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Crossing Sociological, Ecological, and Nutritional Perspectives on Agrifood Systems Transitions: Towards a Transdisciplinary Territorial Approach

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Abstract: The need to reconnect agriculture, environment, food, and health when addressing agrifood system transitions is widely acknowledged. However, most analytical frameworks, especially in the expanding literature about "system approaches", rely on impact-based approaches and, thus, tend to overlook ecological processes as well as social ones. This article aims at demonstrating that a territorial approach to agrifood system transitions is more appropriate to tackle the reconnection between agriculture, food, environment, and health than the larger scales (global or national food systems) or the smaller ones (such as those of alternative food systems) usually addressed in the literature. Co-elaborated by a sociologist, an ecologist, and a nutritionist, this article is based on a focused analysis of the literature that has addressed agrifood system transitions in the food and health sciences and in the social sciences and on the reflexive analysis of two past projects dealing with such transitions. It shows that a territorial approach allows including in the analysis the diverse agrifood systems' components as well the ecological and social processes that may create functionalities for improving agrifood systems' sustainability. This territorial approach is based on systemic and processual thinking and on a transdisciplinary perspective combining an objectification stance and a pragmatist constructivist one. It should allow actors and researchers to build a shared understanding of the transition processes within their shared territorial agrifood system, despite possibly different and diverging views.

Keywords: sustainable transitions; agroecological transitions; food systems; transdisciplinary; nutrition

1. Introduction

While most human communities have long relied—and some still rely—on a universal pattern that articulated agriculture, food, and the local environment holistically, these elements have been disconnected through the modernization and industrialization processes. These processes have led not only to increasing detrimental environmental impacts but also to increasing health problems all over the world. The quality of food products and the diets are impaired by intensified systems and the increasing consumption of ultra-processed foods [1,2]. The changes undergone by food systems since the 1960s have almost halved undernutrition but at the same time doubled the proportion of those who are overweight [3], with a high prevalence of obesity and metabolic-related diseases even in developing and middle-income countries, as well as in the poorest segments of the population in developed countries [4]. The need to stop "sustaining the unsustainable" [5] and to transition to sustainable consumption and production patterns that may reconnect agriculture, environment, food, and health is

increasingly advocated at different levels, from local civil societies to scientific commissions and global policymaking [6–8]. It is present in the 2030 Agenda for Sustainable Development from the United Nations [9], with an explicit articulation between food security, nutrition, and sustainable agriculture in SDG2 ("Zero hunger").

To tackle this necessary reconnection between agriculture, food, environment, and health in agrifood systems' transitions, the territorial scale appears as a potentially appropriate scale, with several recent calls for a stronger integration of social and ecological dimensions at the scale of "city-region food systems" [10] or agro-ecological territories [11] and for more place-based approaches [12]. This article argues that the relevance of a territorial approach relies on two main arguments: (i) it is the scale of direct interactions between ecological and social processes, which may create functionalities for improving agrifood systems' sustainability, and (ii) it allows the identification, and possibly the involvement in the research process, of the agrifood systems' diverse actors. The article is issued from a focused interdisciplinary analysis of a series of conceptual approaches to agrifood systems transitions, in both food/health sciences and social sciences, and a cross-disciplinary reflexive analysis of two recent research projects anchored respectively in the food and the social sciences, that illustrate recent research trends.

The focused analysis of the literature presented in Section 2 leads to show that most approaches, whether in the food/health sciences or in the social sciences, that address the need to reconnect agriculture, food, environment, and health, tend to overlook ecological processes because they are based on impacts and resource-stock visions. In Section 3 is presented the analysis of the two recent research projects. The first project aimed to model feasible sustainable dietary changes without impairing the environment at the regional and national scale and to translate these dietary changes into concrete actions that were assessed by policy makers and practitioners. The second one analysed and characterized social processes involved in a regional agrifood system's past and current transitions. The cross-disciplinary reflexive analysis of these two projects explores their differences and specific limits and shows that both have considered taking the territorial scale as a potentially appropriate analytical scale, albeit for different reasons. In Section 4 are defined the main features of a territorial approach to agrifood systems transitions. Shifting from an impact-based to a process-based thinking, this territorial approach would combine an objectification of the processes and feedbacks that may create functionalities for improving agrifood systems' sustainability, with a pragmatist constructivist stance aimed at including the differing visions and values of the actors that represent the different agrifood systems' components.

2. System Approaches and their Missing Dimensions

Approaches to food systems sustainability (or unsustainability) tend to be framed within distinctive disciplinary narratives [13] that are also most often disconnected. In the agricultural and food sciences, most conceptual approaches to agrifood systems transitions tend to tackle agriculture, food, environment, and health separately, usually linking them in pairs (Figure 1):

- agriculture and environment, with a wide range of ecologically based agricultural models relying on different paradigms and visions on how to create links between agricultural and ecological dimensions and on goals that go from merely reducing the impact of chemicals to redesigning agroecosystems in order to favor ecological regulations [14]. However, most of these approaches do not take into account food practices, diets, and health processes other than assuming that zero input or low-input agriculture is also better for human health.
- agriculture and food, with the increase in use and the diverse conceptualizations of the notion of "food systems" in diverse disciplines and the increasing number of studies analyzing the impact of diverse farming practices on nutritional quality [15,16].
- health and environment, especially with the concept of "One Health" that emerged in the last decade. Although it initially showed a strong integrative potential to think together human, animal, and environmental health as it invited to admit that the human health is strongly

linked to the health of animals and environment based on a collaborative transdisciplinary and trans-sectorial approach at different levels (local, regional, national, and global levels), it has with time become mainly a tool for crisis-prevention, risk-management, or cost-reduction due to diverse factors such as a convenient articulation with securitization agendas [17].

