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Piloting a Meta-Database of Agroecological Transitions: An Example from Sustainable Cereal Food Systems

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Abstract: Despite the fact that policy makers and governments are promoting the development of diverse agro-bio food systems to push and promote sustainability, they are challenging to implement because of a series of obstacles that hinder a successful transition from a conventional to an agro-ecological model of agriculture. Produce is extremely heterogeneous and agricultural technology is often not standard, rather alternative, and knowledge is contextual, tacit and place-specific. However, information about the characteristics of these systems is still sparse and difficult to analyse because of the complexity and multidimensionality. As a result, the aim of this paper is to review the existing literature in order to identify a coding system that allows for the creation of a meta-database of case studies on agroecological transitions. This coding system will be piloted in six case studies dealing with agrobiodiversity along cereal food systems producing grains, bread and pasta in France, Italy and the UK. In this analysis, we found that both the transition towards sustainable agriculture and the reduction of transaction costs require social innovation, which benefits from strong social capital. In the conclusions, we discuss the efficacy of the proposed coding scheme and its ability to capture in-depth information contained in similar case studies.

Keywords: agroecological transitions; agro-biodiversity; alternative food networks; cereal

1. Introduction

Despite the fact that policy makers and governments are promoting the development of diverse agro-bio food systems to promote sustainability, these systems are challenging to implement because of the obstacles that hinder a successful transition from a conventional to an agro-ecological model of agriculture. Agroecology, as a technique and a social movement [1], combines ecological and agronomical knowledge together with local or traditional knowledge with the scope of developing sustainable production systems and enhancing conservation and valorisation of biodiversity [2].

According to Lang and Heasman [3], agroecology represents the underdog model emerging from the food crisis caused by the current dominant productionist paradigm, whose use of high input farming practices has been worsening the health of both the environment and human beings. The adoption of resource-conserving technologies and practices of agroecological systems require demanding learning investments. They tend to implement a great diversity of techniques and practices adapted to specific environmental conditions and have extremely heterogeneous produce. Economic agents must deal with a greater number of products and smaller quantities for sale or processing than conventional agriculture. Agricultural technology is often not standardised,

knowledge is contextual, tacit and place specific, and farmers must experiment more under conditions of uncertainty and take high-risk potential of making mistakes. Conversely, conventional systems tend to be specialized and non-adaptive and require lower capacities of innovation than agro-ecological systems [4]. Thus, to take advantage of ecological processes of local agro-ecosytems, it is necessary to acquire specific knowledge that often is available only locally and accept that ecological processes take time before they become effective. For instance, recovering soil fertility through an increment of the organic soil component or rebuilding the natural buffer of predators and wild plant hosts requires investments in capital and labour that will only have some productive effects after some time.

From an economic point of view, a variety of costs can be associated to the transition towards agro-ecological agriculture (e.g., information and learning costs, costs linked to investments of specific assets such as rebuilding the microflora of the soil). Agro-ecological systems also show higher transaction costs for the use of markets determined by lack of standardization and misalignment with the dominant technology and its institutional setting (e.g., market standards, and safety regulations).

Even if these costs are difficult to measure and escape accountancy, they highlight aspects that are common to a set of sustainable transition paths that can be conceptualized as agroecological transitions (AET) [5]. Notably, these transitions refer to deep changes and innovations that involve both technical and social values in a different way. Transitions toward an agro-ecological model may include, along with changes in production methods, a "diversification of production (crops, animals, etc.), a modification of input supply in terms of choice and ways of accessing resources, and new arrangements to collect, store, and transform produce, as well as a change in consumers' food habits" ([6], p.80).

Research on the interplay between technical, ecological and socio-economic aspects of AET is often qualitative and based on case studies [7–11]. The analysis of a case study, although credited with high internal validity, needs to be reliable and backed up with more similar case studies. Thus, the external validity of case study research can only be attained by conducting comparative analysis involving a sufficiently large number of observations. Comparative analysis, as well as helping researchers discover general patterns analysing critical contextual factors, provides some robustness to policy recommendations at the same time. For example, a similar approach has emerged in the study of collective action solutions for the management of natural resources [12,13].

One of the strategies of producing comparative analyses in a cost-effective way is through the construction of meta-databases of existing published sources on AET case studies. Meta-databases condense information contained in existing studies in a structured and formalized way so that general patterns and cause–effect relationships can be disclosed. However, when pursuing a comparative exercise, the trade-off is always between consistency in data and flexibility. This is because published material is inevitably affected by biases owing to conceptual inconsistencies between different authors, the ability to have a case study published (especially "unsuccessful AET cases"), language accessibility and concerns of different scholars. Yet, biased data can be useful "if the researcher acknowledges the bias, restricts claims of generality accordingly, and suggests adjustments for known biases" ([12], p. 185).

