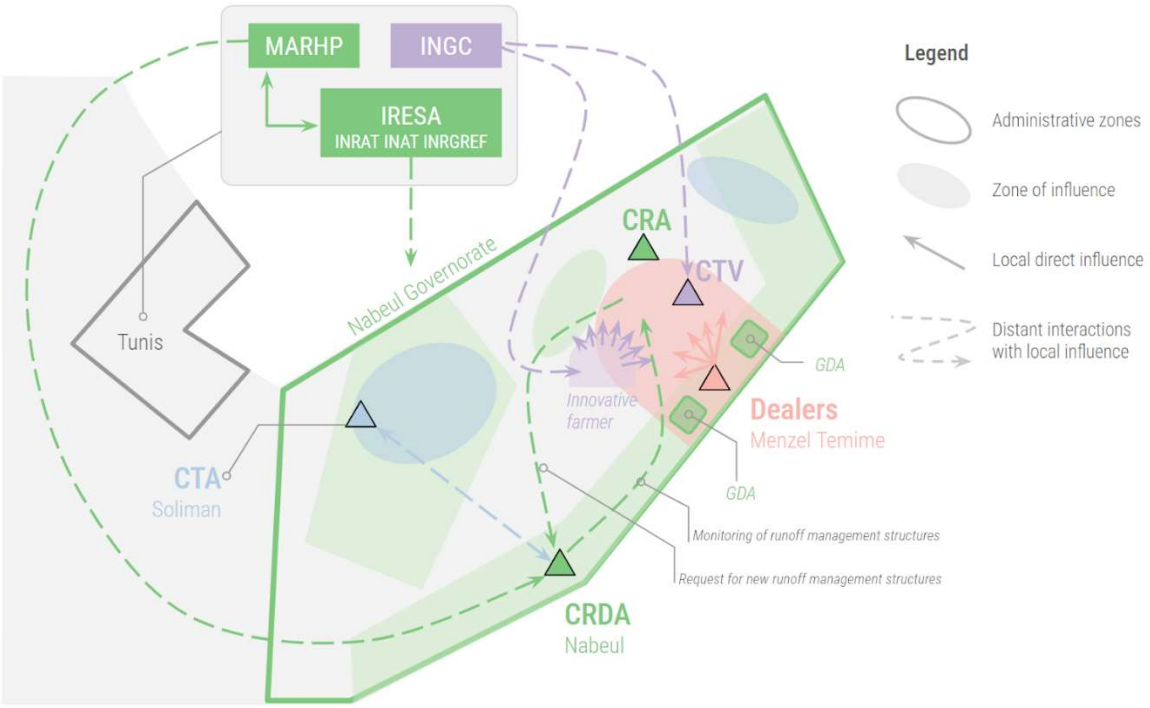
Figure 2. Interest/influence diagram of stakeholders' involvement in the agricultural and water sectors according to their profile. Acronyms identify local actors and stakeholders. Source: survey analysis and synthesis from the students (Béguier et al., 2023), elaborated on base grid adapted from Eden and Ackerman (1998).



The choromatic diagram summarised and made explicit the spatial influence of the different stakeholders in the area (Fig. 3). The diagram reflects the respondents' perceptions of a potential mismatch between the national government and the strength of the local players who appeared to mediate some of the interactions. It is not

so surprising to observe that there is a landscape anisotropy for stakeholder influence and issues related to quantitative water management, which is an organisational process. Indeed, this organisational process shares properties with water-related biophysical processes that are governed by gravity, which gives direction to space (Allard et al., 2016), as for time, creating cumulative processes that result in deeply anisotropic and inhomogeneous spatial processes (Monestiez et al., 2005).
However, local interests are defining new zones of influence. For example, the expectation for new agronomic references to face climate change led to the emergence of a zone of influence of a leading innovative farmer. Furthermore, the search for new economic opportunities for arable crops and dairy production extends the zone of influence of coastal retailers upwards.

Figure 3. Choremetic diagram of the areas of influence of some local stakeholders. Acronyms identify local actors and stakeholders. Adapted from Béguier et al. (2023).