- food and health, with approaches focused on the health impacts of food practices through epidemiological studies about the consumption of food categories (meat, dairy products, cereals, fruits, and vegetables) as reviewed about organic consumption [18,19].

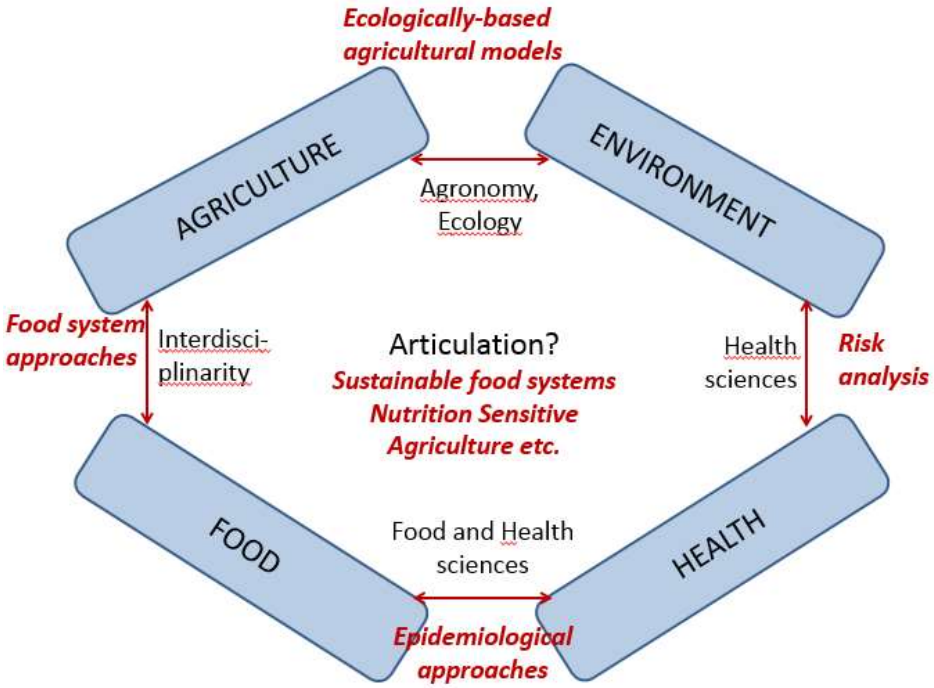

Figure 1. How most approaches tackle agriculture, food, environment, and health mostly by linking them in pairs (source: the authors).

2.1. System Approaches in the Food and Health Sciences

The reconnection of agriculture, food, environment, and health is increasingly advocated in the food and health sciences, as shown by the recent revival of the "sustainable diets" concept. This concept was introduced as early as the 1980s, based on the fact that both human health and ecosystem health are inextricably linked and that these links must be central to our conceptions of food [20]. However, this pioneering holistic approach to diets was later neglected, due *inter alia* to the focus on increasing yields and food production to ensure food security [21]. The "sustainable diets" concept has been revived by some scientists [22–24] and by FAO, which promotes "diets with low environmental impacts which contribute to food and nutrition security and to healthy life for future and present generations" [25].

"Nutrition-sensitive agriculture" is another approach that has been developed recently to address the challenge of ensuring the production of a diversified range of affordable, nutritious, culturally appropriate and safe products in sufficient quantity and quality to meet the dietary requirements of populations in a sustainable manner [26]. However, it appears more as a political term used in international institutions' discourses than as an "actionable concept" that could orientate food systems transitions [27].

Nutrition-sensitive agriculture and sustainable diets might be considered as mirror concepts in the sense that the first one departs from agriculture to reach nutritional issues and the second departs from diet to favor adequate and sustainable agricultural production. Both postulate a virtuous alignment between the de-intensification of agricultural production based on lower external inputs

and a larger use of biological diversity, lower environmental impacts, better nutritional quality of food products, and better health. However, this argument is more often based on the negative links between agriculture, environmental, food, and health (i.e., between intensive agriculture, detrimental environmental impacts, and lower nutritional quality) than on actual evidence of possible positive correlations.

Integrated Food Systems approaches—which are increasingly advocated, developed, and applied by food and health scientists, often in interaction with other disciplines—claim to address these necessary reconnections between agriculture, food, environment, and health. Approaches are mostly designed at the global or national scale [28] and based on life cycle assessment [29] and modeling [30]. Modeling approaches have shown that adopting suitable dietary changes, especially by reducing meat, is necessary to decrease both environmental degradation and health risks [31]. Dietary changes can be identified by mathematical modeling to reach nutritionally adequate diets with a concomitant decrease of Greenhouse Gas Emissions (GHGE) [32,33]. To understand the linkages between diets, agricultural production practices, and environmental degradation, food production systems can be compared in terms of GHGE, land and energy uses, eutrophication, and acidification potentials [34]. However, most of these studies still overlook major aspects such as biodiversity or eco-toxicity [35] and focus on environmental *impacts*, thus also overlooking the role of ecological *processes*. Moreover, they ignore more complex transition mechanisms that involve ecological, social, and economic processes together, such as the consequences of diverse food production systems on rural landscape and quality of life as well as inertia due to cultural habits.

