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Research article

Insights into the agroecological transition: the case of two Italian bio-districts

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Abstract. Bio-districts are a specific form of aggregation which are particularly effective in implementing a multi-stakeholder, environmentally conscious, and place-based approach to food system sustainability. Bio-districts may facilitate the agroecological transition of the local food systems. The aim of this paper is to provide recommendations on how to promote the adoption of the agroecological approach through bio-districts, by analysing farmers' propensity towards agroecology, framing the level of attainement in the transition pathway, and shedding light on the barriers to the broader diffusion of agroecology. A qualitative comparative case study approach has been developed in two bio-districts in Italy. Based on the findings, farmers show a propensity to adopt the agroecological approach, However, a series of barriers have prevented reaching the top level of agroecological transition, especially the need for the adaptation of machinery, a shortage of skilled advisors for knowledge transfer, and poor community awareness. The findings suggest that there is urgent need to face policy, governance-related, and market-related challenges. This study lays the groundwork for the integration of the agroecological approach in the implementation of key policy instruments such as the Italian Common Agricultural Policy Strategic Plan and the European Union Action Plan for the Development of Organic Production.

Keywords: agroecology, organic farming, bio-district, local development, sustainability.
JEL codes: Q15, Q18, Q56.

HIGHLIGHTS

- Farmers' awareness of the agroecology concept is low, but they show a propensity to adopt the agroecological approach.
- There are barriers to further progress in the agroecological transition processes, although this transition is quite advanced.
- Unlike conventional agriculture, agroecology requires a longer time frame for agronomic management, potentially affecting profitability.
- A bio-district strategy that is comprehensive and shared with all the local actors could help to overcome barriers.

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1. INTRODUCTION

Agroecological transitions are systemic transformations of food systems (FSs), with the purpose of bringing in ecological dynamics through the involvement of multiple stakeholders (HLPE, 2019; Magrini *et al.*, 2019). Farmers are key actors in agroecological transitions: they translate "societal, environmental, and economic demands into practices and thereby strongly influencing outcomes for large parts of the landscape and acting as a potential co-carrier of transformation" (Bakker *et al.*, 2023: 689). The participation of non-farming businesses and the activation of infrastructure, processes and activities related to the post-production stages up to consumption is also needed (FAO, 2022). In fact, it is widely acknowledged that the adoption of an agroecological approach requires a fundamental rethinking of landscape structures, farm management, production methods, business strategies, supply networks, and consumption patterns (Brunori, 2022).

The political importance of a transition towards sustainable FSs has emerged since the Farm to Fork (F2F) Strategy (COM(2020) 381 final) of the European Union (EU) acknowledged the urgency of "a fair, healthy and environmentally-friendly food system" in the face of "inextricable links between healthy people, healthy societies and healthy planet". The main policy tools for implementing the F2F Strategy, namely the strategic plans of the Common Agricultural Policy (CAP) 2023-2027, are therefore oriented to support agroecological transition (Langlais, 2023; Vanni and Viganò, 2020) by developing synergies between the specific individualistic interventions of the CAP (so-called Pillar I) and the collective, territorial, and/or integrated approaches under Pillar II. Nonetheless, during this transitional phase from policy design to its implementation, one might ask whether there are barriers to agroecology so that one could collect elements to overcome them.

This paper is focused on bio-districts[1] (BDs) as a specific form of aggregation particularly effective in implementing a multi-stakeholder, environmentally conscious, and place-based approach to FS sustainability.

The development of organic agriculture and the transfer of its values and principles to all the activities in a territory (Schermer, 2005) as well as the construction of a governance and organisational model capable of activating the three dimensions of agroecology, such as science, practice, and movement (SPM) are central to their strategies (Migliorini and Wezel, 2017; Wezel *et al.*, 2009; Wezel and Bellon, 2018). At present, BDs could represent the forerunners of the agroecological transition of the local FSs. Scholars have already shown an interest in targeting BDs as areas for agroecological transition, particularly in terms of governance and participation aspects (Guareschi *et al.*, 2020; Passaro and Randelli, 2022). However, studies focusing on BDs as places where the incremental processes of moving from farm practices towards change at the FS level are lacking. The topic is politically relevant, thanks to the attention given to BDs by European and national policy documents. Specifically, the EU Action Plan for the Development of Organic Production (SWD(2021) 65 final) emphasises the feasibility of BDs as new business models for the integrated sustainable development of rural areas and commits to their development.

The aim of this paper is to provide recommendations on how to promote the adoption of the agroecological approach through BDs, by analysing farmers' propensity towards agroecology, framing the level in the transition pathway, and shedding light on the barriers to the broader diffusion of agroecology. A comparative case study has been developed with two BDs in Italy. The two cases were selected among the 51 Italian BDs (Dara Guccione and Sturla, 2021), as they are reasonably representative of BDs located in mountainous areas and plains or hilly areas, respectively. Mountainous areas are affected by socio-economic and productive issues, such as structural weakness of farms, population loss, and ageing. Plains or hilly areas are characterised by the presence of dominant supply chains and socio-environmental stressors at their borders (Mazzocchi *et al.*, 2021; Sturla, 2019). The work has been driven by the following research questions:

To what extent do farmers have a propensity for agroecology in the analysed territories?
At what level of the agroecological transition are the BDs?
What are the barriers to the adoption of the agroecological approach?

The underlying assumption is that the ability to embrace agroecological transition at the territory level depends on factors that are both internal and external to the farm: the characteristics of farmers and their farms, the vibrancy of the BDs, and the general context.

The following sections provide the conceptual framework of the research (Section 2), present the research methods and data (Section 3), and describe and

[1] Bio districts are conceptually connected to the notion of "industrial district" as introduced by Marshall (1920) and further developed by Italian economists (Sforzi, 2008; Becattini, 2017; Toccaceli and Pacciani, 2023). While the definition of BDs meets Marshall's in describing them as homogeneous territories where the concentration of specialised economic activities generates external economies of scale, they take from the Italian school the attribute of places where communities and productive milieux are inextricably tied.

discuss the results (Section 4). The last section delivers conclusions and implications (Section 5).