In the light of the importance of collecting and comparing information about AET, the aim of this paper is to design and pilot a coding form that allows for the creation of a meta-database of case studies to explore and obtain insights into the role of agrobiodiversity in the EU AET. Our objective is to contribute to and to advance AET literature by analysing—through a common grid—a series of AET case studies across Europe. Although we focus on methodological aspects, we decided to test our coding system for a meta-database on a specific set of agro-ecological initiatives of the wheat bread sector based on agrobiodiversity. These initiatives were identified and reported within the activities of the Cereal Renaissance in Rural Europe (CeReRE) thematic network funded under the European Horizon 2020 research programme [14]. We argue that the debate around agroecological transitions is well developed and that there is scope for uncovering general patterns. We take advantage of the availability of a number of case studies on diversity-based wheat chains collected across selected EU countries by means of a shared protocol developed via a participatory approach

with partners of the CeReRE thematic network. Benefitting from this source of information, we test and propose in this sense, as a first attempt, a coding scheme for analysing AET case studies in other specific contexts. To the best of our knowledge, this is indeed the first contribution that attempts to systematise and translate into easier interpretative forms a series of case studies within the AET context of analysis.

The remainder of this paper is organised as follows. In Section 2, we review socio-economic aspects of agrobiodiversity and AET that provide the key dimensions for the coding scheme described in Section 3. In Section 4, after having briefly described the H2020 project from which case studies are selected we will describe these experiences briefly. In Section 5, we apply the pilot coding to case studies and discuss the results of this exercise. In Section 6, we conclude on the efficacy of the coding scheme and its ability to capture in depth information contained in our sample of case studies.

2. Agrobiodiversity and Characteristics of AET

The development of a coding system for a comparative analysis of AET case studies requires the identification a priori of the salient attributes of these agro-ecological initiatives. As the pilot coding is tested on a set of wheat bread initiatives based on agrobiodiversity, we first recall the role of agrobiodiversity in AET and then illustrate the specificities of these socio-technical transitions.

2.1. Agrobiodiversity and AET

The agroecological model finds its roots in biological diversity and adoption of sustainable technology in agriculture [15]. Biodiversity is one of the 13 principles of agroecology drafted by the FAO high panel of experts on food security and nutrition [16]. Among these 13 principles, agro-biodiversity contributes to the resilience of food systems, as it contrasts the risks associated with relying on a few cultivated species for human nutrition. It also plays a role in cultural services, as diversity-based agricultural systems supporting local heritage traditions in the domain of food [17] can, in turn, also provide a basis for the valorisation of the produce.

Agricultural systems based on the agroecological model are examples of how farmers are re-discovering best practices based on local skills and traditional knowledge that, coupled with findings of scientific research, can create synergies to counteract the current food crisis. These systems rely upon a range of local assets (natural, social and human) and contextual knowledge to ensure food security in less developed countries [18] and food quality reconnecting consumption and production in developed countries [19]. The interaction between agronomic technical aspects and ecological features requires specific information and knowledge along the supply chain because of the location specificity of technologies and practices [4]. A different role between practical and scientific knowledge is observed respectively in diversity-based and conventional agricultural system [20], an aspect that mirrors the importance of "situated technical practices" anchored in local territories rather than large technological systems in AET [5]. Practical and context specific knowledge can be mobilized through social learning processes that have been accepted as a key component in the valorisation processes of agrobiodiversity.

In this context, diversity is a key aspect not only for natural resources but also for the knowledge base supporting the AET process which emphasizes the positive roles of (bio) diversification, ecological processes and services implemented to promote a more sustainable agriculture [5]. The diversity and context specificity of these systems as well as hindering standardization make transaction costs higher than in conventional systems. For example, farmers' varieties or landraces and the products derived from them are typically heterogeneous [15] and high transaction costs are generated to market these products because of lack of bargaining power, limited scale economies and inadequate technical skills [21]. Agro-biodiversity products share the same marketing issues as minor crop systems such as inefficient functioning marketing systems and information asymmetry [20]. As a result, institutional and social innovations are often needed to tackle these aspects. Often, some sort of collective action is requested both to manage agrobiodiversity at local level and to valorise its produce underlining the importance of the characteristics of actors and institutions that assure the governance of the process [21,22].