Several studies, at the interface between food and ecological sciences (sometimes with the input of social sciences), have addressed more directly *ecological* processes within agrifood systems transitions by analyzing the links between agricultural biodiversity, food, and health and especially the role of both farmed and wild biodiversity in improving human diets [36–38]. However, these studies also state that precise correlations between the levels and nature of diversity and the quality of diets are still difficult to assess.

Finally, most studies in the food and health sciences overlook the social processes that can facilitate or impede actual changes in diet: actors' strategies, power relationships, coordination between actors, and public policies. For example, even though nutritional guides in many countries recommend at least 5 portions of fruit and vegetables per day, whether their supply can be sufficiently and adequately distributed to meet this recommendation remains a key question. New methodologies have recently been suggested so as to better include the social criteria in food security assessments [39], but these are once again based on impacts and states at the expense of processes.

2.2. System Approaches in the Social Sciences

Social mechanisms—such as power relations, coordination, interdependencies, and the diversity of knowledge and visions within the agrifood system—are, of course, tackled more directly by approaches that come from the social sciences. Critical approaches to agrifood systems transitions, such as the Food Regimes theory [40] that has been developed since the 1980s, analyze the disconnection of agriculture, food, environment, and health by showing the negative environmental, health, and social effects of the global food system. On the other hand, the development of alternative food networks has led to more optimistic analyses regarding current and possible future transition pathways and their reconnection capacity. For example, progressive learning processes that allow consumers to better understand farmers' practices and concerns lead them to adapt their diets in favor of more seasonal and local products, as well as to collectively reflect about the social and health issues at stake [41,42]. These studies are mainly at the local scale, in sync with the re-localization paradigm (e.g., with the "foodshed" notion [43] that was revived by the food sovereignty turn since the early 2000s). Besides the fact that they cannot address the actual scales of production and consumption flows, these "localized" approaches tend to under-analyze the strong territorial and social inequalities in terms of resources and abilities to operate such relocalization/reconnection processes [44].

Articulating different scales or "levels", sustainability transitions approaches have explored possible "transition pathways" within socio-technical systems based on the Multi-Level Perspective (MLP) [45,46]. The MLP approach, that was recently applied to agrifood systems and agroecological transitions [47], conceptualizes transition as the processes of regime reconfiguration under the pressure of the landscape (exogenous economic, political, and cultural context) and the influence of niches (spaces where radical innovations are developed by small networks of actors). However, Sustainability Transitions approaches have been criticized for overlooking actual changes in practices [48] as well as power relationships between actors and social groups [49] due to their focus on institutional mechanisms.

If these different social science approaches to agrifood system transitions can be considered as processual approaches, they focus, of course, on social processes while health and ecological processes are not tackled as such—except through a constructivist perspective.

2.3. Tackling Environmental Impacts or Ecological Processes?

Despite their differences in terms of how they address agriculture, food, environment, and health reconnection and how they tackle the ecological and social dimensions of agrifood systems transitions (see Table 1), most studies in both the social sciences and food sciences share a common stance: they mainly adopt, whether explicitly or implicitly, an impact and resources-stock approach.

Table 1. How different approaches anchored in the food sciences and in the social sciences address the ecological dimension and the social dimension.

	Food sciences	**Social sciences**
Main approaches to address agriculture, food, environment, and health reconnection	• sustainable diets [20], nutrition-sensitive agriculture [26] • life cycle assessment modeling (of future/possible states, impact, etc.) mainly at the global or national scales [33,34] • interdisciplinary approaches aimed at tackling the ecological dimension (biodiversity/diet interactions) [38]	• critical approaches, carried out at the global scale, showing the negative environmental, health, and social effects of the global food system [40] • alternative food network studies at the local scale [43] • sustainability transitions approaches [46,47] • need for an ecological turn [50,51]
How is the ecological dimension addressed?	• Focus on some indicators such as Greenhouse Gas Emissions (GHGE) to the expense of others such as biodiversity or eco-toxicity • Focus on quantitative impacts approaches and overlook the role of ecological processes	• Focus on constructivist perspectives and/or resources-stock and environmental impacts ones and overlook ecological processes
How is the social dimension addressed?	Overlook social processes (actors' strategies, power relationships, coordination between actors, and public policies) despite an increasing inclusion of stakeholders in research projects	Focus on social processes but based on past or on-going transitions (no modeling/prospective capacity)

In other words, most approaches adopt an *environmental* rather than an *ecological* perspective on the sustainability of agrifood systems. The two terms—environmental and ecological—are often used as synonyms, yet they actually convey different visions on the relationship to nature in a context where human activities have been largely based on placing nature at a distance, with its complexities and uncertainties, as has been described by environmental sociologists and food regime theorists in reference to Marx' notion of metabolic rift [50]. The environmental perspective emerged from a protective view of nature and has been developed in direct links with a vision of natural resources as a finite stock and, therefore, a conception of sustainable management based on "impact

assessment". With this approach, a lesser and/or more efficient use of natural resources in agricultural and food practices must lead to a reduction of the impact on these natural resources. The notion of "carrying capacity" (the maximal load beyond which the environment cannot renew its resources and the system can collapse), which comes from the ecological sciences [52], has been largely mobilized even in the social sciences [53]. Numerous criteria (quantitative and qualitative) have been developed to assess the (negative or positive) impact of human activities (especially agricultural practices) on resources.

The term "ecological" allows introducing explicitly a fundamental change in the way we consider nature and its resources in order to explore functional interactions between agricultural practices and the "non-human". In reference to ecological sciences, the term "ecological", as opposed to "environmental", allows introducing the processual, dynamic, and evolutionary dimension, which is specific to natural systems (and more largely to biophysical systems).