2. CONCEPTUAL FRAMEWORK

This paper is framed within the approach to agroecology theorised by Gliessman (2015), based on the assumption that the challenges related to agroecology should be addressed on three different fronts simultaneously, that is, starting from the practices adopted at the agroecosystem, farm, and landscape levels, while developing the science and social movement dimensions of agroecology. Specifically, practice should be based on the sustainable use of natural resources and on farmers' knowledge and priorities and should be targeted towards the provision of ecosystem services and productive diversification. Science should take on the characteristics of a participatory, holistic, transdisciplinary, and action-research-based approach (Agroecology Europe, 2016). Agroecological movements should defend small and family farms, farmers and rural communities, food sovereignty, local and short food supply chains, the diversity of indigenous seeds and breeds, and healthy and quality food (Agroecology Europe, 2016; Altieri *et al.*, 2015; Peano and Sottile, 2017; Wezel *et al.*, 2009).

Gliessman (2015) described the incremental pathway of transition to agroecology in five levels; the first three relate to the farm and the remaining two to the entire FS. These levels are: (1) increasing the efficiency of inputs; (2) replacing conventional inputs and practices with agroecological alternatives; (3) redesigning the agroecosystem based on a new set of ecological processes; (4) restoring a more direct connection between producers and consumers; and (5) building a new global FS based on equity, participation, and justice. Each level requires the provision of specific support methods to help stakeholders design and put into practice the desired changes, but the fifth level is particularly challenging as we move from a local to a global perspective. The spread around the world of different types of localised and extended alternative food networks (farmers' markets, pick your own, e-commerce, etc.), in which producers and consumers interact, and their growth in terms of size and influence are already starting a process of transformation of the global FS towards sustainability. Researchers have started to deepen the role of BDs with respect to agroecology. Their findings, although limited to the Italian experience and mostly based on qualitative analysis, have shown the specificity of this form of aggregation that makes BDs a suitable model for scaling from practice to movement, as required by agroecology (see, for example, Dara Guccione and Sturla, 2021; FAO, 2017; Passaro and Randelli, 2022; Povellato and Vanni, 2020; Sturla, 2019).

Through their actions aimed at placing the sustainability of productions at the heart of local development, BDs help bridge the gap between the incremental stages of the agroecological approach by involving all other elements of the community beyond production and processing (HLPE, 2019). In other words, their actions concern the embeddedness of FSs (Wezel *et al.*, 2016) and the engagement of the entire productive community, along with their cognitive resources, such as beliefs, values, individual strategies, norms, and informal agreements (Duru *et al.*, 2015), not to mention a cultural perspective shift to trigger the transition (Prost *et al.*, 2023).

Considering their bottom-up, comprehensive approach to sustainability, BDs are seen as the forerunners of the agroecological transition applied to local FSs, first and foremost by their promoters, but also by practitioners and scholars (Dara Guccione and Sturla, 2021). Guareschi *et al.* (2020) showed that the Parma BD (Emilia-Romagna region, central Italy) is able to create organisational structures, which connect local farmers to other economic sectors, and that intermediary institutions play an important role by bringing together different stakeholders. The coalition-building role of BDs has been also acknowledged to in other studies (HLPE, 2019; Rico Mendez *et al.*, 2021; Passaro and Randelli, 2022).

The natural inclination of BDs to promote the agroecological transition of local FSs cannot ignore the existing link between organic agriculture and agroecology. In Italy, the legal definition of BDs comes from the current legislation on organic farming (Law 23/2022, article 13) which defines them as "*local production systems, even of an inter-provincial or inter-regional nature, with a marked agricultural vocation [...] where cultivation, breeding, processing, and food preparation, within the territory identified by the bio-district, of organic products are significant [... and characterised ...] by integration with the other economic activities existing in the area of the district itself and by the presence of landscape areas of importance*". This definition highlights a series of agroecology-related aspects. First, it connects organic farming to local development by defining the role of a BD at the territorial level – that is, BDs are expected to adopt the systemic approach of agroecology by scaling the principles and the values of organic farming to all activities, even beyond the local FS (Schermer, 2005). Second, the definition underscores that the adoption of organic farming within BDs is linked to the objectives of reducing the negative environmental impacts of farming and upstream value chain steps, and to the improvement of

social aspects, such as respect for human rights and the dignity of people (IFOAM, 2019).

Despite common goals, organic farming (EU Reg. 2018/848) differs from agroecology. The major differences are that the former is focused on a framework of thresholds and prohibitions (e.g., the use of chemical inputs is prohibited). Intercropping is required in agroecology, but it is not mentioned in the EU organic farming regulations. Only in agroecology is the importance of agroforestry underlined in its different articulations (silvo-pastoral systems, silvo-arable systems, and agro-silvo-pastoral systems; Rosati *et al.*, 2021). Furthermore, the sustainable management of water resources and landscapes is just a principle in organic farming, while in agroecology it is operationalised, for example, by using drip irrigation, cover crops, and intercropping (Migliorini and Wezel, 2017), and by redesigning the agroecosystems in a joint and shared way with local actors, with the aim of controlling pests and increasing soil fertility, managing adverse weather conditions, and conserving and restoring biodiversity (Boeraeve *et al.*, 2020; Gliessman, 2015; Salliou and Barnaud, 2017). Organic farming is mostly certified by third party entities, while agroecology is not based on universally acknowledged international standards (Bellon *et al.*, 2011; Migliorini and Wezel, 2017). Beyond these differences, these approaches are compatible; actually, the adoption of an agroecological approach improves the performance of organic agriculture in the medium to long term from the point of view of environmental sustainability and food security, overcoming the organic production system based on the substitution of synthetic chemical inputs with those allowed by regulation (Ciaccia *et al.*, 2020).

3. RESEARCH METHODS AND DATA

This research developed a comparative case study approach using multiple methods and data sources (Yin, 2018) to generate a new understanding about agroecological transitions in the context of BDs. The empirical study was performed using a stepwise process (Figure 1).

In 2020, a survey was carried out by using computer-assisted web interviewing. An online questionnaire with 22 topics was administered to farmers (both conventional and organic) and processors, including those not belonging to BDs (Table 1).

