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Setting-up place-based and transdisciplinary research to foster agrifood system transformation: Insights from the Aliment'Actions project in western France

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Many agrifood systems around the world can be characterized as unsustainable. Research is increasingly required to inform the necessary radical transformations of the ways we produce, process, transport, and consume food. This article presents the research approach and methods of an ongoing project carried out at a long-term social–ecological research site, the Zone Atelier Plaine and Val de Sèvre (western France). The research project presented here, Aliment'Actions, started in 2018 and within 10 years of its implementation seeks to study and trigger transformation to enhance the sustainability and resilience of the regional agrifood system. Its research agenda contains four types of actions: (a) backdrop actions that enhance communication and trust between researchers and local stakeholders, (b) targeted actions that are conducted in specific villages with a wide range of stakeholders to elaborate and implement various transformation levers, (c) assessment actions evaluating the effects of different interventions, and (d) communication and result from dissemination actions. Overall, these actions aim to co-produce knowledge, raise awareness regarding challenges in the food system, envision new interactions between stakeholders, collectively generate innovative ideas, and catalyze actions oriented toward agrifood system transformation. The project implementation is adaptive and iterative, from theory to practice. This Methods paper puts this ongoing project into the perspective of other place-based research initiatives and provides insights on how to foster the engagement of non-academic actors in transdisciplinary research supporting agrifood system transformation.

KEYWORDS

place-based research, agrifood system, food system transformation, transdisciplinary research, social-ecological system, resilience (environmental)

1. Introduction

Our global agrifood system[1] is responsible for ∼60% of global terrestrial biodiversity loss, 24–30% of greenhouse gases emissions (depending on whether forest clearance is included), 33% of degraded soils, and the overexploitation of 20% of aquifers (Hajer et al., 2016). Much of these environmental impacts are driven by high-input industrial agriculture, and global supply chains largely are controlled by a small number of multinational agribusiness and food retail companies, generating power asymmetries between farmers and industrial actors (IAASTD International Assessment of Agricultural Knowledge, Science and Technology for Development, 2009; Howard, 2021). Long supply chains also increase the number of intermediaries and create a physical and cognitive distance between producers and consumers (Bricas et al., 2013). The pressure posed by the agrifood sector on natural resources and biodiversity is consequently accentuated by the lack of consumer awareness of how their consumption practices affect ecosystems (Berkes et al., 2006; Godfray et al., 2010).

As the pressure on ecosystems increases, the excessive concentration and internationalization of agrifood systems increase their vulnerability to environmental, meteorological, health, or economic shocks, as well as their dependence on fossil fuels (Tendall et al., 2015; Blay-Palmer et al., 2020). These cascading processes ultimately impede the agrifood system's resilience[2] and highlight the fact that ecological and human systems cannot easily be separated. Understanding how the resilience of agrifood systems may be restored (or at least improved), therefore, requires us to consider them as social–ecological systems or SES (Sundkvist et al., 2005; Ostrom, 2007; Foran et al., 2014), which offers an integrated perspective of humans-in-nature (Folke et al., 2016). The social side refers to the diverse facets of the human dimensions of these systems including economic, political, technological, and cultural aspects. The ecological side refers to the biosphere, biodiversity, and ecosystems. SES, thus, encompass all living beings, including humans, and their dynamic interactions with the dynamics of the earth system, including the biogeochemical cycles (Cockburn et al., 2018).

Considering agrifood systems as SES means that interactions, not only among humans but also within ecosystems and between social and ecological components, must all be considered and cannot be understood independently (Ericksen, 2008). Social components of agrifood systems include all related policies, laws and regulations, sociocultural norms, infrastructures, and organizations. Ecological components include water, soils, air, climate, and ecosystems and genetics (Nguyen, 2018, p. 3). This consideration calls for interdisciplinary approaches in which ecology, agronomy, food sciences, and social sciences tackle co-constructed research questions. It further calls for transdisciplinary research[3] that relies on collaborations among scientists from different disciplines and non-academic stakeholders from business, government, and civil society (Kates et al., 2001; Hadorn et al., 2006).

At the same time, the unsustainable trajectory of our agrifood system requires the implementation of transformative approaches (Olsson et al., 2017; O'Brien, 2018). However, although the idea of SES transformation has recently become more prominent, particularly within the scientific community, there is no clear consensus as to what the concept means in practice and how SES transformation can be triggered, implemented, and evaluated (Nalau and Handmer, 2015; Ziervogel et al., 2016). Importantly, transformation may not always be desirable with O'Brien (2012) underlining the need for "deliberate transformation" to consciously create an alternative future that explicitly includes ethics, values, and sustainability. Deliberate SES transformation implies that the stakeholders acquire "transformative capacity" (Olsson et al., 2010), that is, "the capacity of individuals and organizations to be able to transform both themselves and their society in a deliberate, conscious way" (Ziervogel et al., 2016, p. 2).

This is especially important insofar as resilience is often understood in a normative manner (Fallot et al., 2019). However, it is also important to define what resilience is about and by whom it is needed. When we refer to the resilience of an agrifood system, are we focusing on the system as a whole or its components (e.g., farms, organizations, and sectors)? Thinking about and building resilience of agrifood systems can be considered at different spatial and temporal scales and different levels of an organization, whether social or biological. Moreover, there are many possible ways to increase the resilience of an agrifood system and many possible resilience criteria. Every stakeholder of the system should be able to position himself/herself with regard to the trajectory of the agrifood system (Fallot et al., 2019). Beyond the need to cross-compare the different perspectives and to foster learning from trial and error, it seems important not to consider resilience as a given property of the system, the boundaries and conditions of which would be perfectly known, but rather to consider it as an "object" of collective design and elaboration (Berthet et al., 2022).

The above suggests that enhancing the resilience of agrifood systems requires not only interdisciplinary research but also additionally transdisciplinary and transformative research to generate change and engage diverse stakeholders in the process (Feola, 2015; Nalau and Handmer, 2015; O'Brien, 2018). Until recently, however, most proposals addressing these issues have remained conceptual, with little work on how to move from the theory to the practice of transformation at the scale of SES. As Cockburn et al. (2018) highlight, to achieve this, there is a need to move toward place-based empirical experimentation and active learning about the practice of SES transformation.

In this study, we present such an ongoing initiative, the Aliment'Actions project in France, which specifically aims to empirically study agrifood system transformation toward improved

1 Agrifood systems "encompass the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption and disposal of food products that originate from agriculture, forestry or fisheries, and parts of the broader economic, societal and natural environments in which they are embedded" (Nguyen, 2018, p. 1).

2 Resilience is defined as the way systems "absorb disturbances and reorganize while making changes in ways that retain essentially the same functions, structures, identities, and feedbacks" (Walker et al., 2004, p. 2).

3 Lang et al. (2012, p. 26) define transdisciplinarity as a "reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge".

resilience within a long-term and large-scale research infrastructure. In this Methods paper, we mainly present the background and objectives of the project, the study region and consortium, the research strategy, and ongoing actions. We provide some initial results and finally critically discuss and position the main features of this project within the wider literature on transformative research that targets SES resilience.

2. Methodology and research approach

2.1. Background and objectives of the Aliment'Actions project

Aliment'Actions has been underway since late 2018 and is planned to run for 10 years. It was launched as part of a long-term place-based research program conducted in an agricultural region in western France by the CEBC Resilience research team[4] (Bretagnolle et al., 2018b; Berthet et al., 2022). Several decades of environmental policy implementation and collaborative research with farmers in this area have demonstrated that nature-based solutions (IUCN, 2012; Faivre et al., 2017), such as increasing bee abundance to increase rapeseed yield, are an effective and economically realistic alternative to agrochemical use in the broader region (Catarino et al., 2019a,b). However, at this particular site, as in many other parts of the world, biodiversity decline continued to accelerate (Bongaarts, 2019) while a conventional agricultural model, mainly relying on crop or animal genetic improvement, high use of chemical inputs, and mechanization, remains overwhelmingly predominant. Scientists concluded that public policies and scientific knowledge production were not sufficient to implement an agroecological transition at the agrifood system scale (Kleijn et al., 2019; Berthet et al., 2022) and that other levers had to be explored. The research focus, thus, shifted from analyzing agroecosystem functioning toward achieving a better understanding of the conditions of SES transformation to enhancing system sustainability and resilience. Understanding the causes and process of transformation at the SES scale has become an important research front (Barnes et al., 2017; Pereira et al., 2020b). The research team adopted a transformative research approach and mindset (Schneidewind et al., 2016), following a two-fold aim "to contribute to societal transformation by experimenting with potential solutions" and "to produce scientific evidence about the social robustness of solutions as well as about their scalability and transferability"(Schäpke et al., 2018b, p. 86–87).

Aliment'Actions is actually a part of a larger long-term intervention-based research project named Transform'Actions, which encompasses three research axes: (a) agroecology mainly based on on-farm experimentation and surveys on biodiversity and farmers' practices (Gaba and Bretagnolle, 2020); (b) food mainly covered by Aliment'Actions, and (c) ecohealth, which focused on the chain of the "pressure-exposure-impact" of pesticides on both humans and other species in this rural landscape (Mougin et al., 2018). Therefore, in this broader long-term project, food issues are addressed in conjunction with agriculture, environment, and health issues.