2.2. Specificities of AET Transitions

AET studies posit the existence of coherent conventional sociotechnical systems that encompass technological, social and institutional (regulatory) aspects [23]. The transition toward an agroecological model should thus address interactions between technical, ecological and socio-economic aspects on different scales [5]. We argue that the diverse nature of agricultural systems in combination with the social environment from which they originate inevitably indicates the ways in which transitions towards more sustainable local food systems take place and their perspective evolution. Transitions of these systems imply gradual and pervasive changes where the shift towards sustainability involves sociotechnical adaptation strategies to different modes of production and consumption. Agricultural sustainable techniques reflect the biological and site-specific nature of production processes as well as their ecological dimension. Moreover, in agroecology the relative weight of social rather than technological types of innovation is higher than in other sectors such as transportation and energy [23]. These aspects add further complexity to real contingent processes and hence most authors have organized observed patterns according to general schemes such as the multilevel perspective (MLP) [24]. MLP, initially developed by Geels [25], investigates the transition process whereby innovations created in small environments called niches can eventually spread into larger systems. Examples of studies adopting MLP can be found in the field of transportation such as the move toward either electric car systems [26] or from sailing ships to steamships.

MLP privileges a vertical dimension of analysis as it is centred on three hierarchically ordered levels: niches, socio-technical regimes and landscapes. Niches are transitional contexts where new rules and practices (innovations) are initially developed in an environment protected from market competition and unfavourable regulations. In niches, small networks of actors activate learning processes developing and experimenting innovative rules and practices. As noted by Bui et al. [7], the concept of niche "is very congruent with the definition of alternative food network (AFN)" although the latter is restricted to food issues only. The socio-technical regime instead, is a set of coherent techniques, rules, routines, cognitive frameworks and practices intertwined within institutional arrangements (laws, regulations, organized interests) that stabilize the system. These elements form a somewhat coherent configuration through a continuous process of alignment and mutual adjustment among its components. The modernist (or productionist) agricultural system may be considered an example of a regime where a set of technologies (mainly based on chemical inputs, modern plant varieties and strong mechanization) are coherent with aligned institutions (regulations and policies such as those developed within the CAP, research institution, organised interest groups) [11,27]. Finally, the concept of a socio-technical landscape covers the general political, social and scientific environment that provides the wider context for niches and regimes. In the agro-food context, a rising awareness of food and environmental quality, food safety crises, loss of biodiversity and the recent climate change debate are possible landscape drivers for a regime reconfiguration towards more sustainable practices.

Among these schemes and far from being a simple taxonomy, MLP also provides an evolutionary view of transitions whereby innovations initially experimented within niches progressively destabilize the surrounding regime provoking a reconfiguration of its structure and a re-alignment of practices and institutional structures. Niche-regime interaction, with its insights on the determinants of success or failure of niches in transforming the regime, is one of the core areas of MLP, although "a theory of linking is still lacking" [7].

AET literature has moved away from the MLP approach, integrating it with the specificities of the agro-food systems and the related sociological literature. For example, Wiskerke [11] investigates niche regime interactions within the Dutch wheat chain triggered by a small network of actors willing to bring back into cultivation wheat variety of sufficient baking quality within a regime dominated by feed wheat varieties. Magrini et al. [27] study the path dependency and lock-in effects which led to the marginalization of cover crops in the dominant French agri-food regime. If these examples rely upon MLP or a broader evolutionary economics approach, other works have begun to highlight the limitation of this perspective to the study of AET. MLP has been criticized for its overlooking of agency, politics and power issues as well as for a weak empirical operationalisation of the concepts

of niche, regime and landscape [24]. Bui et al. [7] and Lamine et al. [19] integrate MLP with a rational approach that sheds light on the mechanisms of niche regime interaction (linking) and the mechanism of regime reconfiguration in cases of niches-AFN. In particular, the pragmatist approach addresses the actual changes in practices implemented by actors as well as "the varieties of visions and possible controversies between actors and social groups" [19]. Therefore, objectives and visions of the actors involved are a key aspect of AET. Different from Wiskerke [11], the regime level is analysed on a geographical scale of small regions [9] where niche regime interaction takes place through the progressive enlargement of niche networks and the involvement of local organizations and institutions. Territorial scale seems to be a discriminant among different AET studies.

Ollivier et al. [5] compare the analytical scope and mutual consistency of MLP, resilience thinking [28] and socio-ecological system approaches [29] to tackle the specificities and multi dimensionality of AET, pointing out how none of the existing approaches take into account all three main dimensions of AET: ecological, technical and socio-economic. Indeed, these three dimensions should be used to characterise the type of innovations developed within niches in AET. Ollivier et al. [5] suggest integrating more agency and power relationships into the study of transitions underlining "the role of institutions and emergent collective organisations (agency) at the core of the transition process". On the other hand, they also propose the acknowledgement of both ecological processes and the role of local ecological knowledge, which is important in dealing with technological aspects. Rather than studying large technological systems, AET studies should focus on "situated technical practices" anchored on a local scale within a complex pattern of relationship between farmers' needs and ecosystem processes object of the actors' learning and skill development. Thus, the role of niche development is stressed in the AET although specified along particular angles.

In the light of key AET aspects with specific reference to agrobiodiversity underlined so far, the next chapter will make an attempt to design a tentative coding structure to facilitate the comparative study of a number of AET case studies.