4 Practical and theoretical implications

The main practical implication of the study relates to the spatially explicit description of the stakeholders involved in quantitative agricultural water management in a southern Mediterranean context. It highlights the challenges of balancing centralized government control with local habits. Intermediate actors emerge as crucial bridges facilitating communication across these different levels. Farmers see value in strengthening local branches of national water authorities, believing it would improve communication with regional governments. The private sector is also emerging as a source of new knowledge and resources for farmers, particularly in areas like milk production and crop protection. Nonetheless, the effectiveness of the private sector highly dependent on the economic context. External social and economic forces, such

as regional product availability and market fluctuations, can rapidly reshape zones of influence and the flow of knowledge related to water management practices.
In terms of theoretical implications, the geoagronomic approach proved to be relevant to the socio-technical description of agricultural water management. The spatially explicit description of the zone of influence bridged the land management issues with their biophysical dimensions. The next step in the study should be to enhance the spatial definition of the zones of influence. A multi-level spatially explicit analysis of the areas under the influence or direct control of the relevant stakeholders already identified in this exploratory study could achieve this. The questionnaire design itself could be revised to explore further the role of less interested and/or influential stakeholders.

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Farmers' stance towards landscape change: A case study on Santorini, Greece

Alexandra Smyrniotopoulou and George Vlahos

Department of Agricultural Economics and Rural Development, Agricultural University of Athens, alex_smyr@aua.gr; gvlahos@aua.gr

Abstract: Landscapes are considered the result of the interaction between nature and humans reflecting their dynamics. To understand landscape change it is important to identify the drivers of change, thus this study employs the concept of driving forces to explore changes that have taken place in the landscape of Santorini, a highly touristic island, where small scale agricultural activity is under pressure. We combine qualitative and quantitative data to understand the interplay between driving forces and farmers, as they represent the main actors who directly affect landscape management. Personal interviews with farmers provided useful information that helped us deepen our understanding of landscape dynamics, link the changes in management practices with the different driving forces and understand their influence on the landscape at the local level.

Keywords: agricultural landscape, landscape change, driving forces, farmers

Purpose

Landscape is the focus of various disciplines from geography and ecology to architecture and urban planning, while multiple concepts, methods and theories have been used in landscape research (Antrop, 2000). The European Landscape Convention (ELC) aiming to capture the plurality of meanings related to landscape refers to it as “an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors” (Council of Europe, 2000). Landscape is subjected to change, as humankind, motivated by needs and aspirations, transforms its environment, causing frequently detrimental consequences for human wellbeing (Antrop, 2005).

Research in landscape change has sought not only to describe the changes in land cover and land use, but also to identify and understand the drivers of landscape change (Burgi et al., 2017). The concept of driving forces, defined as the forces that cause the observed landscape changes (Burgi et al., 2004), has become the core framework for studying the causes, processes and consequences of landscape change or persistence and assess policy interventions (Plieninger et al., 2016). In general, two different types of driving forces can be found in the literature: proximate causes are the human actions that directly contribute to landscape change at the local level, while underlying driving forces cover the fundamental social and natural factors that influence the proximate causes and are mainly grouped into five categories: political, socio-economic, technological, natural and cultural driving forces (Plieninger et al., 2016; Burgi et al., 2004).

One of the challenges studies have to address is how to conceptualise the links among the three elements of the system under study -i.e. landscape change, driving forces, actors- and interpret the relations of a particular combination of actors and driving forces that cause change (Hersperger et al., 2010). Especially, in relation to the agricultural

landscape, farmers are the actors who directly change landscape through their farming practices, which are seen as responses to the various political and socio-economic conditions (Kizos et al., 2010). It is also argued that farmers have three different roles, as producers of commodities, as owners of farm properties, and as citizens, that influence their farming practices (Primdahl and Kristensen, 2011). Some researchers include farmer and farm characteristics as a separate group of internal factors that interact with exogenous factors, affecting decision making on management activities (Kristensen et al., 2016; van Vliet et al., 2015).

Based on the concept of driving forces, this paper focuses on the landscape of Santorini, a highly touristic island, where small scale agricultural activity is under pressure, with the aim to understand the interplay among driving forces, farmers and landscape change. The purpose of this paper is to identify changes that have taken place in farmers management practices in the last 20 years, explore how farmers are influenced by various driving forces and shape landscape at the local level. Our intention is to contribute to effective policy making.