Transform'Actions, and essentially Aliment'Actions, adopts an SES approach thoroughly analyzing jointly (a) ecological processes and biodiversity in the local agroecosystem, (b) interactions between farming management actions and ecological processes, (c) interactions between agricultural production and food consumption

4 CEBC refers to the Centre d'Etudes Biologiques de Chizé (Centre for Biological Studies of Chizé).

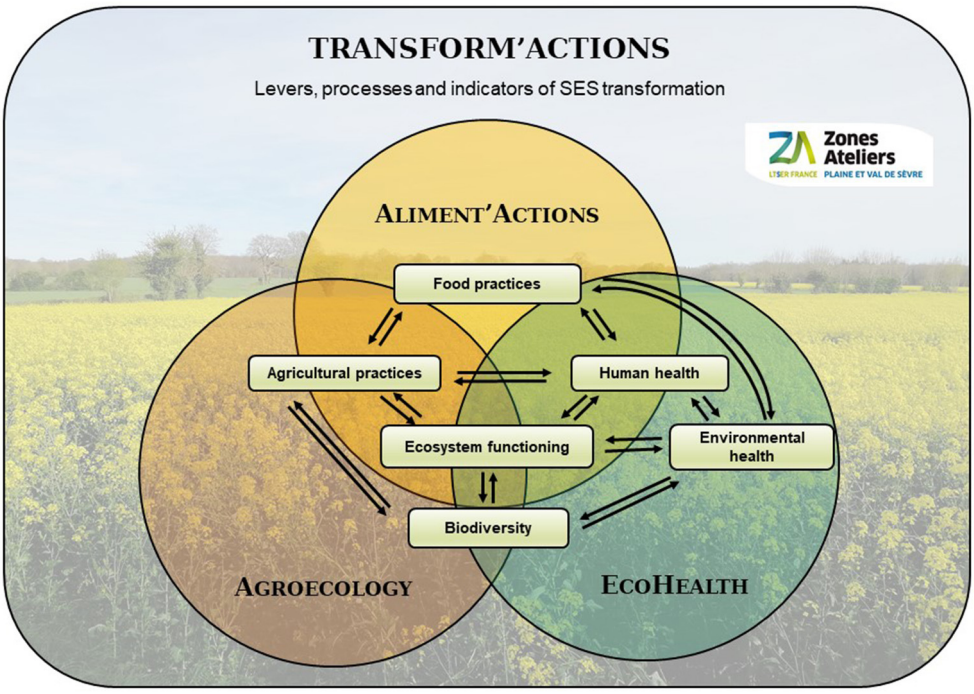

FIGURE 1
Position of the Aliment'Actions project within Transform'Actions.

practices, and finally (d) effects of agricultural and food practices on the local ecosystem and human health (see Figure 1). The research program Transform'Actions articulates three main research questions as follows:

- What are the triggers of SES transformation (at an individual, collective, and system scale)?
- What are the relevant indicators and protocols to monitor SES transformation?
- What are the upscaling processes from individual change to global change through changes in social groups and at the SES scale?

Within Transform'Actions, Aliment'Actions specifically applies the questions related to SES transformation to food, and particular topics are as follows: (a) What are the triggers that can lead consumers to change their food consumption practices? (b) What are the relevant indicators and protocols to monitor the transformation of individual and collective food consumption practices, and ultimately the agrifood system transformation? (c) How can individual and collective transformation of food practices lead to an agrifood system transformation toward greater resilience?

Addressing these questions requires studying either an ongoing agrifood system transformation process toward enhanced resilience or one that is complete. In France, where agriculture is mainly intensive, specialized in crop or cattle production, and export-oriented, quite a few initiatives have sought to enhance agrifood system resilience, and even fewer have achieved an effective transformation. Our research team, therefore, opted for an intervention-based research approach[5] (Hatchuel, 2000) designed to initiate, support, and monitor agrifood system transformation. As part of the transformative science movement (Schneidewind et al., 2016), the Aliment'Actions project, thus, aims to catalyze and analyze the transformation of food practices within a region, by supporting the relocation of the agrifood system and promoting more environment-friendly farming. Here, the term "catalyze" means that the project team stimulates, facilitates, or accelerates initiatives led by local actors but does not replace them in the design or implementation of these initiatives. The local actors may be operating at an individual or collective level, e.g., local non-profits or municipalities.

To achieve this, we propose a research project at the regional scale focused on three levers of transformation of agricultural practices identified by the project consortium: (a) re-connecting consumers to producers, (b) re-thinking how individual food consumption directly affects food production, and (c) relocating the agrifood system. Regarding the latter, the objective is not only to aim for a food self-sustaining region but also rather tilt the balance toward food relocation vs. export. Aliment'Actions ultimately aims to make the transformation of food practices into a lever for the transformation of agricultural practices based on the principles of agroecology (Wezel et al., 2011), as a means of enhancing agrifood system resilience. The idea behind this strategy is that using the lever linked to food demand can be more effective in transforming the food production system than trying to change each component of the system, e.g., the agricultural component (BajŽelj et al., 2014). The project, therefore, mainly targets consumers and farmers that are currently present in the region, without neglecting other agrifood system actors (Lamine, 2015).

2.2. Core characteristics of the Aliment'Actions project

After 3 years of project implementation, we identify five main features of Aliment'Actions that we will outline in more detail below (see Figure 2). Aliment'Actions (a) is a place-based research project anchored in a long-term and large-scale research infrastructure, (b) adopts an SES perspective, (c) is carried out by a transdisciplinary project consortium (where not only several scientific disciplines are represented but also non-scientific actors are also involved in various ways), (d) is carried out following an adaptive, iterative, and reflexive process, and (e) has a research design based on experimentation and monitoring.

2.2.1. Place-based research

First and foremost, Aliment'Actions is anchored in a well-defined region, which is also a long-term and large-scale research infrastructure. In particular, it is linked to the long-term social–ecological research (LTSER) "Zone Atelier Plaine & Val de Sèvre" (ZAPVS), located in the south of the city of Niort (Nouvelle-Aquitaine Region, western France). This research infrastructure is a large rural region (~435 km^2) encompassing ~400 farms and covering 40 villages (c. 24 municipalities) totaling 34,000 inhabitants (Figure 3). The broader area is representative of agricultural intensification and specialization in France and is characterized by extensive pesticide use and landscape simplification due to the removal of hedges, the enlargement of crop fields, the simplification of crop rotations, and the decline of mixed farming in favor of cereal farming. The agrifood system of this region has become more and more globalized, as agriculture relies on imported resources (e.g., fertilizers, pesticides, and seeds), while ~60% of its agricultural output is exported internationally. Furthermore, the area is remarkably rich in biodiversity, while for geological reasons, it is particularly sensitive in terms of water resources (Berthet et al., 2012). As a result, agricultural intensification poses considerable environmental problems in this region with regard to water quality and biodiversity.

Since 1994, the ZAPVS acts as an observatory of the agroecosystem, where long-term surveys are undertaken to obtain an understanding of SES dynamics due to agricultural modernization. Regular (yearly) surveys are conducted by the research team and included the monitoring of land cover, the status of biodiversity, implementation of farming practices (Bretagnolle et al., 2018a,b), and more recently, tracking of food consumption (Berthet et al., 2020). Each year, the local farmers who participate in experiments or allow scientists to monitor biodiversity and ecological functions in their fields are surveyed on their farming practices during the cropping season of interest. Information on soil management practices (type, date), use of pesticides and fertilizers (type, date), sowing (date, cultivar), and harvest (date, yield) is collected. Such information

5 Intervention-based research is a transdisciplinary approach consisting in producing knowledge on collective action by contributing to its transformation. The researcher is thus an actor and stakeholder of collective action.

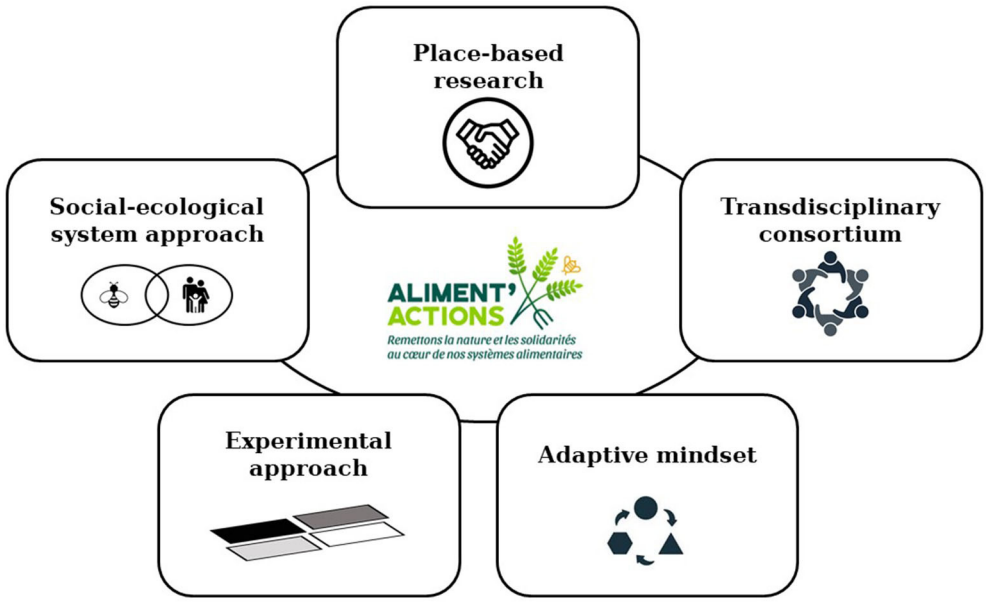

FIGURE 2
The main features of the Aliment'Actions project.

is then used to relate biodiversity, ecological functions, and their relation to yield (see Perrot et al., 2022 for an example). The survey on food consumption is presented in Section 2.4.2. Research programs have been carried out for more than 10 years with farmers, cooperatives, NGOs, municipal councils, and schools (Berthet et al., 2016; Gaba and Bretagnolle, 2020; Houte et al., 2020).

2.2.2. Social–ecological systems perspective

Aliment'Actions, as part of the broad and long-term project Transform'Actions (Section 2.1), considers the local agrifood system as an SES whose various dimensions are addressed through the nexus of food-agriculture-environment-health. This research focuses on a clearly delimited region in which ecological, agricultural, food consumption, and (soon) health parameters and their interactions are monitored in the long run. Furthermore, this research project specifically studies transformation toward ecosystem-based management and governance (Olsson et al., 2008), involving stakeholders in the development and dissemination of nature-based solutions (Faivre et al., 2017; Berthet et al., 2022).

2.2.3. Transdisciplinary consortium

The research conducted within the Aliment'Actions project is transdisciplinary, in the sense that not only a wide range of scientific disciplines is represented (e.g., life sciences, management sciences, and social sciences) but also that non-academic actors concerned by these issues are involved in different ways within the research process. The project consortium is composed of academic and non-academic actors with diverse and complementary expertise such as researchers in ecology, agronomy, agroecology, and social sciences, as well as a social enterprise. In addition, various partners contribute to the project on an *ad hoc* basis according to their competencies and the needs of the project, particularly agricultural development associations and municipal councils. These actors contribute to developing the research questions and providing data. Their initiatives influence the course of the research project, and they are invited to provide feedback on preliminary results during public presentations. Key interactions between researchers and local stakeholders are further detailed below (see Sections 2.3 and 2.4).