3. Case Studies Analysis: Rationale and Identification of the Main Themes and Dimensions

Despite the fact that case study methods are sometimes disregarded in research, much knowledge about the empirical world in different contexts is gleaned by using these methods [30]. This happens because scholars misunderstand the usefulness of this technique and mistakenly do not use case studies because they believe that "one cannot generalise from a single case", "the case study contains a bias towards verification" or "it is difficult to summarise specific case studies" [31]. Comparative case study analyses partially overcome the above criticisms even if these studies are often published without a clear methodological explanation [32]. Comparative case studies also "offer a richness of insight that may be lost in the abstractions of statistical analysis" ([33], p. 7044). Using this technique, researchers contribute to more generalizable knowledge, and to the understanding of how and why particular strategies work and impact within a specific context of analysis.

In our study, the lack of quantitative information about agroecological transition and the availability of case studies from the CeReRE thematic network make this technique paramount to explore and investigate questions of these contemporary phenomena of our current real life [34]. The approach of analysing existing multiple-case studies allows us to link several pieces of information of the same phenomenon that, as well as raising the level of confidence in the robustness of our analysis [34], paves the way for generating ideas and hypotheses on the evolution of this sustainable transition in the cereal sector.

In the present study, the comparative analysis was undertaken among a limited number of case studies, favouring the conceptualization, synthesis, as well as the communication of outcomes across six cross-cutting themes extracted from the AET literature to make provision for a tentative coding scheme to be used in the collection and classification of a larger number of case studies. The selected themes are: *objectives and visions*, *actors*, *territorial scale*, *innovation*, *valorisation*, and *niche development*. These themes can be considered the starting point of descriptors, not only to analyse information of case studies related to the CeReRE thematic network, but also for the development of a general meta-

database of agrobiodiversity based AET case studies. Themes were articulated into dimensions to facilitate both the analysis of case studies and the building of related descriptors as illustrated in Figure 1.

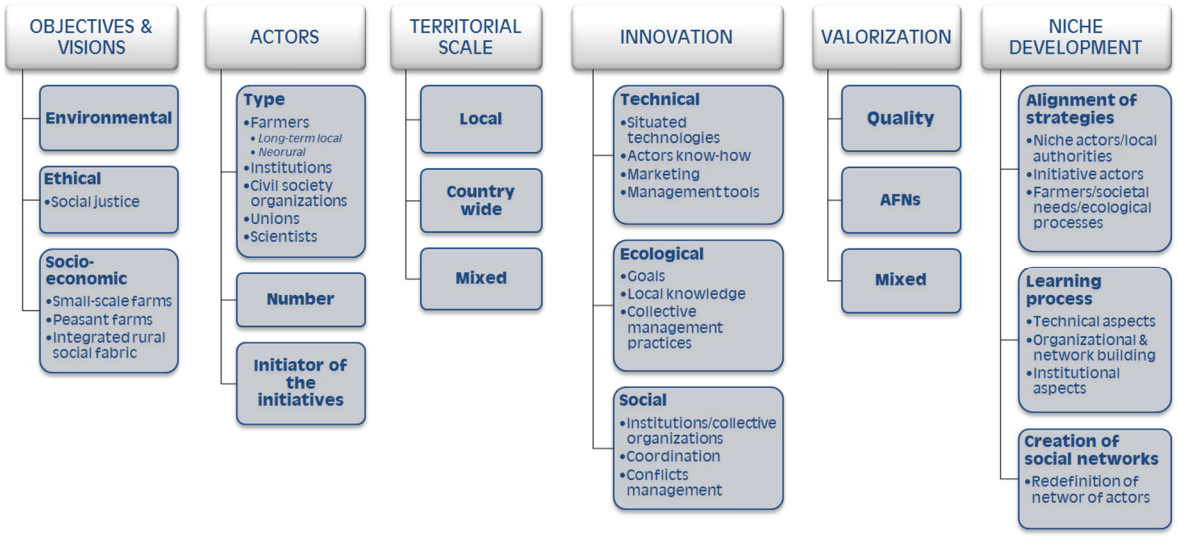

Figure 1. Themes and relative dimensions identified for the construction of the meta-database.

The *objectives and visions* theme supports the development of agroecological initiatives via environmental, ethical, and socio-economic dimensions [9,35]. The environmental dimension is linked to the reduction of the dependence from detrimental external inputs (e.g., chemical pesticides and synthetic fertilizers) leading to the autonomy of food-producing families and communities [8,36]. The ethical component is more closely connected to values linked to justice, social inclusion, and solidarity towards farmers [6]. Finally, the socio-economic dimension, besides opportunities to differentiate products and exploit a market niche, also considers the different nature of the agroecological initiative itself: rooted within the context of small-scale/peasant farms [37], or rather, embedded in the broader rural social fabric.