Some authors have pointed out the limits of an environmental approach focusing only on impacts and state diagnoses and have called for an "ecological turn" in food systems approaches [50] and the need to tackle dynamic system interactions and to consider agrifood systems as embedded in complex ecological, social, and economic processes [51]. Others have suggested to consider "ecological feedback loops" [54]. This notion promotes the idea that sustainability requires that producers and consumers recreate links with resources and the ecosystems in their daily practices, which implies adjusting and adapting practices to signals that these ecosystems send back. However, these approaches still challenge the identification of signals to be observed, how to interpret them in the short or longer term, and how to adjust actions and management. Socio-metabolic approaches claim to address the interconnectedness of socioeconomic changes and changes in natural systems, based on the analysis of material and energy flow data [55]. Some authors have adapted these approaches to agricultural contexts by developing the concept of *agrarian metabolism*, which considers the energy and biomass devoted to the sustainability of the agroecosystem and its reproductive functionality [56]. However, such approaches deliberately focus on a narrow set of variables describing the society–nature interface for which quantitative measurements can reliably be obtained (population growth, diets, land use, and species extinction, for example).

In sum, by focusing on impacts and resources-stock visions, most studies about agrifood system transitions do not address ecological processes at different organizational levels or how these processes may play a role, along with social processes, in threatening or reinforcing agrifood systems' sustainability.

2.4. The Emergence of Territorial Approaches to Agrifood System Transitions

In the literature about sustainable agricultural systems, some authors advocate a change in the scale for agricultural management (from plot or farm to landscape) in order to take into account the ecological processes implied in biodiversity and populations dynamics [57]. By extension, the landscape or territorial scale should also be appropriate when considering not only the reconnection between agriculture and the environment but also their reconnection with food and health in order to study or favor transitions towards more sustainable agrifood systems (as opposed to "only" agricultural systems). It is mainly within the burgeoning field of agroecological studies that such territorial approaches have recently emerged.

Vaarst et al. [10] have suggested a conceptualization of "agroecological food systems" based on the extension of the main agroecological principles (minimizing inputs, resources recycling, resilience, multi-functionality, complexity and scale integration, contextualization, equity, and nourishment) from the scale of agricultural systems to that of agrifood systems [10]. This approach calls for a strong integration of social and ecological dimensions at the scale of "city-region food systems", within a concentric perspective that may not apply to rural territories. Wezel et al. [11] have suggested the concept of agroecological territories, defined as places where a transition process towards sustainable agriculture and food systems is engaged. This approach, based on a combination of agricultural science,

landscape ecology, and social science, defines food systems as "socio-technical networks linking people, natural elements, and artefacts that interact with food issues" [11]. However, although these authors rightly underline the problem of scale mismatches between ecological and social processes, they do not propose to explore the functional links between these ecological and social processes that could support the reconnection of agriculture, food, environment and health.

3. Insights from Two Contrasted Project Frameworks Illustrating Food Sciences and Social Sciences' Focusses

A reflexive analysis of two recent research projects initiated respectively by food and health scientists and by social scientists illustrates the contrasting research trends described above, before we progress towards the elaboration of what we expect to be a more appropriate approach.

3.1. Medina Project—Promoting Sustainable Mediterranean Food Systems for Good Nutrition and Health

The first project, called Medina, brought together multidisciplinary expertise in nutrition, food science, agronomy, and economy. It was elaborated based on the observation that the prevalence of diet-related diseases is high and is increasing in Mediterranean countries as people turn away from traditional Mediterranean diets characterized by a high consumption of plant products, seafood, and olive oil and a low consumption of meat and dairy products [58]. The Mediterranean diet is also well-known for its lower environmental impacts (water use, global warming potential, regional, biodiversity impact, and land use) due to the consumption of more plant-derived products and fewer animal products [59,60]. It, thus, illustrates a potentially virtuous reconnection of agriculture, food, environment, and health.

The main objective of the Medina project was to sustainably maximize agrifood chains' contribution to human health and nutrition based on the general hypothesis that it is possible, based on modeling approaches, to draw virtuous transition pathways that would be beneficial to human health and to the environment, as well as respecting local cultures and diets. Medina proposed to optimize food dietary changes based on the idea that they are probably more efficient than production changes in environmental terms, as reported by Clark and Tilman [34] for greenhouse gas emissions. The project explored how all nutrient needs could be covered in order to maintain good health and to prevent disease (obesity, diabetes, and cardiovascular disease), while minimizing environmental impact, especially through water and land uses.

The project was carried out in two contrasted Mediterranean areas, Southern France and Tunisia. The work was performed at two scales: "macro" (country level) and "micro" (individual or household), for which there were available data.

It was based on an assessment and modeling approach, carried out in 3 main phases:

- The first phase was devoted to gathering and organizing data from available nationally representative dietary surveys and life-cycle assessment tables and food trade. For each country, around 200 foods were characterized by their nutrient content, their environmental impacts, and their import-export levels.
- The second phase was devoted to identifying the dietary changes through a holistic approach using linear programming, a computational technique used to optimize a linear function of variables while respecting a set of constraints on those variables: nutritional recommendations, cultural eating practices, and environmental resources, especially the use of water, which is a crucial resource in Mediterranean countries. The aim of the optimization was to identify a combination of foods that meets this set of constraints. Scenarios were proposed to change both food supply and consumption in a more sustainable way.
- In the last phase, policy options were proposed and analyzed through a participatory appraisal based on a multi-criteria mapping method, involving stakeholders from the food chain and public policies at national and regional scales, in order to test their acceptability and feasibility [61].