The questionnaire comprised 31 questions – mostly multiple choice – divided into four sections. The first section collected data on the farm and on business. The remaining three sections were dedicated to the SPM dimensions of agroecology, with the aim of gathering information concerning agronomic practices, usage, and positioning in the local Agricultural Knowledge and Innovation System (AKIS), marketing strategies, supply chain relationships, and the social aspects of farming activities. There were 31 respondents from the *Valle*

Figure 1. The research design.

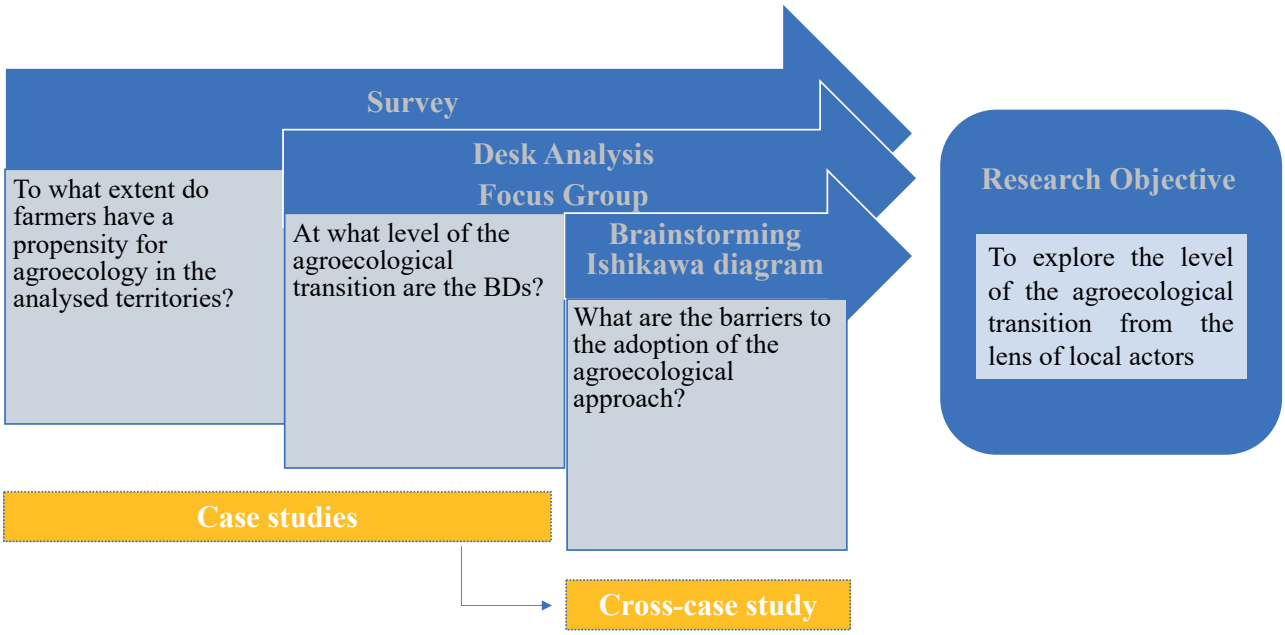


Table 1. Question topics in the online questionnaire marked by the agroecological dimensions.

	Question Topics
1	Crop diversification (P)
2	Crop and animal diversification (P)
3	Organic certification (P)
4	Sales channels (M)
5	Related activities (P)
6	Natural / semi-natural infrastructures (P)
7	Cultivation of local varieties (P)
8	Breeding of local breeds (P)
9	Agroecological cultivation practices (P)
10	Agroecological breeding systems (P)
11	Agroecological practices for the management of water resources (P)
12	Shared farm problem solving (S)
13	Collaboration with universities/research institutes (S)
14	Participation in research initiatives/projects (S)
15	Contribution to research initiatives (S)
16	Participation in training courses (S)
17	Social farming (M)
18	Participation in the organization of events, projects with schools, training courses, etc. (M)
19	Interaction with consumers (M)
20	Collaboration with other farms (M)
21	Collaboration with institutions (M)
22	Participation in networks (M)

Legend: S = Science; P = Practice; M = Movement.

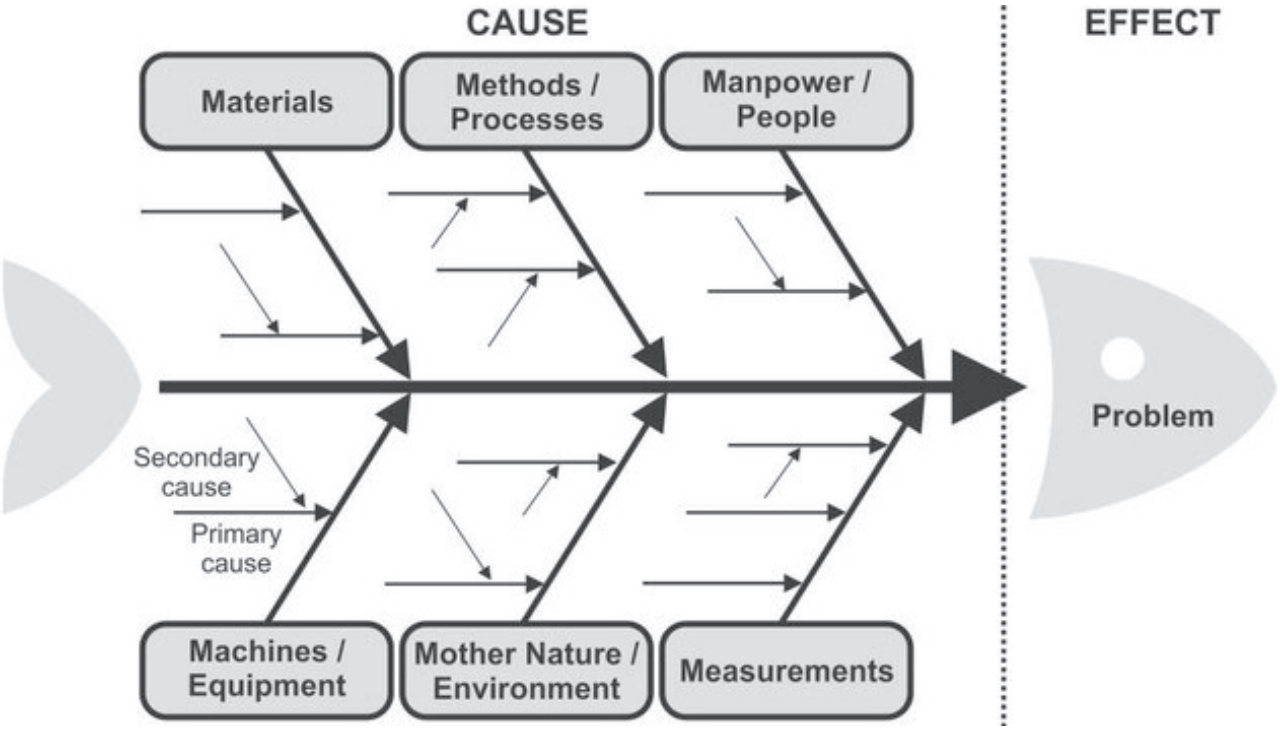
Camonica (*VC*) BD and 30 from the *Terre degli Elìmi* (*TdE*) BD.