The second theme deals with different *actors* involved in agroecological experiences. We take into account aspects regarding their nature-farmers (either neo-rural or original), institutions, organizations (e.g., cooperatives or associations of the civil society, unions) and scientists, the number of stakeholders involved, and the architect of the initiatives in either bottom-up collective initiatives or top-down initiatives orchestrated by a single actor [7,9]. Diverse transition mechanisms may arise depending on the combination of civic society initiatives, private actors' engagement and governance innovations such as collective actions [19].

The *territorial scale* analyses the local or country wide dimensions that are recorded by observing several agroecological initiatives. In particular, Lamine et al. [19] posit the small region scale as the correct level to analyse sociotechnical systems in a dynamic way through the interplay of different system components and actors, the emergence of public problems and contested visions, trajectories and paradigms over time. However, other authors [11,27] analyse the country level to detect the interplay of institutional assets and technical changes. Others consider instead the farm level as pertinent for the analysis of agroecological transitions [6,35].

The *innovation* theme takes into account technical, ecological and social dimensions [5]. From the technical point of view, it is possible to compare specific local technologies, and technical dimensions of practices with associated representations, values, knowledge and know-how of farmers. The ecological component deals with the ways in which actors consider ecological goals, such as the provision of specific ecosystem services, in their management—the maintenance and development of local ecological knowledge and, the creation, re-evaluation and reshaping of individual and collective management practices of local ecosystems. The social dimension explores the role of

institutions and emergent collective organisations as well as conflicts and controversies leading to social signification, agreements and changes that have to be considered within the social facets linked to the innovation dimension [5].

The *valorisation* theme analyses different strategies and measures adopted within initiatives, such as the strengthening of consumers and producers' relations and relative dynamics in AFNs, the focus on product quality or combinations of the two [6,19].

The last dimension, *niche development*, deals with the processes that link niches to socio technical regimes underpinning niche evolution and regime changes [6,7,11]. Alignment of strategies, the learning process and the creation of social networks which extend beyond the niches are the three types of actions underpinning niche development and its transformative linkages with the sociotechnical regime.

4. Selection of Case Studies

Currently, many farmers across Europe are applying alternative and sustainable farming practices and are committed to moving towards the agro-ecological model. As far as the cereal sector is concerned, many smallholders have realized that AET cannot be implemented by growing commercial varieties available on the market under intensive agricultural models, but only by accessing a germplasm that is more adapted to their specific conditions and territories [38,39]. In order to implement these changes, farmers are conducting experiments growing landraces, varieties of ancient grains, varietal mixtures and evolutionary populations with the support and assistance of researchers and seed networks [39,40]. In this context, the CeReRE thematic network was designed to support and promote innovative and emerging sustainable strategies to introduce and manage agrobiodiversity in cereal food systems. These innovative strategies have been identified, bridging the gap between best practices and existing scientific knowledge and bringing together stakeholders from eight European countries (Denmark, France, Finland, Hungary, Ireland, Italy, Spain, and the UK). Stakeholders with different expertise (farmers, processors and other rural actors, researchers, academics, politicians and citizens) working together via a participatory approach have produced a number of case studies aimed at describing best practices grounded in diversity, health benefits and quality of food products related to these innovative systems. For the purpose of this study, six case studies were cherry picked to shed light in practical terms on current European cereal system involved in AET. These case studies (CS) are briefly introduced (for more information see [14]) and discussed in the next section according to results summarised in Table 1 which reflects themes and dimensions highlighted in Figure 1.

4.1. CS1: The Organic Arable Marketing Company, UK

The Organic Arable Marketing Company is an independent farmer-owned company consisting of about 70–80 farmers, which was founded in the Cambridge countryside in 1999 by a group of ten farmers specialising in the marketing of organic grains and pulses. Organic Arable helps national producers to market their crops effectively, efficiently and transparently by providing marketing services through innovative brokerage mechanisms with several economic agents of these supply chains. The main services provided by Organic Arable Marketing Company are related to marketing advice, knowledge transfer, technical help (advice of varieties better suited to the market), free grain testing, pool marketing, and credit insurance.

Table 1. Pilot application on agrobiodiversity transition in the wheat chains.