The project, therefore, brings together actors with complementary approaches, such as citizen engagement, rural development, and transdisciplinary research. In terms of the actual transdisciplinary research process, we broadly follow the approach of Lang et al. (2012) that conceptualize it as a sequence of three phases, namely, (a) collaborative problem framing and collaborative research team development (Phase A), (b) co-production of solution-oriented and transferable knowledge through collaborative research (Phase B), and (c) (re-)integration and application of the produced knowledge in both scientific and societal practices (Phase C). Aliment'Actions encompasses all these phases, but rather than sequentially, they take place simultaneously and in parallel.

2.2.4. Adaptive research process and consortium

The research process and project partnership are adaptive in that they change along with the project's life. The project team meets on a weekly basis to discuss the ongoing actions as well as the evolving context. In addition, project seminars are held several times a year to discuss the project strategy. This strong interaction between the project leaders allows for the timely exchange of information, fluidity of interactions between researchers and local actors, and reactivity. Collectively, these enhance flexibility in the research design, data collection, and action implementation.

This reflects more than just a transdisciplinary research approach, as the scientists adopt a post-normal posture, which is appropriate in cases where "facts are uncertain, values are under debate, stakes are high, and decisions are urgent" (Funtowicz and Ravetz, 1993, p.

10). The project, thus, takes into account the uncertain nature of the agrifood system trajectory in response to climate change, biodiversity degradation, and the complex socioeconomic disruptions it faces. The researchers, together with non-academic actors, regularly discuss the research objectives, implementation approach, and outcomes. Based on these discussions, the researchers adapted the research strategy either by modifying the experimental design (see Gaba and Bretagnolle, 2020) or the boundaries of the system under study (e.g., to include relevant stakeholders or add other taxa) (see Bretagnolle et al., 2018b; Berthet et al., 2022). In addition, the ZAPVS is a platform where various research projects and actions can be implemented and articulated. Agrifood systems by default include multiple actors, such as farmers, consumers, decision-makers, and food processing firms and retailers, which are heterogeneous in the sense that they have different values, expectations, functions, power, or constraints (Moragues-Faus et al., 2017). Hence, there is no single optimal method to involve this large diversity of actors in a collective design process (Blay-Palmer, 2016). In this context, the non-academic facilitators contribute significantly to weaving relationships between the regional stakeholders by (a) constantly creating links (i.e., between the researchers themselves, between the researchers and the regional stakeholders, and between regional stakeholders) and (b) by ensuring that the "territorial rhythm" is effective (i.e., one of the four types of targeted actions discussed below are implemented at least once a quarter in each selected village).

2.2.5. Research design based on experimentation and monitoring

Another major aspect of the Aliment'Actions project is its experimental nature. Arguably, the need to develop and mobilize a diversity of experimental tools and approaches is essential to build trust, frame the issues at stake, develop and discuss imaginaries or values, foster social learning, and facilitate interactions, discussions, and exploration of ideas. The methods and protocols applied are presented in Section 2.3.

2.3. Types of actions implemented within the Aliment'Actions

The project consortium developed an iterative research agenda distinguishing four types of actions. The first is "backdrop actions" that are led at the ZAPVS scale and aim to increase mutual knowledge, trust, and collaboration between researchers and local stakeholders throughout the project. The second is "targeted actions", which in contrast to "backdrop actions", built upon a spatial design and conducted in targeted villages with the aim of generating or stimulating changes in the practices and behaviors of inhabitants (thus following an experimental design model). The third is "assessment actions", which track the effects of backdrop and targeted actions through monitoring and surveys. The fourth

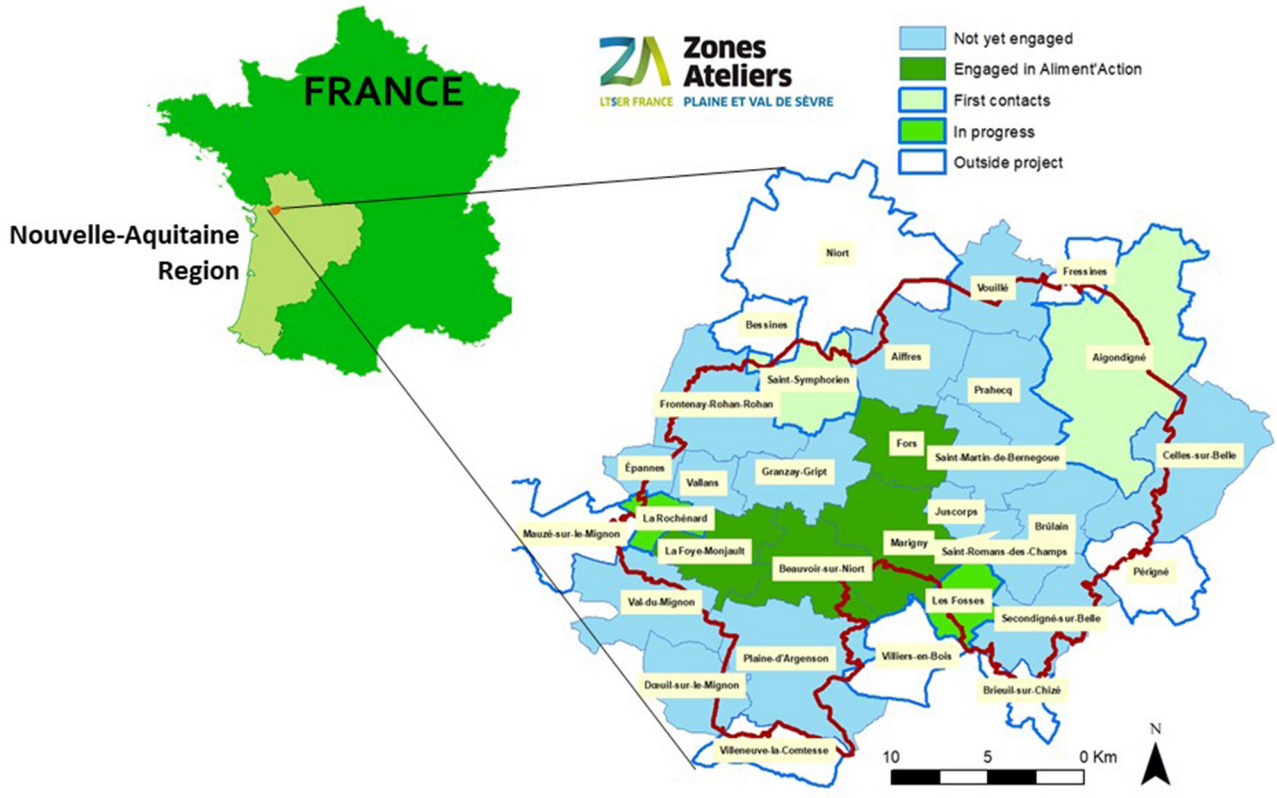

FIGURE 3
Study area of the Aliment'Actions project. The figure highlights all municipalities that intersect with the Zone Atelier Plaine and Val de Sèvre (ZAPVS). Municipalities involved in the project (as of 2021) are indicated in green, while those not yet involved as of 2021 (but that will be within the 10-year project duration) are indicated in light blue. Municipalities usually include several villages, which means that the 24 municipalities actually encompass 40 villages in total.

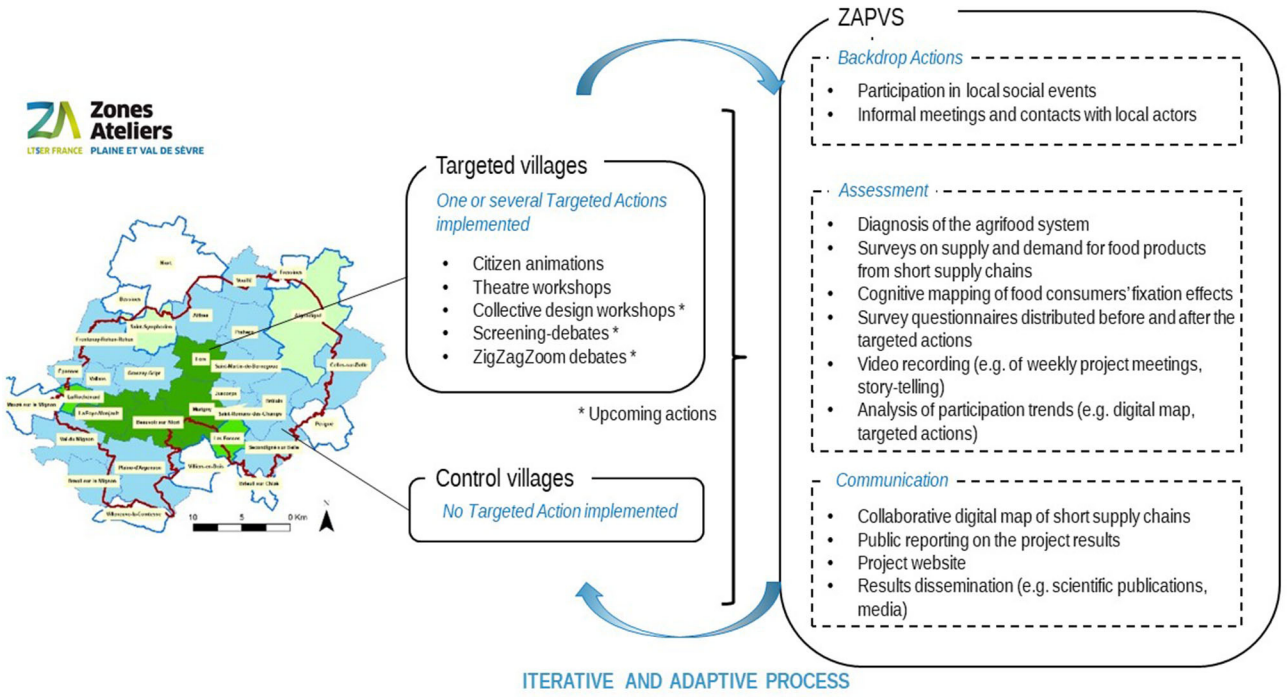

FIGURE 4
The different actions implemented in the Aliment'Actions project.

is "communication actions" that encompass the dissemination of results and exchanges with the public, stakeholders, and scientists, which ultimately may shape or reshape backdrop, targeted, and assessment actions (see Figure 4 for a general description).