Design/Methodology/Approach

1.1. Methodological approach

Driving forces of landscape change are usually studied through single case studies at the local level, focusing on specific site characteristics, driving forces and actors in order to analyse the relations between them and provide a thorough understanding of landscape particularities and changes at the local level (Burgi et al., 2017). In addition, it is argued that the main components of landscape, land cover and land use, cannot capture all dimensions of landscape as defined in the ELC (Burgi et al., 2022), while many studies don't address systematically the role of actors in the landscape change (Plieninger et al., 2016). Thus the application of a mixed-methods approach aims to deal with these methodological issues by considering different sets of information on mapped and perceived landscape changes *(*Burgi et al., 2017).

In this paper, we combined qualitative and quantitative data collected through fieldwork using in depth interviews with farmers along with secondary information extracted from agricultural and tourism statistics and studies in order to investigate the recent changes occurred in the agricultural landscape of Santorini and explore drivers behind these changes as perceived by farmers, whose decisions on management practices result in landscape change or persistence at the local level.

Particularly, we utilised the Integrated Administration and Control System (IACS) for Common Agricultural Policy (CAP) payments (2007-2019), census data (2011) and relevant studies to obtain an overview of the evolution of the agricultural area and determine proximate causes. To explore landscape changes at the farm level and identify perceptions of the related driving forces we designed face to face interviews with 30 farmers, using a semi-structured questionnaire that provided the main source of information on farmers and farm characteristics, participation in policy interventions, changes in management practices over the last 20 years and views on the rationale behind these changes. Interviewees were selected through a snowball sampling process, utilizing personal contacts and familiarity with the case study area from previous surveys.

1.2. Case study description

The case study focuses on the vineyard landscape on the island of Santorini in the Aegean Sea, Greece. Santorini is characterised by a low intensity farming system, mainly specialised in viticulture for the production of superior quality wines. The agro-ecosystem consists of own-rooted indigenous grape varieties -first and foremost the variety Assyrtiko- growing in volcanic and arid soil, enduring a hot and windy summer period. To protect production from these extreme environmental conditions, farmers use two peculiar archaic pruning practices (Xyrafis et al., 2021), which in addition to the propagation technique of layering, result in a unique agricultural landscape of scenic value (Vlahos, 2020). Over the past decades, the wines produced in Santorini have gained status in the global market for quality wines, the number of wineries has more than doubled, and currently, besides the local co-operative winery, there are 20 winemakers, making the wine industry a key economic actor on the island.
Public responses originating from two different policy domains aim to control pressures on the landscape of Santorini and have a conservation effect. On the one hand, CAP measures provide for a special support to maintain the agricultural activity and cultivation of the traditional vines in Santorini due to insularity and geographical constraints as well as a local agri-environmental scheme to maintain the particular pruning system. On the other hand, since 1990 land-use planning policy has defined the Residential Control Zones of Santorini, specifying allowed land uses, while its 2012 revision prohibits the building in land parcels registered in IACS database as vineyards.

Findings

1.3. Evolution of the agricultural landscape

According to the IACS database, vineyards dominate the landscape of Santorini, covering almost 70% of the total land eligible for CAP payments for the period 2007-2019. More than half of the total area of vineyards (56%) is leased. This rate has increased by an average 6.4% annually, indicating that winemaking in Santorini relies increasingly on rented land. Since 2007, the total vineyard area has decreased to just 912.2 ha in 2019 (-29%), while there were 748 vineyard holdings, a 27% reduction from the 1,021 holdings in 2007. The average size of a vineyard holding is 1.2 ha in 2019 and the average parcel size is 0.5 ha, accounting for approximately 2 to 3 vineyard parcels to each holding. In general, findings reveal the presence of small and fragmented vineyard holdings, the vast majority of which (an average of 87% during the examined period) have less than 2 ha of vines.
In parallel, Santorini is a famous global tourism destination that encounters the impact of the massive tourism growth and has experienced considerable changes in the landscape since the 1980s (Sarantakou and Terkenli, 2019). Concerning the key tourism indicators, the total visitors' arrivals at Santorini airport and port from 0.75 million in 2000 (Spilanis, 2017) reached a record number in 2019 exceeding 2 million. Tourist accommodation follows the same upward trend, the number of hotel beds has increased by 54% during the period 2004-2017, while a growth of 46% of informal accommodation is estimated within 2010-2017 (Sarantakou and Terkenli, 2019). In addition, since 1971 housing construction on the island has roughly quadrupled,