		CASE STUDIES					
		CS1	***CS2***	***CS3***	***CS4***	***CS5***	***CS6***
DIMENSIONS		Socio-economic	Socio-economic/Ethical	Environmental	Ethical	Socio-economic	Socio-economic
	Objectives and visions	*To manage farms more efficiently by providing marketing services*	• *To protect and promote ancient grains producing healthy products at fair prices* • *To help producers to comply with production guidelines*	• *To defend the territory against the tendency of both selling off land and overbuilding* • *Bread for crisis (low price) project*	• *To protect human health and agricultural land* • *To promote food sovereignty and critical consumption of bread*	• *To re-localize the bread chain* • *To connect consumers nutritional interests to sustainable agricultural practices*	*To contribute to the development of local economy allowing participants to make a living from their work.*
	Actors	Initiator					
		Farmers	*Farmers, bakers, millers and researchers and municipality*	*Politicians, and farmers*	*Consumers*	*Farmers, millers and researchers (INRA)*	*Farmers*
		N. and type					
		50 farmers members plus serving 20–30 producers on ad hoc *basis*	*40 farmers members plus 10 food-processors*	*7 agricultural producers (6 Farmers, and a baker) and numerous consumers*	*2 farmers, 1 miller, 5bakers 6 retailer shops and numerous consumers*	*6 farmers and millers plus several commercial partners1*	*13 Farmers, 3 millers, 1 retailer and several consumers and institutional partners*
	Territorial scale	Country wide	Local	Local	Local	Mixed	Local
		UK	*Montespertoli (Florence)*	*Mira (Venice)*	*Brianza area (Monza)*	*Languedoc Roussillon region/other French regions*	*Hautes- Pyrénées, Gers, Haute-Garonne areas*
	Innovation	Technical	Social/ Ecological	Social/ Ecological	Social/Ecological	Technical/ Social	Social/Ecological
		Marketing	• *Cooperation among members* • *Coordination management* • *Trust-building practices*	• *Formal business network* • *logistic of organic bread making* • *Social innovation (consumer involvement)*	• *Co-production* • *Fair and transparent distribution of the value chain* • *Sharing of uncertainties between producers and consumers*	• *Local markets and fair pricing* • *proprietary brand* • *Trust-building practices (PGS)*	• *Collective management practices* • *Social inclusion projects* • *Institutional innovation (SCIC)*
	Valorisation	Quality	AFNs	AFNs	AFNs	Quality	AFNs
	Niche development	Learning process	Alignment of strategies/ Learning process	Alignment of strategies/ Creation of social networks	Alignment of strategies/Creation of social networks	Creation of social networks	Creation of social networks/Alignment of strategies
		• *Technical aspects (marketing advice, knowledge transfer and technical help)* • *Free grain testing* • *Pool marketing* • *Credit insurance*	• *Local municipality involvement* • *Experiencing new solutions with local University* • *Scaling-up by replication*	• *Involvement of Fair-Trade network* • *Funding from regional agencies* • *Link with local political party*	• *Wider civil society organisations* • *Network of local relationships* • *Link with CS2*	• *Local institutions involvement* • *Local network development (chain actors)*	• *Local institutions involvement* • *Links with Local organic farmers network*

4.2. CS2: The Associazione Grani Antichi Montespertoli, Italy

Associazione Grani Antichi Montespertoli is a non-profit association established in a small village (Montespertoli) in the province of Florence. The objective of this association is both to promote a local supply of healthy products obtained from ancient grains at fair prices and to help producers to comply with specific production guidelines. Thus, the Associazione Grani Antichi Montespertoli facilitates cooperation between different actors and promotes products along the supply chain assuring a fair distribution of added value. The association also fosters innovation within the chain, experiencing new solutions also in agreement and in collaboration with the University of Florence. Currently, forty organic farmers, one miller, and three bakeries are involved in the supply chain. The Association board sets the prices of wheat, flour and bread, in a way that the price of wheat covers farmers' production costs and a fair distribution of the added value among all actors is attained. Being embedded in the local society, the association benefits from cooperation among members and also creates trust mechanisms with local consumers.

4.3. CS3: Grani resistenti, Italy

Grani Resistenti (Resilient Grains) is a network of agricultural producers who aim to promote an innovative organic wheat and bread chain in order to defend the local territory against the loss of agricultural land to civic and industrial uses. This network was established in 2018 and comprises six organic agricultural farms and a bakery with its own mill. Grani resistenti operates between the provinces of Padua and Venice and manages about 50 ha. The network has rebuilt and created new knowledge through an experiential process of social learning bringing advantages to all actors involved along this supply chain in terms of preservation of agricultural land, quality of products, economics and mutual support sharing risks and benefits. Grani Resistenti has explored new forms of relationships with the Fair-Trade world and has established strong relationships with consumer groups who, as well as being their main buyers, also contribute to the processing of traditional varieties of cereals.

4.4. CS4: Spiga e Madia, Italy

The Spiga e Madia project dates back to 2005, when in Brianza (Italy), a group of critical consumers became co-creator of an innovative chain with the objective of producing bread bearing in mind the protection of human health, preservation of agricultural land and promotion of critical consumption practices. This initiative was brought about, signing an agreement on solidarity economy aimed at promoting the local bread supply chain. The general idea of Spiga e Madia lies in the recovery of food sovereignty both for producers and consumers who cooperate by adopting alternative practices to industrial and mainstream food systems. The actors involved with this agreement share responsibilities and risks linked to the management of the project and adopt a transparent price system in order to guarantee a fair remuneration to actors along the value chain. Nowadays, the project involves two organic farmers, a miller, five bakers, six retail shops, and at about 600 families organized in several solidarity-based purchasing groups.