The relevance of the three agroecological dimensions within each BD was defined by the average of the farms' answers with each agroecological connotation on the total items of the pertinent dimension. A specific Agroecological Propensity Index (API) was built for each BD to evaluate the farmers' propensity towards agroecology and to identify which of the three dimensions were more developed, as these describe the directions along which the interaction of the farms with the BD and its socio-economic and environmental context occurs. First, a score was calculated from the proportion of answers related to agroecology in the three dimensions (SPM) for 22 of the 31 questions. More specifically, because most of the questions allowed multiple answers, a value of "1" was assigned to questions where the number of chosen options relevant to a specific aspect of agroecology was higher than a given threshold, which differed from question to question. For example, for crop diversification, a score "1" was attributed to respondents with at least three crop categories (e.g., vegetables, legumes, cereals) or a permanent crop (vine, olive) on the farm (as in the 2014-2022 CAP greening). Otherwise, a value of "0" was assigned, as the contribution of the answer to the API was considered nil. In a second step, "1" was assigned to farms whose sum score was higher than 11, because they were considered to be inclined towards agroecology; "0" was assigned to farms with a sum score equal to or lower than this threshold. Assessment of the propensity towards agroecology in its three dimensions enables the identification of the functions of farms in fostering the transition at the local level, given that the renewal of FSs starts from the practices and relationships activated at the farm level (Gliessman, 2015).

As the questionnaires were addressed solely to farmers and processors, the transition at the territorial level was first explored through desk research relying on previous studies (Bergamelli, 2021; Sturla, 2019), grey literature, reports, conference papers, and the strategic documents of the two BDs. The results of this review were discussed in two focus groups, one for each BD. The participants were farmers and other BD members, such as local environmental associations, government, and research centres, with a total of 26 local actors in *VC* and 20 actors in *TdE*. The focus groups focused on four main themes: (1) drivers and barriers for farmers to adopt agroecological and/or sustainable practices; (2) the role of the local agribusiness system in communicating the values of agroecology and the role of consumers; (3) the strategy for raising awareness of sustainable FS among the local community; and (4) the role of BD and local administrations. The level of the agroecological transition achieved by the local FS was identified by reviewing the activities performed within the BDs, according to the five levels defined by Gliessman (2015).

The research team performed a cross-case analysis by discussing and interpreting the results obtained previously. During three brainstorming sessions, all considerations were summarised with an Ishikawa diagram (also known as a fishbone diagram), a tool often used to analyse problems by recognising and categorising their causes (Hristoski *et al.*, 2017; Ilie and Ciocoiu, 2010; Ishikawa and Loftus, 1990; Zielińska-Chmielewska *et al.*, 2021). Some adaptations were applied to the generic diagram, which is based on the so-called 5M+E (i.e., manpower/people; methods/processes; machines/equipment; and materials, measurements, and mother nature/environment; Figure 2). The most likely barriers identified as the main cause of the scarce adoption of the agroecological approach were depicted by the diagonal fish bones; each primary causal factor responding to an answer to the question "*Why does the problem exist?*" was represented by a horizontal bone.

Figure 2. A generic representation of an Ishikawa diagram.



Source: Hristoski *et al.* (2017).

This representation helped to maintain a clear distinction between the causes and effects of the problem.

3.1. Case studies

Valle Camonica (VC)

This BD covers an area of just over 350 km^2 in the Alpine valley in the province of Brescia, in Lombardy (Figure 3 and Table 2). Its territory consists of a highly urbanised valley floor, which is affected by the main communication routes and where agriculture is practiced on small plots of arable land and equally small vineyards. Livestock farming is concentrated at medium and high altitudes while the surrounding mountains are covered by forests and, at higher altitudes, by pastures. This BD was created in 2014 by a group of firms to counteract the phenomena of abandonment of agricultural activities by promoting more sustainable agricultural practices. Since its creation, this BD has been characterised by considerable activism, carried out almost exclusively with internal human and material resources and with the support of a few municipalities. The BD membership includes 18 farms, a brewery, three organic shops, and six social cooperatives.

Terre degli Elìmi (TdE)

Situated in the north-western part of Sicily, this BD represents 59% of the Trapani province (Figure 4 and Table 3). Predominantly characterised by rolling hills, this area is further adorned by a diverse and picturesque landscape. This BD was founded in 2019 by means a long bottom-up preparatory phase activated around local sustainability issues. The BD membership includes 28 farms, one oil mill, two cooperative wineries, and three producer associations.

This BD is affected by population decline. Nevertheless, several municipalities in this BD have employment and youth unemployment rates that are better than the provincial and regional averages. The utilised agricultural area of this BD is mainly dedicated to arable crops and permanent crops (especially vineyards and olive trees). Another important economic component is the agri-food industry, which is also linked to products certified as Protected Denomination of Origin (PDO) and Protected Geographical Indication (PGI).

Figure 3. Municipalities included in the *Valle Camonica* Bio-district, Lombardy region (province of Brescia).