One main outcome was the construction of two scenarios in Tunisia [30]. The first scenario was built to reach nutritional adequacy: the main dietary changes were the increase of fruits and dairy products and the decrease of meat and starchy foods. In this scenario, the modeling process showed that all the environmental indicators were impaired when reaching nutritional adequacy. Thus, in the second scenario, the environmental impact (water scarcity, biodiversity, and four indicators for land-use—erosion resistance, mechanical filtration, groundwater replenishment, and biotic production) was constrained to the observed levels. In order to reach nutritional adequacy, the dietary changes needed were still the decrease of meat and starchy foods but also lower increases of fruits and dairy products than in the first scenario, in favor of vegetables. The latter scenario allowed us to construct different actions in terms of consumption behavior and both environment-friendly and nutrition sensitive production. These actions focused on health–nutrition goals (reducing oils, reducing sugar, reducing salt, increasing fruits and vegetables, and increasing sea products), food security (develop processing units to avoid waste and losses and develop eco-friendly agricultural systems), and culture (gastronomic heritage).

In Medina, the ecological dimension was addressed through the evaluation of the environmental impacts of agricultural practices and consumption. This evaluation did not take into account the different impacts of diverse agricultural practices (biodiversity and the use of pesticides) and consumer practices (waste and cooking), due to the lack of data. Thus, agriculture and food were addressed through a limited range of impact variables and without the consideration of diverse farming practices. However, Medina was the first study in which modeled scenarios of dietary changes identified to move towards more sustainable diets have been translated into action proposals that have been evaluated in a participatory interview by different stakeholders.

Social processes were not directly addressed in the analytical phases of the project. In the last phase, the appraisal of actions with stakeholders appeared useful to provide a basis to discuss possible changes in food consumption and production, but it did not serve as a basis to imagine and discuss the pathway from current patterns of agricultural production, agrifood chain organization, and food diets towards future sustainable scenarios. In order to identify these pathways, a more qualitative approach taking into account levers of change, lock in effects, and transition mechanisms would have been necessary.

3.2. Southern Ardèche—Ecological Transition at the Scale of a Territorial Agrifood System

Our second case study is a collaboration that emerged in a rural territory in Southern France (Ardèche Méridionale) at the interface between local stakeholders' questions about the future of their local agriculture and agrifood system and about researchers' interest in transition mechanisms. This territory is a rural region (about 2000 km^2 and 140,000 inhabitants) with diverse agricultural production and landscapes and a variety of grassroots initiatives (such as utopian communities, collective farmers' shops, farmers' markets, and social farming and gleaning). The collaboration between social scientists and local stakeholders was developed in 2 different projects in 2008 and then in 2015–2016, in an iterative way where the first collaboration raised new questions that were addressed in the next step, such as the issues of "inclusiveness" (of both disadvantaged farmers and consumers) within agroecological transitions.

The overall aim was to analyze the mechanisms that allow for agroecological transitions both at the farm level and at the scale of the territorial agrifood system. These territorial agroecological transitions are assessed through not only the increase in the share of organic farming but also the development of other dimensions of agroecological practices, such as short circuits and quality schemes [62].

The main hypothesis was that agroecological transitions, whether at the farm level or at the scale of the territorial agrifood system, result from mechanisms involving this system's different components together (farmers, advisory systems, cooperatives, private actors, civil society, and local policies) not only in changes of practices but also in changes of visions [63]. It is based on a sociological framework

combining a transition studies approach [46] and a focus on the transformation of visions and on related controversies.

In the first period (2008–2009), a first study was based on the analysis of farm trajectories, civil society or private initiatives, and public policies, as well as their interactions and on an analysis of the diverse actors' visions (regarding agriculture and its interactions with food and environment), the possible changes in these visions over time, and the controversies between different conflicting visions. While fieldwork was continued after this first project, it is in 2015–2016 that a second multi-actor partnership led the launch of two focused studies on the processes of learning and mutual support in tutorship systems linking experienced and new farmers, as well as on an initiative devoted to the production and exchange of local seeds. The empirical data come from a series of interviews (n = 50) with key actors (farmers, civil society leaders, intermediaries, local authorities, etc.), as well as ethnographical observations of diverse events, meetings, and interactions carried out between 2009 and 2016.

The outcome of the analysis of these different trajectories, interactions, and collective dynamics was the finding that agroecological transition mechanisms at the scale of the territorial agrifood system rely on the combination of diverse initiatives set up mainly by agricultural stakeholders and civil society organizations—often supported by territorial public policies—and on governance innovations that articulate these different components of the agrifood system and their initiatives. Indeed, some initiatives, based on the development of specific outlets, such as box schemes or producers' shops, contribute to a better connection of local sustainable production and consumption. Some also establish modes of coordination that allow a fairer distribution of the added value between producers and other actors, facilitate learning processes and support among farmers, or favor farmers' autonomy.

The analysis of the different actors' discourses and of local debates also showed a progressive recognition and legitimization of more ecological visions of agriculture and food, over time. Despite diverse visions, organic and small-scale farming increasingly appear as a legitimate option for agricultural stakeholders, even though strong power relationships remain present within the agricultural sector at large and impede a more radical transition. This shows that the changes in visions and the legitimization processes also support the territorial agroecological transition, as was confirmed through a more detailed study in a nearby territory [64].