amounted to 13,528 houses in 2011, while vacant or holiday residential properties representing almost two thirds of total residences (Spilanis, 2017). The dominant role of tourism is also reflected in the employment rates, as employment in agriculture is constantly decreasing, from 7.8% in 1991 to 3.5% in 2011, compared with the rise of tertiary sector, which in 2011 reached 80% of all employments on the island (HSA, 2011). Tourism expansion and residential development for primary and second homes exert pressures on the landscape, resulting in agricultural land contraction and urbanization of rural areas, since built-up area covers 20.3% of the total land area of Santorini (Spilanis, 2021).

1.4. Farmers and farms characteristics

The majority of the farmers in the sample were men, with an average age 54 years. Almost half of the respondents (14 out of 30) had farming as a primary occupation, but only for 3 it was the only source of income. The sample also included 4 retired farmers who have transferred their farm to family successors. They still farm their land, but the responsibility for decision making lies with collaborating winemakers who have taken over their vineyards.

The total area under vines for the 30 farms sampled was 141.8 ha, which was divided into more than 170 parcels. The average size of each farm was 4.7 ha and average size of each parcel was 0.8 ha. However it should be noted that the 12 farms managing more than 5 ha of vineyard each, managed 66% of the total utilised land under vines. Thus the majority of the farms are considered small and fragmented. Half of the vineyard area (50.8%) was rented. For small farms i.e. managing less than 3 ha of vineyards, the land was mostly owned by the respondents (only 14% of vineyards rented) in stark difference to farms bigger than 5 ha where 62% of the vineyards were rented.

1.5. Changes in management of farms over the last 20 years

Almost half of the farmers (13 out of 30) reported that their area under vines has been reduced by 30% on average, including exclusively rented vineyards. The increasing demand for grapes in recent years, due to the high number of winemakers operating currently in Santorini, raised the rent to around €300-350/ha/year, creating serious problems for small and medium-sized farmers who cannot afford it. Respondents argued that, since the need for grapes is constantly increasing, many wineries have started to invest on land with vineyards or even plant new vines, consequently land prices are on the rise.

The demand for Assyrtiko wine from Santorini has risen over the last years along with the price that wineries offer to farmers for grapes, from around 1€/kg in 2000 to 4-4.5€/kg currently. Varietal conversion was mentioned by 7 farmers who have created single-variety vineyards, since Assyrtiko grapes are well paid compared to the other local varieties. Nevertheless, many farmers argued that this conversion results to a loss of varietal plurality, hence impoverishment of genetic biodiversity.

Traditionally the renewal of vineyards was achieved through layering[7] and the resulting thus random scattering of the vines in the parcel, was a prominent landscape feature,

[7] A propagation technique where a cane is selected, bent and buried in the soil keeping the tip above the soil. When the buried part takes root, it is severed from the original plant and a new vine is produced.

albeit rendering mechanical ploughing impossible. Currently new planting and restructuring of old vines is preferably organised in rows to facilitate farming practices, to the detriment of the landscape, while there are efforts to increase the plant density. Almost one third of farmers (11 out of 30) planted new vines covering 12.3 ha in total, the vast majority being on parcels owned by farmers (76%), aiming at replanting old vineyards (79%).

1.6. Participation in policy measures and future land use changes

About one third of farmers (11 out of 30) reported that when they submit an application for CAP support, they declare neither the precise number of their parcels nor the exact acreage, especially of the rented land. It is argued that some landowners prefer to conceal farmed hectares, since they consider them as holding a high potential real estate value. Tourism demand has raised land values to unprecedented levels in Santorini, considered as one of the most expensive areas to buy property in Greece (Kizos et al., 2017).

Only one in six respondents is in favor of changing the land use of their owned vineyards or adapting them to future needs, although not currently considered. The majority of respondents aim to preserve their owned vineyards and maintain the traditional pruning techniques, since it is part of their family history, tradition and cultural heritage from one generation to another.