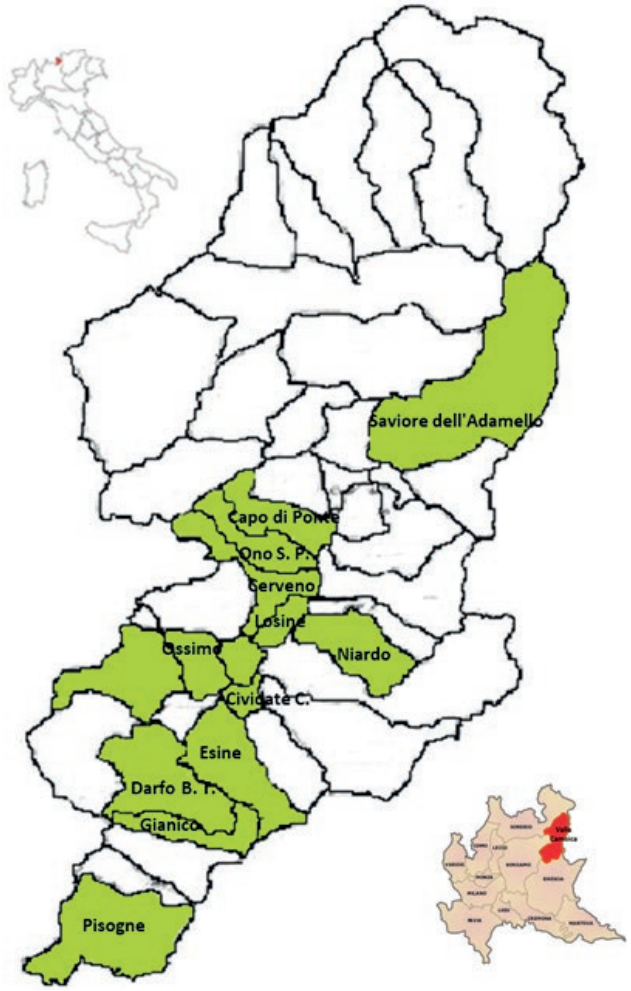
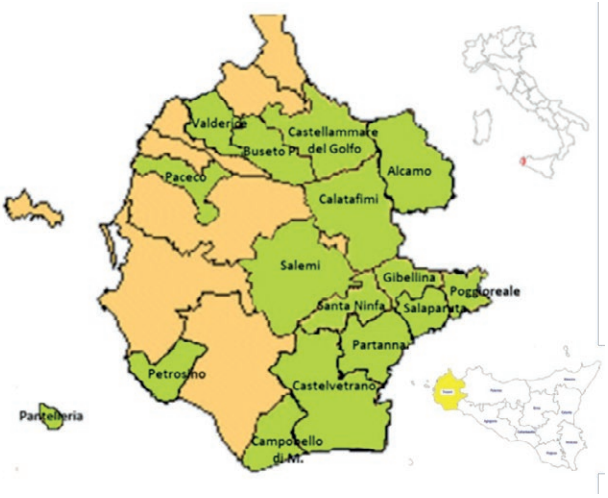


Figure 4. Municipalities included in the *Terre degli Elìmi* Bio-district, Sicily region (province of Trapani).



4. RESULTS AND DISCUSSION

4.1. The farmers' propensity for agroecology

In *VC*, the dimensions of movement and science are more developed than in *TdE*, while the practice component is quite developed in both BDs (Table 4). In *VC*, this is a direct result of tireless efforts to link the local population to local products, to train farmers, and to involve local institutions in local development projects.

Although these initiatives are still run by a dedicated group of farmers, they have the potential to become "lighthouses" for local agriculture, but the lack of public support severely hampers their actions. In contrast, in *TdE* agroecological practices are widespread, but a real movement focused on local needs is still to be developed. The scientific component is the least developed in both BDs, which is an obstacle to the dissemination of agroecological practices and to the transformation of the agroecosystem in a shared way with researchers and other farms, to maximise the environmental and economic benefits of agricultural production.

The API data are shown in Table 5. Just over a third of the farms participating in the survey showed an inclination towards agroecology, mainly concentrated in *VC* (48% of the respective total).

In *VC*, farmers who are aware of agroecology scored higher (10 farmers) than in *TdE* (7) because they are more involved in the activities of the BD. In both

Table 2. Territorial and demographic data of the municipalities in the *Valle Camonica* Bio-district.

	Population 2021 n.	Municipalities		Urban area km²	Population density Population 2021/ municipality area	Organic area 2021 ha	Organic farmers 2021 n.	Farm average size 2021 ha
		n.	km²					
Valle Camonica	46,478	14	351	133	133	60	15	4
Province total	1,253,157	205	4,786	262	262	7,447	445	17

Source: Elaboration on ISTAT and SIB data.

Table 3. Territorial and demographic data of the municipalities in the *Terre degli Elìmi* Bio-district.

	Population 2021 n.	Municipalities		Urban area km²	Population density Population2021/ municipality area	Organic area 2021 ha	Organic farmers 2021 n.	Farm average size 2021 ha
		n.	km²					
Terre degli Elìmi	178,875	16	1,454	81	123	23,928	1,049	23
Province total	417,22	24	2,47	193	169	34,573	1,471	24

Source: elaboration on ISTAT and SIB data.

Table 4. Average of farms' API scores for each dimension of Agroecology in the two Bio-districts.

Case	Agroecology as science	Agroecology as practice	Agroecology as movement
Valle Camonica	0.25	0.49	0.60
Terre degli Elìmi	0.17	0.45	0.44

Source: Elaboration by authors from questionnaires.

Table 5. Number of respondent farms with API = 1, relative percentage incidence and API average.

Case	Farms with API = 1 (No)	Incidence of farms with API = 1 on the total farms (%)	API average
Valle Camonica	15	*48*	0.50
Terre degli Elìmi	*7*	*23*	0.39
Total	23	*36*	0.45

Source: Elaboration by the authors from questionnaires.

territories, however, the productive milieu is not conducive to agroecology, and its principles and practices have not been adopted by those who are not members of the BD. This is particularly evident in *VC*, where activism clearly has not reached the non-member farms. Therefore, the BDs should activate processes of inclusion of non-member farmers, who are less inclined to adopt the agroecological approach, and of knowledge sharing, in order to spread this approach more widely and increase its effectiveness.