In contrast to the Medina project, the Ardèche collaboration was mainly focused on the articulation of agriculture, food, and the environment, and health issues were not directly considered. Qualitative surveys with consumers involved in local alternative food networks have suggested that health motivations were present along with more environmental, ethical, and social ones. These surveys have also showed that among the many factors favoring more "ecological" diets is the access to a variety of networks and places where local, seasonal, and "ecological" products can be made available. However, no quantitative analysis of the changes in diets and their possible impact on consumers' health has been carried out within the project.

Ecological issues were, of course, central to this project, although not in an "objectification" perspective but through a constructivist perspective focused on the visions and controversies among the diverse actors involved. For example, while the qualitative approach has shown that the adaptation to local conditions was one of the key motivations for farmers to get involved in on-farm seed production—in order to select seeds that would be better adapted to their soil, climate, and conditions—no agronomic or ecological observations have yet been carried out.

Indeed, this collaboration was focused on the analysis of social processes, through the qualitative and comprehensive insight on past and current transition mechanisms. Based on qualitative work (qualitative interviews and observation), these transition mechanisms were analyzed as social processes that result from the strategies and interactions of the different actors and institutions constituting the territorial agrifood system [62].

3.3. Comparison of the Two Frameworks

While both projects focused on the ecologization of agrifood systems, they involved different disciplines, had contrasting objectives, relied on different methods, produced different types of outcomes, and addressed differently the agriculture, food, environment, and health reconnection and the ecological and social dimensions of food systems transitions (Table 2).

Table 2. The analysis of two projects anchored respectively in the food and the social sciences (source: the authors).

	Medina Project—Promoting Sustainable Mediterranean Food Systems for Good Nutrition and Health	**Southern Ardèche—Ecological Transition at the Scale of a Territorial Agrifood System**
Disciplines	Led by food/health scientists (with agronomists and economists)	Led by sociologists in liaison with a network of local actors
Main objective	Maximize agrifood chains' contribution to human health and nutrition in a sustainable way	Understand agroecological transition processes at the local scale
Core research object	Food diets	Territorial agrifood system
Methods	2 assessment steps: • Modeling of diets in order to cover all nutrient needs without deteriorating the environment • Translation into policy actions then tested with stakeholders	• Study of initiatives, public policies, interactions, coordination modes, visions, and controversies within the agrifood system
Main outcomes	Scenarios modeling dietary changes and minimizing environmental impacts [30]	Transition mechanisms rely on the combination of initiatives from agricultural actors and civil society organizations and on governance innovations
How are AFEH (Agriculture, Food, Environment, and Health) articulated	AFEH are articulated through a modeling approach linking AFEH variables, based on a quantification of impacts/effects and a modeling approach	Mainly AF and E are articulated, through a qualitative and trans-disciplinary approach focused on the understanding of transition processes
How is the ecological dimension tackled?	Modeling of healthier food diets integrating environmental constraints (mainly on water and land)	Constructivist perspective on actors' visions (and possible controversies over agroecological models)
How is the social dimension tackled and how are practitioners involved?	Social processes are not key to the analysis, but key actors are involved afterwards to discuss possible solutions	Social processes are central to the approach (coordination, governance, changes in visions, controversies, etc.) and practitioners are involved in the whole process
Strengths	Identification of possible dietary changes based on a modeling approach	Collective understanding of past and current transition mechanisms
Limits	Data only at macro/individual level; No insight on the transition pathways/processes	No prospective work and no modeling of possible changes and impacts

The comparison of the two frameworks that are anchored in two contrasting approaches to agrifood system transitions highlights the comparative strengths and limits of both options. The Medina project was designed to evaluate and measure possible future dietary changes (and their health and environmental impacts) based on modeling and impact approaches but did not explore the transition pathways allowing these changes. The Ardèche project was set up to understand contextualized past or current trajectories of the territorial agrifood system and the related transition mechanisms, based on a qualitative perspective, but did not carry out any prospective work in order to link agricultural evolutions and dietary changes within future scenarios. The Medina project was based on the idea that the future state of the agrifood system can be defined based on the *objectification*

and *quantification* of impacts and effects, whereas the Ardèche project aimed at *understanding* the past and current transition processes of this agrifood system.

Despite these differences, both approaches tend to overlook ecological processes, given their conception of the agrifood system respectively as a system of material flows and phenomena (products, nutrients, and health status) and as an actor network and not as a complex socio-ecological system. Of course, environmental issues are at the core of both projects, but they are addressed respectively as inputs or outputs of the system (resources or impacts) and as actors' stakes and visions. This is at the expense of an integration of ecological processes along with health and social ones as possible bases to create functionalities for improving agrifood systems' sustainability, along with the integration of actors' visions.

4. Discussion: Towards a Territorial Approach that Tackles Ecological and Social Processes by Combining an Objectification Stance and a Pragmatist Constructivist One

The comparison of the two above frameworks allowed specifying some key requirements for an integrative approach of agrifood systems transition. The first one deals with scale: both projects have considered taking the territorial scale as a potentially appropriate analytical scale. While the first project addressed agrifood systems transition mainly at the national and individual/household scale, its current developments focus on the regional scale [30]. This leads to suggest that the territorial scale of a small region (of diverse spatial sizes depending on the local ecological and social characteristics) may be an appropriate analytical scale to address agrifood systems transitions. Our second requirement is to shift from an impact assessment to a process understanding approach (including social and ecological processes, that were overlooked in both projects). Our third requirement is to involve stakeholders who embody the Agriculture, Food, Environment, and Health (AFEH) issues in order to build a shared understanding of transition mechanisms.