Backdrop actions are carried out all over the ZAPVS, systematically, opportunistically, or randomly, depending on the situation. They contribute to collecting information on (and improving the understanding of) the interests and needs of the region's residents, fostering their trust and commitment, and creating and maintaining relationships between residents and the research team. Such actions are essential to ensure that the project is accepted, endorsed, and promoted. They are also aimed at creating a fertile ground so that the "seeds" sown later by the consortium or other actors (e.g., elected officials, associations, and citizens) can germinate and develop in concrete actions. These "seeds" are both the targeted actions described below and the local stakeholders' initiatives. Backdrop actions often entail the participation of the project members in local events as well as informal and formal meetings with residents, farmers, local authorities, or other types of stakeholders.

Targeted actions are implemented at the village level. They are designed to test individual or collective transformation levers (the "triggers" of research question 1; see above) to accelerate the transformation of the agrifood system. More specifically, these actions first contribute to raising awareness about food issues, then to increasing local stakeholders' capacity, and finally to catalyzing stakeholders' initiatives[6] to involve them in a democratic way in the transformation of the regional agrifood system. We adopt the targeted actions to the societal context, given that this context can change quickly, which significantly modifies the perception, behaviors, and mobilization of the actors, as witnessed, for example, during the COVID-19 pandemic. The villages, in which targeted actions are implemented, are selected following a spatial design. By spatial design, here, we refer to the fact that action protocols differ between "targeted" villages (in green in Figures 3, 4) and "control" villages, where no targeted actions are implemented (in blue in Figures 3, 4). The type and number of targeted actions vary according to the characteristics of the village and the triggers to be tested and are described in more detail in Section 2.4. Actions are, thus, differentiated in space, allowing the identification of contrasts between villages that are monitored and analyzed. The spatial design that informs the decisions over the implemented targeted actions is essential to enable comparisons between villages, even if it is not always feasible to achieve an "all things being equal" condition. As Bergmann et al. (2021, p. 545) highlight, "*a critical task relates to the context-specific nature of experiments with only limited, participatory control of many factors, which challenges the generation of comparative and transferable insights*". Several types of targeted actions have been implemented up to now, which are presented in Section 2.4. We report some preliminary results in Sections 3.1–3.3.

Assessment actions seek to assess the effects of backdrop and targeted actions. Assessment is crucial to understand the project's impacts and answer the three research questions presented in Section 2.1. Assessment actions are facilitated by long-term place-based

6 Stakeholders' initiatives may be conducted at the individual, collective or municipal scale. Examples of initiatives at the individual level include changing one's diet such as to reduce meat consumption. Initiatives at the collective level include setting up an educational garden in a school. Initiatives at the municipal scale include the provision of municipal land to a vegetable farmer, who then sells its products to the inhabitants.

research and information on the SES transformation trajectory. To understand how the various actions affect the trajectory of the local agrifood system and to ensure that successful solutions can be transferable in other agrifood systems and/or transdisciplinary projects, we perform an overall assessment of the conditions of action implementation, reception, and impacts. To this end, we document the processes operating along with the way (e.g., project meetings/events and evolution of partnerships) and analyze the key aspects of success or failure, difficulties, and questions. The assessment follows a diversified project monitoring approach, which includes (a) qualitative surveys of the reactions and viewpoints of the actors and social groups of the ZAPVS concerned by the project, (b) a video library that contains the recording of all weekly videoconferences about the evolution of the project since March 2020, (c) "story-telling" videos developed by the project's facilitators, (d) reports of the events organized within and outside the project by facilitators or observers from the research team, and (e) survey questionnaires distributed before and after the workshops. The assessment also includes quantitative monitoring of participation in the surveys and citizen engagements, as well as the dynamics of the digital map of short supply chains outlined below (e.g., number of outlets on the map, website traffic). The consortium also plans to co-construct relevant indicators with local stakeholders to monitor individual and collective transformation trajectories, relating for instance to food practices, representations, or knowledge among others.

Communication and result dissemination actions are very diverse. A wiki-type website features a collaborative map of local short food supply chains, serves as a platform to gather the different project outputs (e.g., texts, reports, photos, and videos), and aims to create a dynamic space where local actors can express themselves and interact with one another. The reflexive follow-up and collaborative dissemination of the project (involving non-academic actors) are envisaged to promote the uptake of the project and the themes it addresses. The research team organizes the different village activities that disseminate to the local residents and the publicly released reports, which are then followed by discussions. Scientific publications and studies delivered at conferences that present the project (and its results) are beginning to be produced, as of the writing of this study. Finally, a communication strategy targeting various media (e.g., press, radio, and Internet) is also being developed.

2.4. Details of targeted actions and monitoring activities

As outlined above, the Aliment'Actions project has been implemented since 2018. Its first phase, which we qualify as the project launch and calibration, has ended, and a new one has started in January 2022. For the sake of clarity, in this Methods paper, we only present the main targeted actions and assessment actions that are either implemented or upcoming as of the writing of this study.

2.4.1. Ongoing and upcoming targeted actions

The main ongoing and upcoming targeted actions include (a) citizen engagements, (b) theater workshops, (c) ZigZagZoom debate sessions, (d) collective design workshops, and (e) conference debates (see Table 1). Below, we briefly outline their key aspects.

The citizen engagements are set up by two mediation professionals. They are designed to encourage citizens to engage with food issues and to motivate all the participants (e.g., consumers, elected officials, and producers) to actively get involved and cooperate with each other (e.g., shared gardens, short cereal-meal-bakery chains). So far, six municipalities have been involved with an average of two new ones added each year (e.g., two were planned for 2022) (see Figure 4). In each village, the citizen engagements start with a standardized sequence consisting of a Samoan Circle and then an Open Forum to which we add customized formats [e.g., Six thinking hats (De Bono, 2017), specific engagements for a school public, etc.] based on the first observations, reactions, expectations, and initiatives. These engagements started in November 2018 and continued in 2020 and 2021, despite the COVID-19 pandemic. Since the launch of the project, and as of the writing of this study, 56 such targeted actions took place in six municipalities, reaching over 1,000 individuals. This constitutes what we name the "territorial beat", that is, in reference to heartbeat: a succession of events that builds trust and supports changes in mindsets. These engagements involve citizens in the identification of what may be a desirable trajectory for their agrifood system. There have also been some emerging actions led by citizens or municipalities, including for instance new food markets established in three villages.

The theater workshops collectively create original plays on specific controversial or socially relevant issues. For the participants, the aim is to relate complex and sometimes divisive issues and to develop the imagination to change representations (Fournout and Bouchet, 2019). This methodology of collective creation was first implemented within the project in October 2020 with the theme: "Farmers and inhabitants, citizens of the same region: what relationships?" Its purpose is to enable farmers and other citizens to transpose the relationships between them in a play of which they will be the authors, stage directors, and actors. This allows them to put into perspective their preconceived ideas, questions, and desires for the future. They identify new avenues for individual or collective action in a way that, far from being only an intellectual or linguistic endeavor, it will be as in "real life", namely, embodied, emotional, existential, and creative. A survey questionnaire that was distributed before and after the theatrical performance, gave participants the opportunity to describe the effects of the diversion through the imagination, particularly in terms of the recommendations for action that may emerge. The results of the survey clearly show that the participants perceived the theatrical collective experiment as an opportunity to "let go" of mental postures and stereotypes. A theater troupe spirit emerged with a wish to perform the plays again in other villages. As one of the participants suggested, "we meet by the market and play something fun, then we have a big Citizens Assembly to put into debate the street show". Although this has not been possible during the COVID-19 pandemic, new theater workshops are planned given that the public health situation allows it again. The target is to hold one or two such events per year given the difficulty to recruit participants who are not theater professionals and may not immediately feel comfortable engaging in such activities. Previous experiments that followed the same methodology (Fournout and Bouchet, 2019) showed that although it is not easy to convince the participants to start the process, once there is momentum and proper help from professional mediators, the participants feel secure

TABLE 1 Summary of the targeted actions.

Targeted actions	Citizen engagements	Theater workshops	ZigZagZoom debate sessions	Collective design workshops	Conferences-debates
Aim	Encourage citizens and local authorities to engage with the food issue and cooperate	Create original plays on a specific societal issue Use the imaginary to change representations and enhance dialogue.	Use a dialogic protocol to enhance debates on controversial issues. Identify points of convergence on which to build actions	Apply a collective design method to help participants develop innovative projects to enhance agrifood system resilience	Alert local residents and actors to the crises posed by the Anthropocene. Talk about potential initiatives and solutions they could implement
Number planned	2–4 citizen engagements per year in each targeted village	2 plays per year	2 debate sessions per year in each targeted village	10 workshops in total	5 conference-debates in total
Number implemented	39	2	0	0	0
Scale	Village	Set of three villages	Village	School or village	Village
Number of engaged individuals per session	5–50	10–15	15–30	15–30	30–50

TABLE 2 Summary of the diagnosis and monitoring actions.

	Food system diagnosis	Local food offer and supply	Diagnosis of fixation effects on food practices
Aim	Produce knowledge about the agrifood system components, functioning and dynamics	Confront food and demand trends in the region	Determine fixation effects for children, teenagers and adults on how to improve food consumption
Number of interviews	32	c.700 (in Sept. 2022)	325 children (from 9 to 16 years old)
Number of targeted people	>30 diverse actors within the agrifood system	>20–30% of households in each village	1,000 children, teenagers and adults
Theoretical framework	Social networks. Multi-level perspective	NA	Cognitive psychology. Innovative design theory
Method	Semi-structured interviews	Structured interviews	Creativity tasks and questionnaires

and more eager to contribute and have a good time together. The prospect of performing the play in front of a real audience acts then as a strong incentive.