The farmers in both BD expressed a general mistrust of organic certification, but in *VC* it has a strong ideological connotation that prevents farmers from certifying. Therefore, farms that produce according to sustainable criteria can become members of the BD even without organic certification.

4.2. The level in the agroecological transition pathways

The *VC* strategy on agroecology is driven by the consideration that sustainability in the FS cannot be isolated from overall sustainability and requires the involvement of the local community, starting from consumers. Since its foundation in 2014, the actions of *VC* have been aimed at achieving greater local sustainability and equity. Starting from the conversion to organic farming by its founding farms, it has organised several training courses for other farmers willing to convert, as well as informative events for the local community (Bergamelli, 2021; Sturla, 2019). It actively seeks collaboration with local research institutions, administrations, and associations. Such activism has already led to the recovery of the local supply chain of neglected local wheat varieties, from the field to bread (the Growing Resilient Landscapes Project), to which several food education initiatives have been linked. Although such a renewal process struggles to reach the local population as a whole and to involve all the farmers and processors of *VC*, and the systemic nature of the agroecological approach requires interventions on many fronts – some of which are still unexplored, especially regarding the science dimension – it has reached level 4 of the transition towards agroecology (Table 6).

The protracted process of territorial consultation that marked the inception of *TdE* was accompanied by the initial strides of the agroecological approach, predating the formalisation of the BD (Table 7).

The increase in organic farming areas and the exchange of knowledge within the BD have indeed spurred the adoption of sustainable practices and techniques, extending even to operators without organic certification. Collaboration with research centres and universities has furthered the recovery and repurposing of production waste within the framework of the circular economy. Additionally, various initiatives promoting the direct sale of local organic products have emerged, in conjunction with PDO and PGI products. These have supported the development of other sectors such as tourism, catering, hotel hospitality, handicrafts, and the local artistic and cul-

Table 6. Achievement of the transition level in the *Valle Camonica* Bio-district.

Year	Activity	Transition level
2014	Conversion to organic farming of the Bio-district founding members	Level 2–3
since 2015	Bio-district fair	Level 4
since 2015	Training courses for perspective organic farmers	Level 2–3
2016	"Biosnack" in schools	Level 4
since 2018	Growing resilient landscapes project:	
	Elaboration of a growing protocol for local cereal varieties	Level 2
	Recovery of local cereal varieties in terraced fields	Level 3
	Recovery of the local wheat– Bread supply chain with training of local bakers	Level 4
	Training courses on baking local varieties for consumers	Level 4

Table 7. Achievement of transition level in the *Terre degli Elìmi* Bio-district.

Year	Activity	Transition level
2016	Adherence to organic certification systems	Level 2
2016	Crop diversification	Level 3
2016	Membership in associative forms (wineries, consortia)	Level 3
2016	Diversification of activities (contract farming, agritourism, tourist services, processing)	Level 4
2018	Practices and techniques for eco-sustainable agriculture	Level 2
2018	Agronomic practices (intercropping, rotations, cover crops, etc.)	Level 2
2019	Territorial services (public green space maintenance)	Level 4
2019	Agroecological infrastructure	Level 3
2019	Circular economy (composting, agricultural waste and by-products and pruning residues)	Level 4
2019	Farm exchange	Level 3
since 2020	Participation in research projects	Level 3
2020	Renewable energy production	Level 4
since 2021	Field experimentation	Level 3
2021	Selling organization within the territory (Ho.re.ca., SPG, farmers market)	Level 4
2022	Direct sales (e-commerce, retail outlet)	Level 4

tural offerings. The presence of notable tourist attractions, along with the considerable natural and cultural heritage, has also boosted initiatives aimed at the valorisation of the territory and its products. In addition, *TdE* has reached level 4 of the transition towards agroecology.

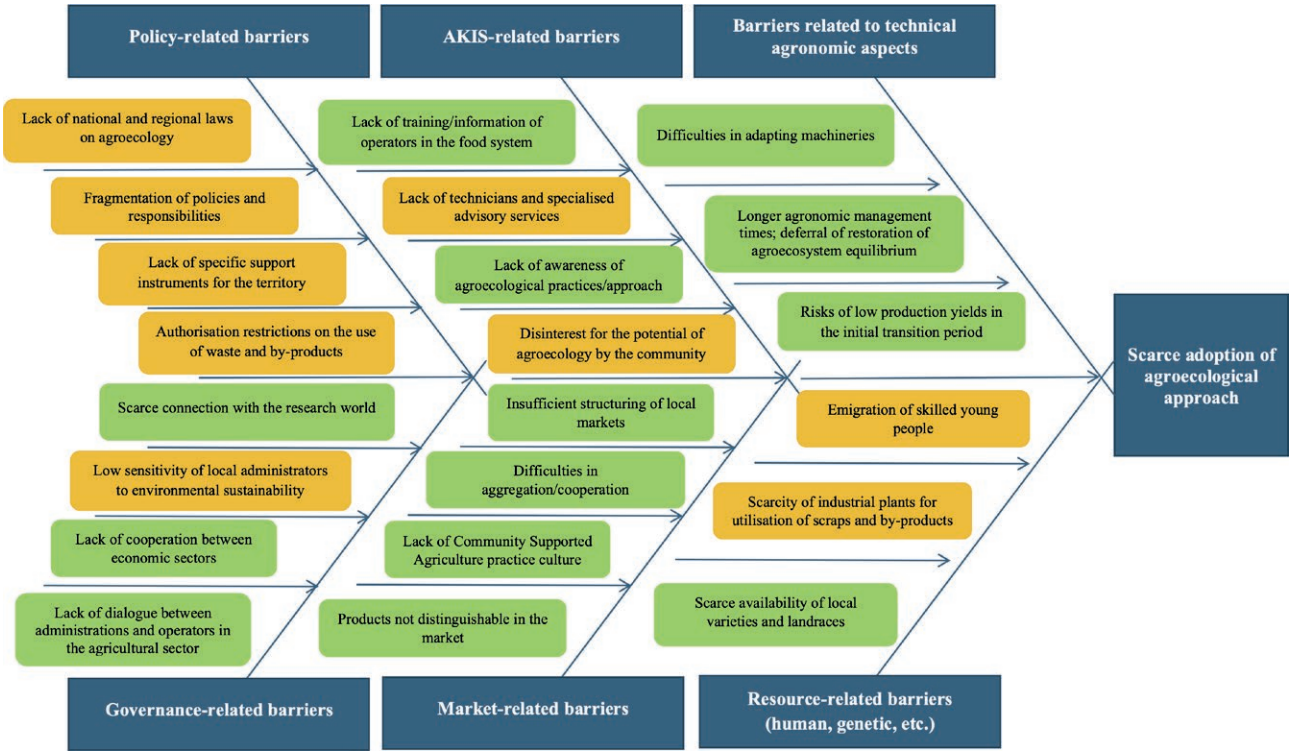
Both BDs, albeit to varying degrees, have contributed to the diffusion of the principles of participation, equity, and justice, and thus to the construction of a global FS shaped by these principles.