4.1. Addressing Agrifood System Transitions at the Territorial Scale

The territorial scale has been explored in academic work through the notions of foodshed [43], regional food systems [65,66], or territorialized food systems [67]. However, these authors do not particularly address ecological transitions or health issues and, thus, do not tackle the reconnection of agriculture, food, environment, and health. In link with the extension of agroecological approaches from agricultural to food systems [68,69], recent studies have suggested to tackle agroecological transitions at the scale of territorial agrifood systems.

A recent conceptualization of "agroecological food systems", based on the extension of the main agroecological principles from the scale of agricultural systems to that of agrifood systems [10], calls for a strong integration of social and ecological dimensions at the scale of "city-region food systems". However, this approach, based on a concentric perspective, sees the processes related respectively to ecological and social dimensions as spatially disconnected. For example, in this approach, biodiversity and sources of natural regulation are mainly outside consumption areas, while these provide potentially recyclable waste for production areas. This concentric perspective does not seem fully relevant in more rural territories where production areas are intertwined with ecological systems and with consumption areas.

The concept of agroecological territories, defined as places where a transition process towards sustainable agriculture and food systems is engaged [11], is based on a combination of agricultural science, landscape ecology, and social science and takes social processes as central, with arguments such as the need for "embedded" food systems and stakeholder support. Food systems are defined as socio-technical networks linking people, natural elements, and artefacts that interact with food issues. However, despite the authors rightly underlining the problem of scale mismatches between ecological and social processes, they do not suggest to rely on the functional links between these ecological and social processes.

This is precisely where lies one of the two main arguments in a favor of the territorial scale: it is the scale of direct interactions between ecological processes and social processes, the scale at which both types of processes could be articulated in order to support the reconnection of agriculture, food, environment, and health.

4.2. From Impact Assessment to Process Understanding

Within food system approaches such as in the Medina project described above, the reconnection between agriculture, food, environment, and health is mainly addressed by impact assessment approaches which proceed by cross-comparing ex post data and indicators at a scale chosen in relation to the objective of the assessment (individuals, plot, and farm). In such approaches, data can be collected at this given scale or be an outcome of an extrapolation or aggregation process. This is typically the case of biodiversity indicators as diversity surveys are very often difficult to carry out on a large scale. As a result, how biodiversity is really distributed at different scales tends to be overlooked, and the causality with the other dimensions studied is misunderstood.

Agrifood system transitions that reconnect agriculture, food, environment, and health require approaches that address the interrelationships between the processes specific to each of these four dimensions at different organizational levels. Thus, they require process-based approaches, although these might be combined with impact assessment ones that can support initial diagnoses about the state of ecological systems. This article has focused on ecological and social processes, but health processes should also be tackled in future studies. However, can social, ecological, and health processes be addressed at the same scale? Can natural agricultural, health, and social scientists adjust their scales of analysis? The analytical solution to these crucial questions lays not so much in finding a compromise between different scales defined a priori but rather in considering that the scales of articulation will be defined by the nature of the processes involved. The aim is to be able to explore the diversity of the potential interactions between ecological, health, and social processes at different scales. The territorial scale should allow the empirical exploration of the diversity of interactions between ecological, health, and social processes within the agrifood system under study and the identification of those that need to be built to support sustainable transitions within this system. Observations at the territorial scale could allow for the measuring of ecological responses and feedback loops as suggested by Sundkvist et al. [54]. In parallel, the territorial scale is the most suitable one to analyze social processes within agrifood systems and along their trajectories, as well as social and health feedback loops such as those linked to the implementation of new public policies or initiatives.

An example is changes in public food procurement. Public policies that favor changes towards more local and "ecological" products, along with changes in meal composition, would enhance ecological processes (linked to agroecological practices), health processes (through the effects of diets and product quality on health), and social processes (social access to quality food, relationships, and collective learning processes between farmers, teachers, pupils, and families). A recent analysis, based on a Brazilian case, of the effect on the local biodiversity of both agricultural policies (focused on family farms and agroecological practices) and food policies (public food procurement schemes) appears to be a good example of these potential interactions between ecological, health, and social processes [70].

In the case of the Medina project, in addition to the analysis of the impact on both health and the environment of the increased consumption of plant-derived products, it would be possible to explore the best combinations articulating food, agriculture, environment, and health. This could be achieved by improving the agroecological production of plant products based on ecological regulations, thus combining an environmental perspective and an ecological one. In contrast to the traditional combinations based on "historical" agronomic patterns (such as the combination of cereals, pulses, and plants that limit erosion), today, changes in favor of such types of combinations would have to rely on the implementation of adapted incentives and public policies that provide both enhanced ecosystem services and essential nutrients. These policies themselves would also have to be based

on the understanding of current agricultural and food practices and of their processes of change (or difficulties thereof, due to power relationships or coordination issues). This possible evolution of the Medina framework exemplifies how ecological, health, and social processes could be tackled all together.

4.3. From Interdisciplinarity to Trans-Disciplinarity: Building a Shared Understanding of Transition Mechanisms

The second main argument in favor of the territorial scale is that it allows the identification, and possibly the involvement in the research process, of the diverse actors involved in the interrelationships between agriculture, food, environment, and health.