ZigZagZoom debate sessions will be organized in the near future among farmers, consumers, scientists, local politicians, and other regional stakeholders. ZigZagZoom is a dialogic protocol inspired by the approach promoted by the Braver Angels[7] Organization in the United States to improve debates between democrats and republicans. A ZigZagZoom debate session can be held either online or with in-person attendance. It lasts for 90 min and starts with a "yes/no" shared question. An equal representation of "yes/no" answers to this shared question is agreed upon among the participants before the session. A dialogue facilitator leads the exchanges and the points of view alternate with questions from attendants taken between each intervention. The theoretical underpinning of these debate sessions is rooted in the work of Habermas (1991). The protocol of the ZigZagZoom debate sessions for the Aliment'Actions project was created and tested throughout 2021 and the beginning of 2022 by two consortium members that have implemented 17 such sessions in contexts other than the ZAPVS. Within the Aliment'Actions project, this engagement will be conducted to tackle collectively divisive questions such as "should we stop using pesticides in the fields next to our village?".

Collective design workshops will be implemented in a semi-experimental way in several villages across the ZAPVS to determine the extent to which implementing a design method can increase consumers' openness to change. These workshops have two objectives: (a) to accompany the regional actors in the elaboration of their projects that aim to enhance agrifood system resilience and (b) to produce data that enable a better understanding of the impediments and determinants of the food transition in a comparative way through workshops. We will apply the Knowledge-Concepts-Proposals (KCP) method (Hatchuel et al., 2009), which has been proven to enhance design capacities (Hooge et al., 2017). However, the implementation of KCP in a context where such groups do not necessarily already exist is original and challenging. Questionnaires will be circulated before and after each design workshop to assess the impacts of the workshops on participants' ability to overcome their entrenched beliefs and increase their agency (e.g., transform their ideas into projects and increase their self-confidence).

Conferences-debates are planned in different municipalities as of the writing of this study to alert the local residents and actors about the shocking consequences of the Anthropocene and discuss possible initiatives they could potentially implement to increase the resilience of the agrifood system. These talks will be based either on short films generated through the biodiversity- and agroecology-related research conducted within the ZAPVS or on scientific studies of the state of the world facing the Anthropocene and its diverse

7 Refer to: https://braverangels.org/.

environmental challenges. These scientific talks are intended for the general public and focus on key concepts, such as global change, the Anthropocene, tipping points, or transformative change. Before and after the talks, short inquiries, as well as interviews with the participants, will be organized to ascertain whether the talks (and in particular which key points) have elicited positive emotions (defined as triggers that support collective action toward a more sustainable or desired future). There will also be efforts to offer such talks for teenagers and children.

2.4.2. Monitoring actions

The main diagnosis and monitoring actions presented here are the food system diagnosis, the assessement of local food offer and supply and the diagnosis of fixation effects on sustainable food practices (see Table 2). First, to enhance the resilience of an SES, a fortiori and agrifood system, there is a need to have deep knowledge about its components, functioning, and dynamics. Toward this end, a diagnosis of the local agrifood system was carried out in 2021 (Berthet and Deroche-Leydier, 2022), drawing on 32 interviews with local stakeholders. These included representatives of local authorities, farmer cooperatives, groceries, consumer associations, food supply chains, mass catering, and restaurants. Furthermore, we conducted surveys with farmers and consumers in the frame of the Aliment'Actions project, as well as participant observation and document analysis. This sociotechnical diagnosis combined three complementary analytical frameworks sociotechnological transitions (Geels and Schot, 2007), social networks (Scott, 1988), and SES (Berkes et al., 2000). Some results are presented in Section 3.1.

A qualitative and quantitative survey about the supply of food products from short supply chains was launched in early 2019. This survey sought to identify the producers selling food products through short supply chains in the ZAPVS, their production, development prospects, and possible difficulties. This assessment also targeted intermediate actors. At the end of 2022, we have identified more than 100 producers whose market at least part of their food products through direct sales and are either situated in the ZAPVS or market their products in the region. This is equivalent to ∼15% of the farmers in the region (not all producers who sell directly are necessarily farmers). Based on this survey, meetings, and word of mouth, the project consortium enriched, made interactive, and finally put online a map of short supply chain outlets, which had originally been developed in 2017 (refer to: https://aliment-actions.fr/?CarteProducteur). This digital map is collaborative insofar as each resident in the region, whether a producer or not, can inform it. Moreover, the survey is carried out iteratively with a series of telephone interviews conducted during and after the COVID-19 lockdown in the spring of 2020. This involved ∼20 actors of short supply chains.

Second, an evaluation of the demand for short supply chain food products is underway. The intention is to conduct interviews with a large proportion (30–50%) of households in 24 municipalities. In May 2022, four of these municipalities have been surveyed (Les Fosses, Marigny, Fors, La Foye-Monjault). In total, 603 individual interviews were conducted accounting for 30.3–56.7% of the inhabitants in these four municipalities. The objective here is to quantify the current food habits and uses in the region, as well as expectations around short supply chains including obstacles and possible levers of action to overcome them. The findings of these surveys are disseminated during public presentations (in person or remotely, depending on the constraints posed by the COVID-19 pandemic) to encourage reflection and action by respondents and to motivate them to increase the consumption of local food products.

Third, the literature on creativity and design highlights the fact that a major obstacle to idea generation is the fixation effect, i.e., "the fact that some knowledge about existing or obvious solutions is spontaneously activated and constraints the generation of new solutions" (Agogué et al., 2014): (1). To identify consumers' fixation effect, we draw on previous research that combined cognitive psychology with design sciences, first to determine fixation effects for specific individuals on specific subjects and second to test levers to overcome them (Agogué et al., 2014). For this, we assess knowledge and map ideas about how to increase sustainable food practices for a large number (target: 1,000) of consumers in the ZAPVS (from children to adults). We will use this fixation effect mapping in combination with the collective design workshops to test two types of inputs that may increase creativity and transformation in consumer projects: (a) targeted ecological knowledge (beyond common knowledge) and (b) innovative examples of cooperation between farmers and consumers (outside pre-identified fixation effects).

3. Results and discussion

3.1. Identifying actors' strategies and needs for cooperation in the agrifood system

Our system diagnosis (Section 2.4.2.) revealed various stakeholder strategies with regard to the agrifood system dynamics in the study region, such as enhancing food relocation, developing organic farming, or maintaining current trends (BAU scenario). It also helped to understand the nature of the relationships between the stakeholders, as well as the strength of these relationships. This system diagnosis highlighted, in particular, various strategies of innovation niche building such as the development of consumer associations to promote peasant farming or online marketplace for local and organic food products. Furthermore, it pointed to the hybridization between some of these niches and the dominant regime, this hybridization is the outcome of both policy pressure and consumer demand. Some examples are the provisioning of school catering through both short and long supply chains or farmer cooperatives that target both local and international markets. Such types of coexistence and confrontation of food system models have been observed and analyzed in other regions over the world (Gasselin et al., 2021), highlighting that various actors of food systems, be they farmers, cooperatives, or retailers, hybridize long and short supply chains for various reasons, notably to spread the risks.

In addition, despite highlighting the active involvement of some innovation intermediaries, our agrifood system diagnosis also showed a lack of connectivity between some niches. For instance, our social network analysis highlighted two "cliques[8]", one in Niort (∼60,000 inhabitants) and one in Melle (∼ 6,000 inhabitants), these cities being 30 km apart. Both "cliques" have distinct compositions and functioning and have little interaction between them. The first "clique" (Niort) gathers mainly institutional actors linked with formal

8 In the social sciences, a clique is a group of individuals who interact with one another and share similar interests (Lazega, 1998).

arrangements and is quite centralized. The second "clique" (Melle) gathers more diverse types of actors (e.g., local authorities, local food retailers, associations, and farmers) who interact both formally and informally, relying on trust relationships and shared values. Each municipality builds its own "territorial food project" in a quite redundant way. In addition, as most retailers or canteens build their own provisioning networks, our study showed the lack of visibility of the adequacy between local food offer and demand in the region. Overall, our findings highlight the interest in a transversal organization that would better coordinate short supply chains at a regional scale.

3.2. Assessing the local demand for food products from short supply chains

In the four municipalities where surveys were conducted up to the writing of this study (see Section 2.4.2.), ∼57–72% of the respondents in each municipality stated that they regularly buy local food products (excluding food self-provision), i.e., they bought at least one item in the last month. This is consistent with a national survey[9] indicating that 64% of French consumers bought products from short supply chains at least once a month in 2020. Most purchases are done directly at farms or on open-air markets (Figure 5).

The main motivations for purchasing food items through short supply chains include the quality and traceability of the products and better remuneration for the farmers. This is consistent with other studies that mention the quality and traceability of food products as major motivations for purchasing food from short supply chains, amidst concerns over health and the environmental impact of food (Chiffoleau and Dourian, 2020). Similarly, the fair compensation of farmers has emerged as a topic of concern among many food consumers in the EU, as the low prices often received at farm gate are considered unfair in view of price escalation by intermediaries (Lappo et al., 2015; Chiffoleau and Dourian, 2020). This high interest in purchasing food from short supply chains is also reflected in ∼80% of respondents that did not report buying food locally claimed, they were prepared to do so within the next months.

However, the surveys also identified some obstacles to engaging in such purchasing behavior, including the additional economic cost, lack of time, mobility problems, and lack of information on the sales outlets. Similar constraints have been identified in other studies (Maréchal et al., 2019).

3.3. Upscaling the place-based approach

The decision to anchor the Aliment'Actions project in a delimited and well-defined region draws upon the assertion that transformations toward sustainability are generally triggered at the local scale. As Balvanera et al. (2017, p. 2) pointed out, "*place-based research (…) is uniquely positioned to explore the interplay between the local and the global scales, by recognizing the distinctiveness of local entities, while addressing the impacts of global dynamics on them*". Place-based approaches are also advocated by Sonnino and Milbourne (2022) who underline their potential to address the complex entanglements of relations within food systems, the

9 This study was conducted from 15 to 22 April 2021 on the Kantar Profiles panel with a representative sample of the French population (1,000 individuals).