4.3. The barriers to the adoption of the agroecological approach

The adoption of agroecological behaviour is hindered by six clusters of barriers (Figure 5): (1) technical agronomic aspects, (2) resources, (3) AKIS, (4) market, (5) policies, and (6) governance. Among the 22 subcategories of barriers, some are endogenous to the farm (highlighted in green), while others are external (highlighted in orange).

The barriers related to technical agronomic aspects are linked to the difficulties that farmers have in adopting agroecological practices, mainly due to the fear of an initial decrease in yields. This problem is common to many organic farms and often leads them to adopt an input substitution model of organic farming, which, unlike agroecology, does not require substantial changes in management. Compared with conventional agriculture, agroecology implies longer timeframes for agronomic management and, therefore, for achieving results

Figure 5. Ishikawa diagram on the scarce adoption of the agroecological approach in two Italian bio-districts



in terms of both profitability and restoration of agroecosystem equilibria. Another obstacle is the challenge of covering the costs associated with adapting machinery and equipment for agroecological crop management.

Other barriers are directly related to the AKIS. These arise mainly from a scarcity of skilled advisors who can transfer knowledge and facilitate the application of research results and innovations in a way that meets the specific needs of the farm. As a result, farmers may find it difficult to access tailor-made advisory services. This barrier is particularly felt in *TdE*, where actors complain that advisors have poor agroecological skills. Informal channels (e.g., self-training), including peer-to-peer learning, are often the only source of information for many farmers (75% of respondents in *VC*). Formal sources (advisory services, farmers' organisations, research centres, and universities) are used more rarely.

The lack of skilled advisors contributes to maintaining a limited awareness of agroecological practices (e.g., intercropping, crop rotation, recycling, adoption of landraces, etc.) that farmers might already be using rather than following traditional techniques, leading to a low level of adoption of innovations or delaying it. Besides the significant number of farmers without awareness of the word "agroecology" (44 out of 61 respondents to the questionnaires), this is also indicated by the fact that the answers to the question about the type of the agroecological practices adopted were clustered among a few options: in *TdE*, manure heaps, rotations, and the use of pruning residues, while in *VC*, agroforestry, intercropping, and cover crops. These techniques are strongly connected to local land uses. However, the lack of awareness concerns not only the holistic agroecological approach at the farm level, but also the understanding that agroecological transition is a gradual process of adapting one's own agroecosystem. As a result, expert advice becomes paramount.

The shortage of skilled advisors is also accompanied by an inadequate supply of training/information services. Moreover, acquisition of the necessary entrepreneurial and technical skills is crucial for adopting agroecological behaviour (Bakker *et al.*, 2023; Ciliberti *et al.*, 2023; Ives *et al.*, 2020).

Also pertaining to the knowledge system is the barrier concerning the community's lack of awareness about agroecology. The local communities of both *VC* and *TdE* are not very interested in the role of local agriculture in the sustainable management of the territory and in the quality of the food consumed. This also hinders the creation of a demand for "agroecological"

products which could help to stimulate the adoption of agroecological practices by farmers, when the interaction between producers and consumers is fundamental in the transition processes towards sustainable FSs (Altieri *et al.*, 2015; Gliessman, 2015; Marino and Viganò, 2021; Wezel *et al.*, 2018).

Policy-related barriers are evident in the individual sectors as well as the overall framework of territorial development. Expectations for *ad hoc* legislation for agroecology at the national and regional levels have not been met. The fragmentation of intervention instruments and governmental responsibilities (at the national, regional, and local levels) as well as the lack of information on calls for tender and funding opportunities are barriers to radical modernisation projects. For example, during the *TdE* focus group, a farmer expressed the need to adopt the circular economy approach as a response to climate change, but recycling is hampered by some legal restrictions on the use of waste and by-products and by the lack of industrial facilities in the area.

Another major barrier is the lack of policies and instruments tailored to the specific characteristics and needs of the territories. The local actors referred to the measures to support organic farming, but they generally reported a serious feeling of abandonment by the institutions.

The governance-related barriers are closely connected to the previous ones, because they hinder the interaction between local forms of capital (economic, human, social, natural, cultural, etc.), needs, and aspirations with higher-level hierarchical policies (Anderson *et al.*, 2019; Viganò and Sturla, 2013). These barriers arise from the low sensitivity of local administrators to environmental sustainability; they do not share views with agricultural operators, and the latter are not very familiar with some local sustainability initiatives (e.g., voluntary "river contracts" for implementing territorial governance within a river basin). Governance-related barriers include the lack of cooperation with other economic sectors, weak links with research, and poor AKIS development. These barriers should be considered as a part of the wider issue of the lack of networking (e.g., local farmers associations, Solidarity Purchasing Groups, etc.). Apart from being members of the BDs, more than 60% of the interviewees do not belong to any network.