4.5. CS5: Flor de Pèira, France

Flor de Pèira® is a collective registered brand developed in 2012 by a group of farmers and millers in the Languedoc Roussillon region with the aim of helping the local economy by triggering consumers' nutritional interests in sustainable agriculture. Flor de Pèira supplies organic flours and bread of high nutritional quality which is distributed by a network of sales partners also in other regions (Aude, Ariège and Pyrénées-Orientale). Since 2016, this group of farmers and millers certify the quality and validate all productive procedures via a participatory guarantee system. The participatory guarantee system has a strong social impact not only for the verification processes but also for its character that is closely related to the learning process, know-how sharing and supportive and mutual trust action among members.

4.6. CS6: The Odyssée de l'Engrain, France

The Odyssée de l'Engrain is a Cooperative Company of Collective Interest (Société Coopérative d'Intérêt Collectif - SCIC) founded in 2013 which produces organic pasta made with ancient varieties of wheat or einkorn. Odyssée de l'Engrain aims at preserving crop biodiversity contributing to the promotion and development of the local economy through collaboration and human relations in the areas of the Hautes-Pyrénées, Gers, and the Haute-Garonne. The company is managed collaboratively by a 12-member steering committee of producers, processors, distributors and consumers. The SCIC legal form allows each of the 70 members who have contributed financially to its establishment to have equal decision-making power—this includes producers from small or big companies, consumers and professionals. The project allows participants to make a living from their work, looking after each facet of grain production, from milling to sales.

5. Pilot Coding of Selected Case Studies from CeReRE Project

Table 1 summarizes the results of the previous six case studies in relation to the dimensions identified for the construction of a meta-database of AET case studies. Far from being a comprehensive repository of AET experiences, the proposed pilot meta-database represents a fruitful starting point to synthetize and introduce generalizable knowledge about AET themes descriptors and their relative dimensions of analysis.

All case studies analysed are characterized by the involvement in agro-biodiversity management and thus, to a larger or lesser extent, the environmental dimension seems to be a common denominator of the objective and visions theme other than for CS1 where the economic actors are focused mainly on the socio-economic dimension. However, this theme also allows us to pick up differences on the socio-economic and ethical dimensions. The different focus correlates to some extent with the nature of the involved actors. Initiatives dominated by farmers or farmers' organisations are focussed on socio-economic goals, while ethical, health and environmental issues are preferred by consumers and civil society organisation.

These AET processes are generally started by farmers alone (CS1 and CS6) or in collaboration with other actors other than for CS4 where this initiative, designed by consumers willing to improve the democratic process of food choice, fostered the development of the local supply chain. This is an instance of citizens' practicing critical consumption and respecting small local productions that sheds light on the role of consumer associations and cooperatives co-producing value in AET food chains. In other cases, AFNs are promoted by farmers in collaboration with millers, politicians, researchers and consumers. The collaboration of these economic agents generates networks (cooperatives or associations) that are characterised by a small number of farmers, millers, and numerous consumers operating at a local or regional level. They bypass middlemen and retailers trying to take control of the supply chain and establish direct contacts with consumers on the basis of trusted mutual relationships among all economic agents. When these networks operate at a national level, we observe a larger number of farmers and several commercial partners other than those serving a niche market.

As far as the nature of innovation is concerned, all initiatives share an interest in organic or low input agriculture and management of agrobiodiversity especially with regard to germplasm selection. Technical aspects of cultivation and processing diversity-based wheat produce is at the core of these initiatives. Aspects of *innovation*, expressed in four out of six case studies (CS2, CS3, CS4, and CS6), offer interesting information within the ecological and social dimensions. In particular, initiatives characterized by a local scale dimension inevitably deploy a range of social innovations in the territory ranging from form of co-production activities involving consumers (CS4) to social inclusion aspects such as the presence of some form of fair pricing or the involvement of disabled people.

In CS2, CS3, CS4 and CS6, the *valorisation* of produce is carried out mostly within AFNs based on a local territorial scale, where embeddedness of biodiversity among farmers and consumers play a key role in the collective rethinking of core values of the agro-food system [39]. In CS1, the

valorisation of produce is achieved by transferring technical and marketing advices to farmers, while in CS5 it is achieved by communicating to consumers the quality process and the nutritional properties of the bread marketed in local networks.