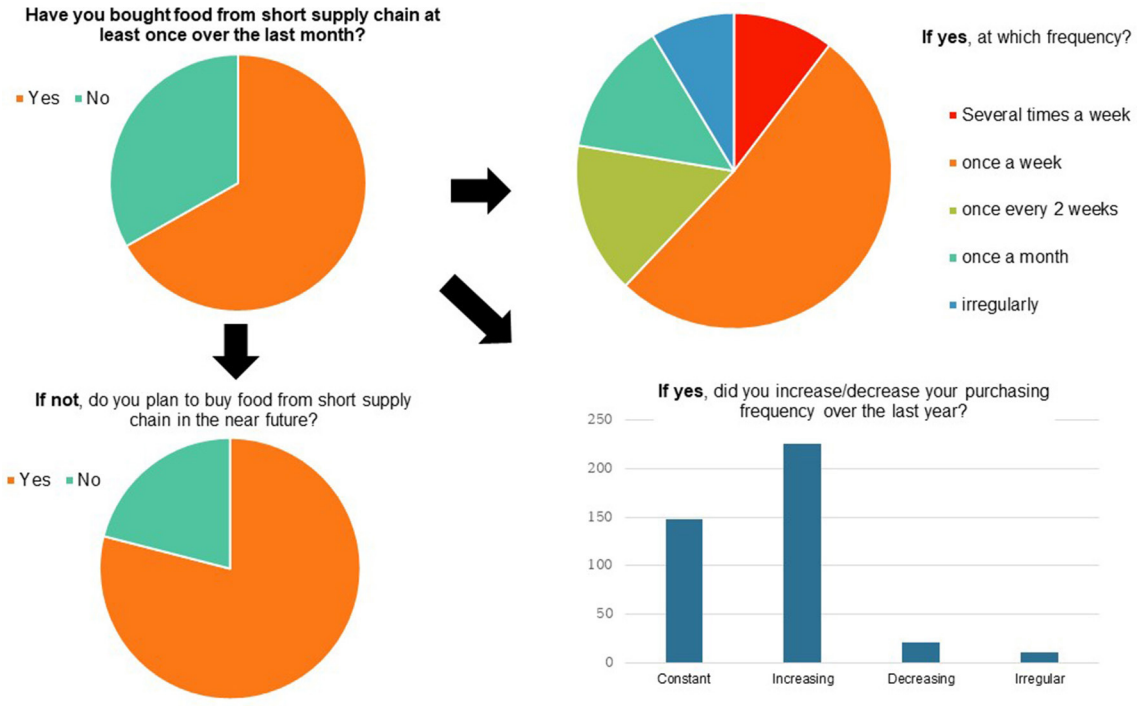

FIGURE 5
Preliminary results of consumer surveys (n = 603).

stakeholders' diverging views, as well as the coevolution between different human and non-human interacting elements. Balvanera et al. (2017) highlight the strengths, challenges, and opportunities of place-based research, with the main challenges being transferability (as they are context dependent and may rely on place-based knowledge) and upscaling (taking into account interactions between various governance levels). Balvanera et al. (2017) also highlight the need for new theoretical frameworks that would advance our understanding of how to assess multiscale dynamics.

Agriculture in the ZAPVS is typical of Western and Northern Europe, where agriculture has been intensifying and specializing in crop farms, which are mostly family-operated. As this type of agricultural landscape and agrifood system may not necessarily reflect those encountered in many other parts of the world, possibly the results of Aliment'Actions are not directly transferable outside Europe. However, we argue that our experimental approach could be transferrable in other contexts, as long as there is a commitment to long-term research and collection/analysis of a large volume of data to inform the food system transformation trajectory.

3.4. Engaging various stakeholders for an experimental approach at the regional scale

Sustainability challenges are complex and even wicked, which often makes linear and technocratic approaches insufficient (Sonnino and Milbourne, 2022). In such contexts, there is a need for an experimental turn in research (Overdevest et al., 2010). An important challenge, when carrying out experimental research at the regional scale, is not only to ensure scientific rigor but also the democratic involvement of stakeholders (Sonnino and Milbourne, 2022), as well as the transferability of results/approaches in other regions (Balvanera et al., 2017). As discussed throughout this study, the processes of experimentation, evaluation, learning, and innovation carried out by Aliment'Actions with the participation of actors outside academia are intended precisely to facilitate societal transformation (Loorbach et al., 2017).

However, conducting transdisciplinary research raises a series of challenges regarding both the effective involvement of non-academic actors and the emergence of conflicts due to differing values, conflicting interests, dissimilar claims of legitimacy, and diverse knowledge claims (Siebenhüner, 2018). The Aliment'Actions project developed several strategies to cope with these challenges, such as (a) build and maintain trust with local stakeholders, particularly through backdrop actions and the frequent interventions of the project team facilitators in the region, (b) conduct in parallel diverse activities with various stakeholders to enhance participation and account for multiple perspectives (here, although diverse types of consumers were the main targets, the project team involved producers, local authorities, and various other economic actors in the project), and (c) put forward approaches that foster mutual consideration and dialogue.

Indeed, in contexts characterized by uncertainty, it is legitimate that science should experience controversy where arguments in search of proof and facts confront questions from society (Callon et al., 2001). While such differences of viewpoints prove useful for scientists in search of a consensus, it is often magnified as irreconcilable positions in the public arena. Someone in the audience of a theater workshop production puts it: "I wanted to thank you for taking the risk to get together and expose something else than conflict, as it is staged every day by the predominant media" (quoted by Fournout and Bouchet, 2019, p. 93). Furthermore, within the Aliment'Actions project, the various engagement tools (e.g., theater workshops and ZigZagZoom debates) seek to give a chance to procedural ethics of discussion and to foster collective imagination for tackling the ecological challenges posed by current food production and consumption practices. This would require more than knowledge and facts and calls for creative, imaginative, and experiential ways of thinking, communicating, generating change, and creating new narratives (Galafassi et al., 2018).

Nevertheless, involving diverse actors in a transdisciplinary research project is challenging, with the COVID-19 pandemic generating added unprecedented difficulties. The Aliment'Actions project team is, thus, continually adapting, enriching, and renewing these strategies to facilitate stakeholder engagement to catalyze and foster agrifood transformation in the study region.

3.5. Rethinking the role and positionality of researchers in transformative science

Up to now, the Aliment'Actions project has been pioneering not only in terms of its wide geographical and temporal scope but also of the role and positionality of the involved researchers. The approach is not overhanging but aims at catalyzing and analyzing local initiatives, in close interaction with citizens and actors from the associative and entrepreneurial worlds. Engaging with stakeholders in this process, encompassing the diversity of relevant actors and creating a shared understanding of the problems, can arguably change the way researchers learn about SES. The focus is, thus, shifting from a rather "positivist" and reductionist approach to a more "constructivist" and holistic approach (Hazard et al., 2020), and from a knowledge-transfer perspective to a post-normal science perspective (Ainscough et al., 2018). This reflects the fact that research addressing wicked problems faces a double epistemic uncertainty (Hazard et al., 2020, p. 5): "*The first is the result of the imperfection with which science tackles societal problems: a single original and clear research question cannot adequately represent the fuzziness of an indeterminate situation. The second uncertainty arises from the unpredictability of the effects of scientific knowledge when introduced in a complex situation*".

Planning the project for at least 10 years (2018 onwards) enables the implementation of what Ansell and Bartenberger (2016) describe as "generative experimentation", as distinguished from "controlled experimentation" and "Darwinian experimentation". Similar to controlled experimentation, generative experimentation focuses on a single experiment but rather than seeking to determine causal chains, it aims to stimulate the generation and analysis of information about the actual experiment by the participants themselves, with the overall aim of achieving collective learning (ibid). Here, the boundary between observers and participants is abolished, which opens the way to achieve a richer collaboration. Generative experimentation is similar to Darwinian experimentation in that it takes place in real-life conditions, but while the latter focuses on "populations of experiments", the former focuses on a single experiment (ibid). This single experiment is essentially seen as an evaluation in progress where iterative improvements occur to

find solutions to the problems that arise until a (always transitory) solution is found.

3.6. Developing a research infrastructure for transformative governance

As part of its effort to transform the regional agrifood system, the Aliment'Actions project seeks to foster new alliances and solidarity within the agrifood system in the study region (i.e., between producers, processors, distributors, consumers, and municipal councils). These alliances participate in the (re)construction of a peaceful dialogue between the actors of this rural region and aim to co-construct individual, collective, and region-wide solutions to enhance agrifood system resilience. As discussed throughout this study, Aliment'Actions deploys various actions to achieve this (e.g., workshops, citizen engagement, and surveys) that collectively contribute to the development of adaptive governance of the agrifood systems. Along with the way, the impact of the proposed innovations to enhance the resilience of the agrifood system (in terms of the value chain, governance, food production, and consumption practices) is analyzed, and the plan is to disseminate the results through various channels.

In this sense, the ZAPVS could become a part of a new research landscape that has a methodological focus on real-world experiments to understand sustainability problems and develop possible solutions through science–society collaboration (Bergmann et al., 2021). A broad array of research approaches fit this long-term and transformation-oriented research landscape, including urban and sustainable living labs (Liedtke et al., 2015), transformative spaces (Pereira et al., 2020a), and real-world labs (Schäpke et al., 2018a). Arguably, the ZAPVS echoes the five characteristics of real-world labs described by Schäpke et al. (2018a, p. 86): *"(1) [aim] to contribute to societal transformation, (2) [use] experiments as core research method and (3) transdisciplinarity as core research mode, (4) [have] a long-term orientation and seek scalability, and transferability of the results while (5) building on learning and reflexivity"*.

However, Aliment'Actions has some additional original features. First, it has a longer span, as some monitoring actions in the region started more than 25 years ago and have continued without any interruption. Second, the close collaboration between academic and non-academic actors throughout the duration of this project is seldom encountered within most other transdisciplinary projects, where interactions between scientists and local stakeholders are limited to information or consultation (Bergmann et al., 2021). Finally, to our knowledge, the spatial design of the targeted actions, which allows for experimentation and comparison, is unique. We argue that all these features distinguish Aliment'Actions from other research efforts that seek to transform agrifood systems and are not only critical to experiment with an innovative research project governance but also SES transformative governance.