Practical Implications

The analysis of the information collected identified the most important factors shaping changes in the landscape and explored the points where current policy is ineffective. According to the official data, farmers and vineyards are constantly decreasing, while the number of winemakers is increasing, accumulating an increasing share of vineyard area, which calls for a thorough examination of these trends and the sustainability of vineyard holdings. Farmers' interviews revealed that lack of adequate land-use planning has adverse outcomes, leading to extensive illegal urban sprawl in the agricultural area of Santorini (Sarantakou and Terkenli, 2019) and compelling some farmers to operate informally in the black market network. Policy design should address the current landscape changes considering the different types of actors (farmers, landowners) and the different roles of farmers (Primdahl and Kristensen, 2011). The CAP measures seem not to be effective against non agricultural pressures, such as housing and real estate (Vlahos, 2020).

Theoretical Implications

This paper employed the concept of driving forces to distinguish between proximate causes and underlying driving forces, focusing on the local case study level (Plieninger et al., 2016). Findings support that landscape change is typically determined by a combination of underlying drivers, political, economic and cultural, revealing that tourism growth and global market for quality wine are the underlying driving forces that were mostly related to contraction of agricultural land, intensification of vineyards management and urbanization.

According to occupation status and share of farming income respondents can be categorised to four groups, full-time, part-time, hobby and retired farmers (Kizos et al.,

2010; Primdahl and Kristensen, 2011). Data revealed the multifunctionality of agricultural activity in Santorini as essential for the economic survival of farmers, since most respondents are part time and hobby farmers (21 out of 30), who primarily aim at maintaining family owned property and perceive farming more as an identity and "a way of life" (Kizos et al., 2011). This categorization has also yielded differences concerning farm size, as full time farmers rely mostly on rented vineyards.

Although this paper represents a context specific study, the approach followed highlighted the importance of mixing different but complementary information. Land cover and land use data are not able to depict the actual management practices, thus other types of data are required. Personal interviews with farmers helped us deepen our understanding of landscape dynamics, link the changes in management practices with the different driving forces and understand their influence on the landscape at the local level.

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Co-designing an agroecological citrus orchard: a multi-stakeholder's participatory assessment

Fida Temani[1], Imène Mahjoub[2], Intissar Ferchichi[1], Salah Benyoussef[3], Insaf Mekki[1], Frédéric Jacob[4], Rim Zitouna-Chebbi[1]

[1]National researches institute of rural engineering, water and forestry, Hédi Karray street 2080 Ariana, Tunisia, fida.temani@yahoo.fr; ferchichiintissar@hotmail.fr; insaf.mekki.im@gmail.com; rimzitouna@gmail.com

[2]Citrus technical center, Road Grombalia-Béni khalled 8099, Tunisia, imenemahjoub@hotmail.com

[3]National Institute of Agronomic Research of Tunisia, Hédi Karray street 2080 Ariana, Tunisia, benyoussef.salah02@gmail.com

[4]IRD, UMR Lisah, 2 place Pierre Viala, 34060, Montpellier, France, frederic.jacob@ird.fr

Abstract:
Citrus represents 10% of the irrigated area of fruit trees in Tunisia, where water availability is a major concern. Aggravated by climate change, water scarcity is negatively influencing citrus production. Thus, irrigation optimization and the adoption of more sustainable farming strategies are needed. Intercropping has been suggested as an agroecological approach to mitigate the effects of climate change and improve the environmental and economical sustainability of farming systems. However, implementing diversification into citrus groves requires the involvement of various local stakeholders to establish coordination at different levels. The study aimed to build a participatory design of mixed citrus groves scenarios and their evaluation using indicators. Our results highlighted the generation of five scenarios of diversified citrus orchards. In fact, the choice of a diversification component was made according to its economic and environmental benefits as well as its technical management. However, several factors discourage farmers from opting diversification (e.g. lack of labor staff and technical support...). Thus, we recommend, (i) providing technical assistance regarding emerging crops; (ii) building links with other key authorities, who could guarantee the security of citrus farms (e.g. Ministry of the interior...); and (iii) strengthening links with key actors responsible for the development of supply chains.
Keywords: diversification, stakeholders, citrus groves, participatory, design.

Purpose:

The present work is a continuity of a set of participatory workshops that started in 2015 to develop a simple and free decision support tool 'CITRIG' that helps citrus producers to schedule irrigation, based on the FAO 56 document. Here, we aim to design collectively real scenarios of citrus groves diversification and their evaluation using performance indicators in order to adapt 'CITRIG' to mixed citrus groves.