Moving to market-related barriers, the farmers stated that the choice of adopting agroecological practices has evolved over time along with an increasing awareness of environmental and health-related issues. Such an ethical motive is not detached from market considerations in response to the growing demand for high-quality and healthy food. This shift has been fostered by new generations taking over farm management, who have shown a greater aptitude for innovation, production diversification, distribution channels, and increased interactions with consumers. However, even the products and messages promoted by young farmers do not go beyond a narrow circle of regular customers. In *VC*, the main issue is the scarce integration between tourism, handicrafts, and agriculture, which is left to individual initiatives (e.g., local restaurants), while in *TdE*, the need to structure a local supply chain for certain products has been highlighted.

In a small mountain community like *VC*, there are few consumers but, surprisingly enough given that *VC* is very active in organising initiatives aimed at involving consumers. In addition, there is very limited awareness of the importance of consuming local food. On the other hand, the residents of *TdE* live in a peri-urban environment and seem to be more sensitive to food security issues.

On the demand side, agroecology is almost unknown to consumers and civil society, so products obtained using agroecology are not distinguishable on the market. Even organic farming does not seem to be a solution: in addition to the usual bureaucratic burden of the conversion to organic farming, conventional farmers in *VC* see organic certification as useless, as they consider their farming method to be more sustainable than the certification standard. Conventional farmers from *TdE* do not need organic certification because they already have a strong trust-based relationship with consumers through direct sales. The lack of a Community Supported Agriculture (CSA) culture negatively affects the possibility of building a stronger consumer-producer relationship (Espelt, 2020; Wezel *et al.*, 2016), for example, for building trust and creating a sense of community around local agriculture and food production. Consumer participation in production in its various forms (e.g., through pre-purchasing of products, harvest shares, or purchasing groups) is not supported by local food policies and governance structures, which could play a crucial role (e.g., through Green Public Procurement [GPP], education campaigns for schools and citizens, etc.).

In both BDs, the adoption of agroecological practices encounters resource-related barriers that are highly place specific, highlighting the importance of embracing innovation, sustainable resource management and maintaining biodiversity-based agriculture (Duru *et al.*, 2015). In *VC*, stakeholders firmly believe that preserving and promoting local breeds, varieties, and landraces can contribute to the resilience of agroecosystems; unfortunately, in Italy it is often challenging to find this genetic material on the market. Conversely, in *TdE* there are very few industrial facilities for recycling scraps and

by-products. Moreover, in some municipalities of the inland hills, the emigration of skilled young people is an issue, because the transition to agroecological practices is facilitated when young people take over farms. This offers a new and longer-term perspective on the development path of the farm, which over time justifies, for instance, the surrender to higher yields in the short term and intensive land use in favour of preserving natural resources.

5. CONCLUSIONS

The research described in this paper aimed to explore the agroecological transition by analysing farmers' propensity towards agroecology, the degree of transition at the territorial level, and the barriers to the systematic adoption of the agroecological approach. The findings show that *VC* is working to re-establish a more direct connection between producers and consumers, aiming at a vision of a global FS based on participation, localness, equity, and justice (levels 4 and 5). *TdE* is "younger" than *VC* by 5 years and characterised by intensive agriculture. The main aims of this BD are to improve the ecological performance of the agroecosystem and to reconnect producers and consumers within its flagship supply chains (levels 3 and 4). The solutions for developing and extending activities related to levels 2-4 of agroecological transition have already been partially identified within the two BDs. These are based on a clear awareness by local agroecological pioneers, who are the main drivers of the two BDs.

The results of the study suggest that BDs could foster a transition towards agroecology, but the systemic approach underlying it implies the need to further develop the three dimensions (SPM) through relevant context-specific actions based on participation and localness. This endeavour is not only about establishing local FSs and networks that hinge on the interaction between consumers and organic producers. It is also about aligning the entire local community with the values and principles of organic agriculture. These actions aim to ensure equity in terms of access to healthy food and to reduce the ecological footprint of all socio-economic activities in the district area (Gliessman, 2015). Therefore, to improve the sustainability of local FSs, BDs should define a comprehensive strategy and share it with public institutions and other stakeholders to activate and integrate several EU and national policies (also beyond the CAP; Sturla, 2023). Changing the global FS requires much more than BDs; however, they can contribute to the development of new modes of production and consumption based on equity, participation, and justice, which are necessary to change habits. This is worth consideration given the role that the European strategies assign to BDs as suitable tools for the sustainable revitalisation of rural areas, by tackling global problems (e.g., pollution, climate change, and disadvantages of rural areas) from a local perspective. Italy has emerged among European countries given that BDs are spread over almost 31% of the national territory, with some of them covering an entire region (Sardinia, Marche and Umbria).

This study is a starting point for more ambitious research on the agroecological transition of local FSs, as well as the transfer of this knowledge to the implementation of the Italian CAP Strategic Plan and of the EU Action Plan for the Development of Organic Production.

From a methodological perspective, a specific index was conceived to help describe and assess farmers' propensity to adopt behaviours and practices with agroecological connotations. Such an index led to an additional exploratory analysis of certain attributes of the farms considered to be more "agroecological", although a major limitation of this research is the small number of observations within the two study areas. The API could be made more robust by introducing a weighting system to consider the relative importance of the survey questions in relation to the agroecological approach. The Ishikawa diagram proved to be particularly effective not only in identifying the barriers related to the research problem, but also in better understanding the interlinkages between these barriers. Hence, a solution/action could contribute to solve more than one barrier to the same problem at the same time. The assessment of farmers' propensity towards agroecology and of the level of agroecological transition in BDs could trigger further multidisciplinary research that considers multiple cause-and-effect relationships between the different components (environmental, agricultural, social, economic, cultural, and political) that affect the barriers to the development of agroecology in a given context. Moreover, an Ishikawa diagram could be further refined by prioritising the barriers according to the application context.

AUTHOR CONTRIBUTIONS

G.D.G.: Conceptualization, Supervision, Writing, Original draft preparation, Reviewing and Editing. L.V.: Methodology, Data curation, Writing, Original draft preparation. A.S.: Data curation, Writing, Original draft preparation. A.V.: Writing, Original draft preparation, Reviewing. L.C.: Original draft preparation, Visualiza-

tion. T.P.: Original draft preparation, Visualization. F.V.: Methodology, Conceptualization, Supervision, Writing, Original draft preparation, Reviewing and Editing.

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