4. Conclusion

This Methods article presents the research agenda and geographical setting of the Aliment'Actions research project that was initiated in 2018 in the LTSER zone Atelier Plaine & Val de Sèvre (Western France). This project has been planned to run for at least 10 years at the regional scale. It aims to achieve a better understanding of the factors and conditions that can catalyze agrifood system transformation to increase its sustainability and resilience. Throughout the research processes, the researchers both study and are involved in an ongoing transformation process. The project entails various actions seeking to understand transformation processes in the agrifood system, facilitate the engagement of stakeholders, monitor the different interventions, and communicate the main findings. The Aliment'Actions project has five main overarching features, namely, it adopts an SES perspective, it is place-based, transdisciplinary, adaptive, and iterative, and its research design is based on experimentation and monitoring. As the project is ongoing as of the writing of this paper, our aim here has been to share its approach, methodology, preliminary results, as well as how the research team addressed some of the research challenges. As many of the features of this pioneering project were developed along with the way, we believe that its overall approach may be useful for other transdisciplinary projects aiming at transforming agrifood systems.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

EB, SG, CB, and VB conceived the ideas and designed the methodology. EB, SG, CB, MG, OF, and VB implemented project-related actions and collected the data. EB, SG, CB, MG, OF, NB, and VB analyzed the data. EB, SG, and VB led the writing of the manuscript. All authors wrote parts of the article, contributed critically to the drafts, and gave final approval for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Agogué, M., Kazakçi, A., Hatchuel, A., Le Masson, P., Weil, B., Poirel, N., et al. (2014). The impact of type of examples on originality: explaining fixation and stimulation effects. *J. Creat. Behav.* 48, 1–12. doi: 10.1002/jocb.37

Ainscough, J., Wilson, M., and Kenter, J. O. (2018). Ecosystem services as a post-normal field of science. *Ecosyst. Serv.* 31, 93–101. doi: 10.1016/j.ecoser.2018.03.021

Ansell, C. K., and Bartenberger, M. (2016). Varieties of experimentalism. *Ecol. Econ.* 130, 64–73. doi: 10.1016/j.ecolecon.2016.05.016

BajŽelj, B., Richards, K. S., Allwood, J. M., Smith, P., Dennis, J. S., Curmi, E., et al. (2014). Importance of food-demand management for climate mitigation. *Nat. Clim. Chang.* 4, 924–929. doi: 10.1038/nclimate2353

Balvanera, P., Calderón-Contreras, R., Castro, A. J., Felipe-Lucia, M. R., Geijzendorffer, I. R., Jacobs, S., et al. (2017). Interconnected place-based social–ecological research can inform global sustainability. *Curr. Opin. Environ. Sustain.* 29, 1–7. doi: 10.1016/j.cosust.2017.09.005

Barnes, M. L., Bodin, Ö., Guerrero, A. M., Mcallister, R. R., Alexander, S. M., and ROBINS, G. (2017). The social structural foundations of adaptation and transformation in social–ecological systems. *Ecol. Soc.* 22. doi: 10.2139/ssrn.2932575

Bergmann, M., Schäpke, N., Marg, O., Stelzer, F., Lang, D. J., Bossert, M., et al. (2021). Transdisciplinary sustainability research in real-world labs: success factors and methods for change. *Sustainability Science* 16, 541–564. doi: 10.1007/s11625-020-00886-8

Berkes, F., Folke, C., and Colding, J. (eds.). (2000). *Erratum: Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge University Press.

Berkes, F., Hughes, T. P., Steneck, R. S., Wilson, J. A., Bellwood, D. R., Crona, B., et al. (2006). Globalization, roving bandits, and marine resources. *Science.* 311, 1557–1558. doi: 10.1126/science.1122804

Berthet, E., and Deroche-Leydier, Y. (2022). "Combining transition, social network and social-ecological system frameworks in view of transforming agrifood systems," in *Transforming Food Systems: Ethics, Innovation and Responsibility* (Wageningen Academic Publishers). 21–27.

Berthet, E., Gaba, S., Bombard, C., Tardieu, V., Bergé, L., Houte, S., et al. "Concevoir collectivement un système alimentaire résilient: les pistes explorées par un projet de recherche-action dans une plaine céréalière de Nouvelle-Aquitaine," in *14èmes Journées de recherches en sciences sociales SFER-INRAE-CIRA* (2020).

Berthet, E. T., Bretagnolle, V., and Gaba, S. (2022). Place-based social-ecological research is crucial for designing collective management of ecosystem services. *Ecosyst. Serv.* 55, 101426. doi: 10.1016/j.ecoser.2022.101426

Berthet, E. T., Segrestin, B., and Hickey, G. M. (2016). Considering agro-ecosystems as ecological funds for collective design: New perspectives for environmental policy. *Environ. Sci. Policy* 61, 108–115. doi: 10.1016/j.envsci.2016.04.005

Berthet, E. T. A., Bretagnolle, V., and Segrestin, B. (2012). Analyzing the design process of farming practices ensuring little bustard conservation: lessons for collective landscape management. *J. Sustain. Agric.* 36, 319–336. doi: 10.1080/10440046.2011.627988

Blay-Palmer, A. (2016). *Imagining Sustainable Food Systems. Imagining Sustainable Food Systems.* England, UK: Routledge. doi: 10.4324/9781315587905-12

Blay-Palmer, A., Carey, R., Valette, E., and Sanderson, M. R. (2020). Post COVID 19 and food pathways to sustainable transformation. *Agric. Human Values.* 37, 517–519. doi: 10.1007/s10460-020-10051-7

Bongaarts, J. (2019). *IPBES, 2019 Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.* New York: Wiley Online Library. doi: 10.1111/padr.12283

Bretagnolle, V., Berthet, E., Gross, N., Gauffre, B., Plumejeaud, C., Houte, S., et al. (2018a). Description of long-term monitoring of farmland biodiversity in a LTSER. *Data in Brief.* 19, 1310–1313. doi: 10.1016/j.dib.2018.05.028

Bretagnolle, V., Berthet, E., Gross, N., Gauffre, B., Plumejeaud, C., Houte, S., et al. (2018b). Towards sustainable and multifunctional agriculture in farmland landscapes: lessons from the integrative approach of a French LTSER platform. *Sci. Total Environ.* 627, 822–834. doi: 10.1016/j.scitotenv.2018.01.142

Bricas, N., Lamine, C., and Casabianca, F. (2013). Agricultures et alimentations: des relations à repenser? *Nat. Sci. Soc.* 21, 66–70. doi: 10.1051/nss/2013084

Callon, M., Lascoumes P., and Barthe, Y. (2001). *Agir dans un monde incertain.* Essai sur la démocratie technique, Paris, Le Seuil (collection "La couleur des idées"). p. 358.

Catarino, R., Bretagnolle, V., Perrot, T., Vialloux, F., and Gaba, S. (2019a). Bee pollination outperforms pesticides for oilseed crop production and profitability. *Proc. R. Soc. B* 286, 20191550. doi: 10.1098/rspb.2019.1550

Catarino, R., Gaba, S., and Bretagnolle, V. (2019b). Experimental and empirical evidence shows that reducing weed control in winter cereal fields is a viable strategy for farmers. *Sci. Rep.* 9, 1–10. doi: 10.1038/s41598-019-45315-8

Chiffoleau, Y., and Dourian, T. (2020). Sustainable food supply chains: is shortening the answer? A literature review for a research and innovation agenda. *Sustainability* 12, 9831. doi: 10.3390/su12239831

Cockburn, J., Cundill, G., Shackleton, S., and Rouget, M. (2018). Towards place-based research to support social–ecological stewardship. *Sustainability.* 10, 1434. doi: 10.3390/su10051434

De Bono, E. (2017). *Six Thinking Hats: The Multi-Million Bestselling Guide To Running Better Meetings and Making Faster Decisions*. London, United Kingdom: Penguin.

Ericksen, P. J. (2008). Conceptualizing food systems for global environmental change research. *Global Environm. Chan.* 18, 234–245. doi: 10.1016/j.gloenvcha.2007.09.002

Faivre, N., Fritz, M., Freitas, T., De Boissezon, B., and Vandewoestijne, S. (2017). Nature-Based Solutions in the EU: innovating with nature to address social, economic and environmental challenges. *Environ. Res.* 159, 509–518. doi: 10.1016/j.envres.2017.08.032

Fallot, A., Bousquet, F., and Dury, S. (2019). Les paradoxes de la résilience en matière de sécurité alimentaire. *Revue internationale des etudes du developpement.* 57–87. doi: 10.3917/ried.239.0057

Feola, G. (2015). Societal transformation in response to global environmental change: a review of emerging concepts. *Ambio* 44, 376–390. doi: 10.1007/s13280-014-0582-z

Folke, C., Biggs, R., Norström, A. V., Reyers, B., and Rockström, J. (2016). Social-ecological resilience and biosphere-based sustainability science. *Ecol. Soc.* 21:41. doi: 10.5751/ES-08748-210341

Foran, T., Butker, J. R. A., Williams, L. J., Wanjura, W. J., Hall, A., Carter, L., et al. (2014). Taking complexity in food systems seriously: an interdisciplinary analysis. *World Dev.* 61, 85–101. doi: 10.1016/j.worlddev.2014.03.023

Fournout, O., and Bouchet, S. (2019). "Le champ des possibles," in *Dialoguer autrement pour agir.*

Funtowicz, S. O., and Ravetz, J. R. (1993). Science for the post-normal age. *Futures.* 25, 739–755. doi: 10.1016/0016-3287(93)90022-L

Gaba, S., and Bretagnolle, V. (2020). Social–ecological experiments to foster agroecological transition. *People Nature.* 2, 317–327. doi: 10.1002/pan3.10078

Galafassi, D., Daw, T. M., Thyresson, M., Rosendo, S., Chaigneau, T., and Bandeira, S. (2018). Stories in social-ecological knowledge cocreation. *Ecol. Soc.* 23. doi: 10.5751/ES-09932-230123

Gasselin, P., Lardon, S., Cerdan, C., Loudiyi, S., and Sautier, D. (eds.). (2021). *Coexistence et confrontation des modèles agricoles et alimentaires. Un nouveau paradigme du développement territorial?* (Versailles: Éditions Quae), 307–313. doi: 10.35690/978-2-7592-3243-7

Geels, F. W., and Schot, J. (2007). Typology of sociotechnical transition pathways. *Res. Pol.* 36, 399–417. doi: 10.1016/j.respol.2007.01.003

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., et al. (2010). Food security: the challenge of feeding 9 billion people. *Science.* 327, 812–818. doi: 10.1126/science.1185383

Habermas, J. (1991). *The Structural Transformation of the Public Sphere: An Inquiry into a Category of Bourgeois Society*. Cambridge, MA: MIT Press.