Design/Methodology/Approach:

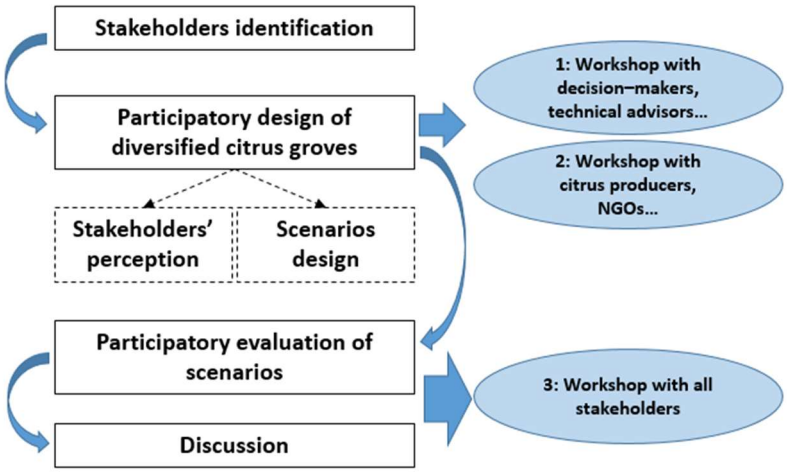
2.1. Study site

The study area is the "Cap Bon" region in northeastern Tunisia (36 "N, 10 "E). Cap Bon is Tunisia's citrus main producer, supplying 86% of national production (Khebour Allouche et al., 2021) on about 19200 ha (68% of the total citrus-growing area, (General Direction of Agricultural Production, 2020)). Cap Bon's irrigation supplies for agricultural activities are mainly ensured by the Mejerda-Cap Bon canal (JICA, 2009) and groundwater extraction activities (Chebil et al., 2018) resulting in groundwater resources overuse and their quality degradation. Consequently, water sustainability becomes a major concern and a real challenge for both decision makers and citrus producers.

2.2. Methodological framework

Our approach combines participatory design of diversified citrus groves scenarios and participatory evaluation of co-designed scenarios. This approach requires stakeholders' participation (decision-makers, technical advisors, NGOs, researchers and farmers, etc.). Our work was organized into 4 steps, which are detailed below.

Figure 1. The methodological approach adopted in the study.



Firstly, the research team identified stakeholders whose could be involved in agroecological transition particularly in citrus groves. During a first workshop, the research team engaged local decision-makers (Ministry of agriculture structures, technical advisors, etc.) with deep knowledge i) on actual citrus cultivation and its irrigation water management and supplies, particularly in the Cap Bon region, including local farming practices and ii) crops that could be introduced into fruit groves. Citrus producers and NGOs were also interviewed during a second workshop about citrus orchard diversification. During three hours of collective working session, participants were invited to present their i) perception regarding diversification as an agroecological practice and ii) own design of mixed orchard scenarios (e.g. diversification elements including trees, windbreaks, annuals, livestock, crop management, etc.). Scenarios assessment using performance indicators of the agro-ecological transition (Trabelsi, 2017) was the subject of a third workshop. Thus, groups of stakeholders including i) decision-makers, technical advisors, etc., who provide a wide range of support (e.g.

subsidies, good practice guides...), and ii) farmers, who are determinant in scenarios implementation in practice, were asked to choose one or two scenarios to evaluate. This task allowed to align stakeholders needs and expectations. Finally, the last step of the method was reserved to present and discuss the results of the different groups' evaluations.

Findings

3.1. Stakeholders perception regarding citrus groves diversification

Four types of stakeholders were interviewed: decision-makers, technical advisors, NGOs and citrus producers. Their visions of diversified groves were largely in agreement with each other. Diversification was defined as a wide range of cropping practices, including multiple cropping (fruit trees, windbreaks, woody trees, etc.), intercropping (mixing perennials with annual crops), and livestock incorporation into based citrus systems. Other actors describe diversification according to the range of benefits that can be generated such as i) improving soil fertility and reducing its salinity, ii) enhancing cropping systems' resilience towards climate change, iii) reducing water evaporation (using mulch, soil cover, etc.), iv) mitigating heatwaves thanks to microclimate effects provided by citrus trees, and finally v) increasing cash income by producing other marketable products.