A comparison of the *niche development* processes requires some caveats, as the life span of the different initiatives is not homogeneous. For example, the Montespertoli case study has unfolded over a period of about 15 years, sufficient to allow the observation of scaling-up processes through the replication of the initial scheme in other local contexts spread across the country. However, the creation of a network of actors at the local level and the alignment of strategies and values with local institutions seems to be one of the main niche development strategies so far adopted. Learning processes are common to all initiatives, as related to the management of agro-biodiversity, which requires the adoption of situated technologies and mobilization of local ecological knowledge as suggested in section three. In a single case (CS1), learning processes were highlighted, as they are at the core of the initiative—notably, a country-wide one.

6. Conclusions

Agroecological transitions are long-term, complex and multidimensional processes whereby innovations initially developed by small initiatives spread to larger contexts involving a wider network of agents and institutions. Their study intertwines technical, ecological and social aspects. As they concern relationships of a group of agents with a new technique and a new approach to the surrounding agro-ecosystem, the characteristics of the social interaction of people involved, of the new technological solutions adopted and the specificities of the agro ecosystem are of paramount importance. Owing to the fact that agro-ecosystem and socio-cultural contexts are typically territorially diversified, technological solutions must be adapted to such contexts, and as a result, a wide diversity of transitions is expected to emerge from these alternative networks. The adaptive nature of agroecological transitions also point outs the key role played by agrobiodiversity. As stated by Pretty [4], sustainability in agriculture "emphasizes the potential benefits that arise from making the best use of both genotypes of crops and animals and their agroecological management". By providing genotypes adapted to specific environmental contexts, agrobiodiversity contributes decisively to the future of the agroecological model of agriculture. Hence, there is a necessity to accumulate and systematize as much evidence as possible on the initiatives of AET based on agrobiodiversity, to identify, if any, common patterns and cause–effect relationships.

Notably, the majority of studies dealing with sustainability transitions in agriculture, and in particular AETs, are qualitative and based on case studies [24], a characteristic inherited by the most-used theoretical framework, i.e., multilevel perspective [41]. Given the qualitative nature of these studies, our initial comparative analysis of AET experiences, via the construction of a pilot meta-database of published case studies, represents a conceptual advancement of the existing literature on agrobiodiversity. By condensing information in a structured and formalized way, we translated a series of existing qualitative case studies within the AET process into a more conclusive and easier interpretative form. Specifically, we designed a coding form for the meta-database and piloted it over a few case studies on the use of agro-biodiversity in wheat chains. Although it was only a coding attempt of a particular type of AETs, our approach to a systematic comparison of case studies has already provided some hints about covariation of some dimensions such as the nature of the actors involved, the values underpinning the initiatives and the prevalent type of innovation and the territorial scale of the initiatives.

Even if the small number of cases analysed in this study does not allow us to make generalisations, we assume that this first exercise can trigger the systematization of knowledge among scholars as well as generate new debates and hypotheses into the research on sustainability transitions. Moreover, we also argue that a few more case studies introduced in this analysis would not have helped us to escape from any meta-database shortcomings, such as difficulty of comparability, inconsistency of conceptualisation, missing information on specific aspects of AETs and selection bias.

These weaknesses could be overcome either by a network of researchers conducting field-based research or by increasing—in a consistent way—the sample size of case studies included in the comparative analysis. The setting up of a network of researchers could help reach a consensus via a participatory approach about common conceptualization, salient aspects to be investigated and the relative importance of the interaction of all these aspects. This approach should generate a common protocol for data collection of case studies, assuring conceptual consistency and data comparability. Although the large number of factors and theoretical models associated with the study of AETs make this intellectual enterprise challenging, similar experiences have been carried out in other fields of similar complexity [12]. Alternatively, a larger number of case studies could be collected and analysed from a multidisciplinary perspective involving research from different backgrounds, such as sociologists, economists, linguists and marketing and policy experts. In this case, the use of modern developments of automated text analysis could help researchers to identify and collect a large body (a corpus) of textual data such as abstract of articles, and full text documents whose analysis can uncover patterns of AETs and AFNs. In this respect, structural topic modelling [42,43] could be helpful, at least in the winnowing stage of the construction of a meta-database [12] when relevant papers for the topic must be selected.

Even if it is demanding, the development of common protocol or of a larger meta-database would be a first step that could probably uncover general covariations among selected dimensions of AETs and AFNs that can sustain further structured initiatives having the scope of providing support for policies promoting an agroecological approach to the production of food. The development of such meta-databases can produce interesting implications for several actors of these new food systems such as researchers, practitioners and policy-makers. Researchers could benefit from a wide set of tools and data sources and identify problems and solutions in a multidimensional space. Practitioners of sustainable food systems can benefit from best practices and strategic learning processes adopted in several AET initiatives. Finally, policy makers could take advantage of comparative research when evaluating the impact of policies developed by different institutions in diverse socio-economic and cultural context simplifying, enhancing and speeding up sustainable productions of agroecological transitions and alternative food networks.

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