It is now widely acknowledged that addressing agrifood system transitions requires interdisciplinarity in order to bring together the relevant competencies to analyze the various dimensions and processes characterizing these agrifood systems. There is also consensus over the necessary involvement of key actors in the research process. However, who the relevant actors to include actually are and at which stage of the research process they should be involved is by no means a consensual issue. It has generated vivid debates within trans-disciplinary literature, that have emphasized the differences between complex system approaches, where the diversity of actors is taken into account in an analytical perspective, and extended peer community approaches, where these actors are involved in the research process in a transformative perspective [71].

The territorial approach advocated here would combine a transformative perspective where the aim is to bring researchers and actors together in the process of thinking and possibly implementing possible transition pathways and an analytical perspective. Indeed, taking into account the ecological, social, and health processes together as active principles of the organization and transition mechanisms of agrifood systems should rely on the collective (trans-disciplinary) analysis of past, current, and future transitions at the territorial scale. This would allow for a collective understanding of the biological (ecological and health) dimensions of possible changes in food practices (as shown in Medina) and of the social processes of transition mechanisms (as shown in the Ardèche project). The challenge is to share an appropriation, by the different disciplines and actors, of the ecology of a territory and the interplay of ecological and social processes within the territorial agrifood system. This can rely on the extension of the notion of ecological literacy, which defines the ability to understand the organizing principles of ecological systems and their links to sustainable transition processes, to that of socioecological literacy. In contrast to studies carried out at the global or national scales, at the territorial scale, this is facilitated by the fact that people share a community of fate: the future of their landscape, of the local farms, and of the local and cultural food practices.

However, this emphasis on socioecological literacy does not mean that an objectification of ecological and social processes, with the objective of establishing indisputable facts (as in impact assessment approaches), is sufficient nor realistic. Even at the territorial scale, the diverse actors will not necessarily have the same visions and values. Hence, this diversity of visions and values has to be acknowledged and integrated into the approach itself, within a pragmatist constructivist stance. The aim is not to subsume this diversity in any form of consensus (as in a deliberative perspective) but to acknowledge and respect the diversity of visions and values. It is necessary to analyze the controversies that arise and the transformation of these visions, values, and controversies over time, for these transformations of visions and values also contribute to transition mechanisms [72]. The findings in the second project above and other recent studies [64] have suggested that the legitimization of more ecological visions of food and agriculture would progressively lead to actual changes in production, consumption, or nature preservation practices. Conversely, visions are reinforced through the collective experimentation with alternative ways of producing, consuming, or protecting nature. Further research should aim at combining this pragmatist constructivist stance with an objectification stance, aimed at evaluating actual changes in ecological and health status.

5. Conclusions

It is widely acknowledged that the challenge of feeding equitably, sustainably, and healthily the global population requires taking into account the effects of global changes (climate change, depletion of non-renewable natural resources, demographic transition, energy transition, etc.) in food systems. It also requires adapting differentiated trajectories to the needs and supply flows of different regions and contexts.

The reflexive and interdisciplinary analysis of two past projects and literature showed that the reconnection of agriculture, food, environment, and health within agrifood systems transitions would be better tackled through territorial approaches. The article also suggested a shift from impact assessment approaches to process-based approaches aimed at the exploration and understanding of ecological, health, and social processes and of their interactions. This should combine qualitative and quantitative approaches. Qualitative methods enable us to understand ecological and social transition mechanisms within the territorial agrifood system, while quantitative methods and modeling allow scenario building for future transitions. Finally, this article suggested involving key actors embodying the different components of the territorial agrifood system in the analysis, from both an analytical and a transformative perspective. While in many projects, this involvement of key actors comes as a second step in the definition of solutions (problem solving), this approach suggests that actors should already be involved in the analysis of ecological, health, and social processes.

The territorial agrifood system is viewed as the shared research–action object (of the researchers and actors involved) within a perspective that combines analytical and transformative stances. In the interdisciplinary perspective adopted here, the agrifood system is not only considered as a system of material flows and phenomena (such as products, nutrients, and health status, etc.), as food and health scientists alone would define it, nor only as a socio-technical system composed of actors, practices, regulations, power relationships, and interdependencies, as sociologists alone would consider it, but also as a system anchored in specific ecosystems and characterized by specific ecological processes. In interaction with health and social processes, these ecological processes contribute to the reconnection of agriculture, food, environment, and health.

This territorial approach can be combined with microscale approaches (in order to study changes in agricultural or consumption practices at the level of individuals or to address biological health processes or biotic regulation processes) and with macroscale ones (global economic and environmental change). In order to better address ecological dimensions, the territorial scale serves as a mesoscale where processes at smaller scales can be taken into account. In order to assess social processes, the territorial scale allows us to identify empirically the different institutions and actors that are involved in agrifood system transitions, their visions, values, and power relationships and—from a more transformative perspective—to involve them in collective interventions or experimentations. It also allows us to trace empirically the multiple manifestations of the larger and global scales that are reflected in actors' and networks' trajectories and relationships at the territorial scale. However, retracing the diversity of the "inter-scalar pathways", from the very small to the very large, remains a pressing challenge [73].

Finally, while agrifood systems transitions have been addressed here through a cross-disciplinary analysis based on sociology, nutrition, and ecology, another key challenge for future research is to integrate an economic perspective. Despite this limit, this article is a theoretical contribution to the expanding debate about territorial approaches to agrifood systems transitions in a context where the territorial scale is increasingly recognized by international organizations [74,75]. It will also provide practitioners and policy makers with key principles to support actions and policies that would better fit with the complexity of the ecological, health, and social processes at play within agrifood system transitions.

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