3.2. Participatory scenarios designing

Future trends imagined by stakeholders were carried out in order to obtain achievable scenarios of citrus orchard diversification under Tunisian context. Five main trends have been identified, corresponding to different associations. Scenario 1 presented citrus association with a mixture of cereals and legumes. This system also includes the presence of livestock or beekeeping. The choice of short-cycle crops (e.g. mainly winter crops barley, triticale, oats with vetch, etc.) was made to provide fodder for the farmer's livestock. Scenario 2 mixed citrus trees with other fruit trees (e.g. olive, carob, almond...), which can improve field productivity. Stakeholders also proposed other combinations of citrus trees with i) aromatic and medicinal plants 'scenario 3' (e.g. rosemary, thyme, coriander, etc.), ii) vegetables 'scenario 4' (e.g. carrots, tomatoes, etc.), and iii) cereals 'scenario 5'. The design of citrus-based diversified system depended on its capacity to be adopted by farmers as well as its contribution to generate socio-economic benefits.

3.3. Participatory scenarios evaluation

In order to highlight relevant factors influencing the adoption of these practices, as well as reasons encouraging or limiting scenario implementation, three complementary evaluation processes are adopted. Here, stakeholders describe scenarios using several indicators of i) impact in terms of the challenges to be dealt with, ii) feasibility linked to limitations to be overcome, and iii) acceptability of adopting these practices.
The evaluation showed similarities between working groups assessment. Stakeholders suggested 18 indicators (table 1) which are summarized into sections belonging to three

dimensions i) agroecological dimension, ii) socio-territorial dimension and iii) financial and economic dimension. These indicators highlighted current factors which limit farmers' motivation to adopt agroecological practices. Overall, four main factors were raised i) limitation of labor staff, ii) unsuitability of some crops, particularly in terms of pest management, iii) the inadequacy of scenarios to meet farmers' economic needs in order to ensure their subsistence and improve their financial situation, and iv) groves insecurity (e.g. robbery problems).

Table 1. Evaluation criteria for co-designed scenarios.

Dimension	**Section**	**Indicators**
Agroecological dimension	Farm diversity	Diversity of perennial crops
		Annual crop diversity
		Animal diversity
	Farm management	Optimizing land use
		Field size
	Farming practices	Pesticides (use, frequency…)
		Pest management
		Water resource management
		Protection of farm natural resources (soil fertility, water salinity)
		Access to mechanization
Socio-territorial dimension	Employment and services	Labor staff availability
		Labor intensity
		Valuing local products and industries
	Agricultural development	Training/agricultural advisory services
	Government responsibility	Farm security
		Marketing and distribution systems
Financial and economic dimension	Financial support	Access to subsidies and financial aids
	Economic sustainability	Economic profitability, income…

According to stakeholders, an acceptable scenario must fulfill the following expectations: i) be supported and encouraged by the government (e.g. financial assistance, technical guides, security....) ii) provide a good economic income and iii) respect the trade-off between water availability and water crops' demand. In addition, stakeholders' discussions highlighted the importance of having measurements and predictions of the quantities of available water (rain and irrigation water) available for combined crops.

Participants also raised the issue of groundwater quality, which is affected by high salinity. Thus, glasswort introduction was suggested as an effective mean in salt phytoextraction. According to stakeholders, citrus-aromatic and medicinal plants combination is an interesting combination. However, it requires assistance from both i) decision-makers mainly regarding marketing chains and ii) researchers and technical advisors through training in crop management. Overall, agroecological transition needs to involve other key authorities such as the Ministry of the Interior contributing to the adoption of these practices at different levels (from plot to territory).

Practical Implications

Our study offers a holistic understanding of the risks and benefits of diversifying citrus plantations within an agroecological transition through establishing coordination between all stakeholders. These discussions clarified i) the specific needs and concerns of different stakeholders, ii) stakeholders' expectations and iii) current government subsidies/support related to diversification. In addition, our approach highlighted several environmental and socio-economic implications associated to agroecological transition in citrus groves, particularly by improving water quality, soil fertility and land/resource use efficiency in order to satisfy local (90% of citrus national production, National Agricultural Observatory, 2018) and world demand.

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