Hadorn, G. H., Bradley, D., Pohl, C., Rist, S., and Wiesmann, U. (2006). Implications of transdisciplinarity for sustainability research. *Ecol. Econ.* 60, 119–128. doi: 10.1016/j.ecolecon.2005.12.002

Hajer, M., Westhoek, H., Ingram, J., Van Berkum, S., and Özay, L. (2016). *Food Systems and Natural* Resources. Nairobi, Kenya: United Nations Environmental Programme.

Hatchuel, A. (2000). "Intervention research and the production of knowledge," in Group, L. (ed.) *Cow Up a Tree, Knowing and Learning for Change in Agriculture.* Paris: INRA.

Hatchuel, A., Le Masson, P., and Weil, B. (2009). "Design theory and collective creativity: a theoretical framework to evaluate KCP process," in *International Conference on Engineering Design*. Stanford, CA, USA: Stanford University.

Hazard, L., Cerf, M., Lamine, C., Magda, D., and Steyaert, P. (2020). A tool for reflecting on research stances to support sustainability transitions. *Nat. Sustainabil.* 3, 89–95. doi: 10.1038/s41893-019-0440-x

Hooge, S., Béjean, M., and Arnoux, F. (2017). "Organising for radical innovation: The benefits of the interplay between cognitive and organisational processes in KCP workshops," in *The Role of Creativity in the Management of Innovation: State of the Art and Future Research Outlook*. Singapore: World Scientific. doi: 10.1142/9781786342010_0011

Houte, S., Laurent, D., and Becu, N. (2020). L'émancipation des habitants pour une gouvernance adaptative de la biodiversité: étude d'un dispositif participatif. *Participations.* 2020, 223–249. doi: 10.3917/parti.026.0223

Howard, P. H. (2021). *Concentration and power in the food system: Who controls what we eat?* Nigel Newton: Bloomsbury Publishing. doi: 10.5040/9781350183100

IAASTD International Assessment of Agricultural Knowledge, Science and Technology for Development. (2009). *Agriculture at a Crossroads – Global Report.* Washington, DC: Island Press.

IUCN (2012). *The IUCN Programme 2013–2016*. Switzerland: IUCN Gland.

Kates, R. W., Clark, W. C., Corell, R., Hall, J. M., Jaeger, C. C., Lowe, I., et al. (2001). Sustainability science. *Science.* 292, 641–642. doi: 10.1126/science.1059386

Kleijn, D., Bommarco, R., Fijen, T. P., Garibaldi, L. A., Potts, S. G., and Van Der Putten, W. H. (2019). Ecological intensification: bridging the gap between science and practice. *Trends Ecol. Evol.* 34, 154–166. doi: 10.1016/j.tree.2018.11.002

Lamine, C. (2015). Sustainability and resilience in agrifood systems: reconnecting agriculture, food and the environment. *Sociol. Ruralis.* 55, 41–61. doi: 10.1111/soru.12061

Lang, D. J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., et al. (2012). Transdisciplinary research in sustainability science: practice, principles, and challenges. *Sustainability Sci.* 7, 25–43. doi: 10.1007/s11625-011-0149-x

Lappo, A., Bjørndal, T., Fernández-Polanco, J., and Lem, A. (2015). *Consumers' Concerns and External Drivers in Food Markets*. Rome, Italy: FAO Fisheries and Aquaculture Circular.

Lazega, E. (1998). *Réseaux sociaux et structures relationnelles, Paris, Puf, coll.* Que sais-je, (3399).

Liedtke, C., Baedeker, C., Hasselkuß, M., Rohn, H., and Grinewitschus, V. (2015). User-integrated innovation in sustainable livinglabs: an experimental infrastructure for researching and developing sustainable product service systems. *J. Clean. Prod.* 97, 106–116. doi: 10.1016/j.jclepro.2014.04.070

Loorbach, D., Frantzeskaki, N., and Avelino, F. (2017). Sustainability transitions research: transforming science and practice for societal change. *Annu. Rev. Environ. Resour.* 42, 599–626. doi: 10.1146/annurev-environ-102014-021340

Maréchal, K., Plateau, L., and Holzemer, L. (2019). La durabilité des circuits courts, une question d'échelle? L'importance de court-circuiter les schémas classiques d'analyse. *Économie rurale. Agricultures, alimentations, territoires.* 45–60. doi: 10.4000/economierurale.6487

Moragues-Faus, A., Sonnino, R., and Marsden, T. (2017). Exploring European food system vulnerabilities: towards integrated food security governance. *Environ. Sci. Policy.* 75, 184–215. doi: 10.1016/j.envsci.2017.05.015

Mougin, C., Gouy, V., Bretagnolle, V., Berthou, J., Andrieux, P., Ansart, P., et al. (2018). RECOTOX, a French initiative in ecotoxicology-toxicology to monitor, understand and mitigate the ecotoxicological impacts of pollutants in socioagroecosystems. *Environ. Sci. Pollut. Res.* 25, 33882–33894. doi: 10.1007/s11356-018-2716-5

Nalau, J., and Handmer, J. (2015). When is transformation a viable policy alternative? *Environ. Sci. Policy.* 54, 349–356. doi: 10.1016/j.envsci.2015.07.022

Nguyen, H. (2018). *Sustainable Food Systems: Concept and Framework*. Rome, Italy: FAO.

O'Brien, K. (2012). Global environmental change II: From adaptation to deliberate transformation. *Prog. Hum. Geogr.* 36, 667–676. doi: 10.1177/0309132511425767

O'Brien, K. (2018). Is the 1.5 C target possible? Exploring the three spheres of transformation. *Curr. Opin. Environ. Sustain.* 31, 153–160. doi: 10.1016/j.cosust.2018.04.010

Olsson, P., Bodin, Ö., and Folke, C. (2010). "Building transformative capacity for ecosystem stewardship in social–ecological systems," in Adaptive capacity and environmental governance. Berlin, Germany: Springer. doi: 10.1007/978-3-642-12194-4_13

Olsson, P., Folke, C., and Hughes, T. P. (2008). Navigating the transition to ecosystem-based management of the Great Barrier Reef, Australia. *Proc. Nat. Acad. Sci.* 105, 9489–9494. doi: 10.1073/pnas.0706905105

Olsson, P., Moore, M.-L., Westley, F. R., and Mccarthy, D. D. (2017). The concept of the Anthropocene as a game-changer: a new context for social innovation and transformations to sustainability. *Ecol. Soc.* 22:31. doi: 10.5751/ES-09310-220231

Ostrom, E. (2007). A diagnostic approach for going beyond panaceas. *Proc. Natl. Acad. Sci. USA*. 104, 15181–15187. doi: 10.1073/pnas.0702288104

Overdevest, C., Bleicher, A., and Gross, M. (2010). "The experimental turn in environmental sociology: pragmatism and new forms of governance," in *Environmental Sociology*. Berlin, Germany: Springer. doi: 10.1007/978-90-481-8730-0_16

Pereira, L., Frantzeskaki, N., Hebinck, A., Charli-Joseph, L., Drimie, S., Dyer, M., et al. (2020a). Transformative spaces in the making: key lessons from nine cases in the Global South. *Sustainabil. Sci.* 15, 161–178. doi: 10.1007/s11625-019-00749-x

Pereira, L. M., Drimie, S., Maciejewski, K., Tonissen, P. B., and Biggs, R. O. (2020b). Food system transformation: integrating a political–economy and social–ecological approach to regime shifts. *Int. J. Environ. Res. Public Health* 17, 1313. doi: 10.3390/ijerph17041313

Perrot, T., Bretagnolle, V., and Gaba, S. (2022). Environmentally friendly landscape management improves oilseed rape yields by increasing pollinators and reducing pests. *J. App. Ecol.* 59, 1825–1836. doi: 10.1111/1365-2664.14190

Schäpke, N., Bergmann, M., Stelzer, F., and Lang, D. J. (2018a). Labs in the real world: Advancing transdisciplinary research and sustainability transformation: mapping the field and emerging lines of inquiry. *GAIA*. 27, 8–11. doi: 10.14512/gaia.27.S1.4

Schäpke, N., Stelzer, F., Caniglia, G., Bergmann, M., Wanner, M., Singer-Brodowski, M., et al. (2018b). Jointly experimenting for transformation? Shaping real-world laboratories by comparing them. *GAIA*. 27, 85–96. doi: 10.14512/gaia.27.S1.16

Schneidewind, U., Singer-Brodowski, M., Augenstein, K., and Stelzer, F. (2016). *Pledge for a Transformative Science: A Conceptual Framework*. Wuppertal Papers.

Scott, J. (1988). Social network analysis. *Sociology.* 22, 109–127. doi: 10.1177/0038038588022001007

Siebenhüner, B. (2018). Conflicts in transdisciplinary research: reviewing literature and analysing a case of climate adaptation in Northwestern Germany. *Ecol. Econ.* 154, 117–127. doi: 10.1016/j.ecolecon.2018.07.011

Sonnino, R., and Milbourne, P. (2022). Food system transformation: a progressive place-based approach. *Local Environ.* 1–12. doi: 10.1080/13549839.2022.2084723

Sundkvist, Å., Milestad, R., and Jansson, A. (2005). On the importance of tightening feedback loops for sustainable development of food systems. *Food Policy* 30, 224–239. doi: 10.1016/j.foodpol.2005.02.003

Tendall, D., Joerin, J., Kopainsky, B., Edwards, P., Shreck, A., Le, Q. B., et al. (2015). Food system resilience: defining the concept. *Global Food Sec.* 6, 17–23. doi: 10.1016/j.gfs.2015.08.001

Walker, B., Holling, C. S., Carpenter, S., and Kinzig, A. (2004). Resilience, adaptability and transformability in social–ecological systems. *Ecol. Soc.* 9 doi: 10.5751/ES-00650-090205

Wezel, A., Bellon, S., Doré, T., Francis, C., Vallod, D., and David, C. (2011). Agroecology as a science, a movement and a practice. *Sustainable Agri.* 2, 27–43. doi: 10.1007/978-94-007-0394-0_3

Ziervogel, G., Cowen, A., and Ziniades, J. (2016). Moving from adaptive to transformative capacity: building foundations for inclusive, thriving, and regenerative urban settlements. *Sustainability.* 8, 955. doi: 10.3390/su8090955