

Top-down vs bottom-up processes: A systematic review clarifying roles and patterns of interactions in food system transformation

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ABSTRACT

Urgent calls for food system transformation have spurred a variety of responses globally. In some cases, these calls have been answered through top-down led processes, driven by public agencies to design and implement measures that can drive societies towards more viable patterns of development. In other cases, transformation processes have been ignited by community level actors who addressed sustainability issues with context-specific solutions. The broad range of actors raises the question of whether it is top-down or bottom-up processes and actors that are better placed to deliver the fundamental and system level changes that characterise transformation. Through a systematic review, we identified 40 case studies across 24 countries to investigate the role of top-down or bottom-up processes in transformation, whether the two might intertwine, and with what results. We propose five different types of interactions: Autonomous Bottom-Up, Collaborative Bottom-Up, Top-Down Struggles and Resourceful Bottom-Up, Collaborative Top-Down and Transformation Alliances. Based on our analysis, we propose a new heuristic of roles and interactions between different actors. We suggest a shift from dichotomic views on top-down and bottom-up actor roles towards the concept of “transformation functions,” which would re-centre the discussion around the existing or needed capabilities for transformation in different contexts. Finally, we call for further research to determine how different transformation functions need to become more synchronised -or coordinated-to accelerate transformation.

1. Introduction

Calls for food system transformation are increasing in frequency and urgency, with many actions, actors, and processes around the world striving to transform food systems in a multitude of ways (Béné and Abdulai, 2024; Rockstrom et al., 2023). In some cases, these calls have spurred top-down led processes to address the needs and concerns of diverse populations, as in the case of the UN Food Systems summit (Tanzer et al., 2022). Public agencies, such as governments, public

research organisations and universities, and international development agencies, have attempted to design and implement measures to shift production, processing, distribution or consumption towards more environmentally, socially and economically sustainable outcomes (Conti et al., 2024a; Fanzo et al., 2024). In other cases, transformation processes have started taking root from the bottom-up. Sometimes, these bottom-up processes become increasingly mainstream to challenge food system structures, as in the case of the Landless Workers' Movements in Brazil or the Slow Food Movement (Petrini, 2015; Robles, 2011). In

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Box 1**Top-down and bottom-up processes: brief overview and definition**

Initially, the top-down and bottom-up dichotomy revolved around how international development interventions should be envisioned (Chambers, 1983, 1994). Policymakers and many academics argued that to achieve broad goals such as poverty alleviation, food security and others, it is vital to mobilise science and technology, regulations, financial and other incentives – a task that could only be achieved through top-down processes (Toenniessen et al., 2008). Others instead advocated for more participatory and locally-focused actions as the only way to account for the different preferences, values and contextual factors that characterise different food (and other) systems (Chambers, 1983; Stöhr, 1978). This tension remains unresolved and today spills over into broader transformation debates (Conti et al., 2024c; Easterly, 2008). For instance, the terminology of “niche” and “regime” in the Multi-Level Perspective framework (MLP) (Geels, 2004, 2006) is one of the most widely used to describe transformation processes in the food systems and beyond (El Bilali, 2019). The MLP sets a clear demarcation between bottom-up and top-down actors and processes. It suggests a rivalry between “niches” - local and community level initiatives advocating for alternative pathways - and “regimes” - the incumbent configuration and its formal and informal rules that inherently thwart transformation efforts – as two opposing poles (Stone et al., 2024). This conceptualisation is not universally applicable, and questions around whether a clear demarcation truly exist between top-down and bottom-up actors have been raised. For instance, citizens might see municipal governments as top-down actors, whereas the national government might consider them as local and relatively bottom-up actors (Kanosvambhira and Tevera, 2024). Whether corporate actors, mentioned in the introduction, would belong to the first or latter actor group, remains unclear, and they remain under-investigated in transformation processes (Yates et al., 2021). For the purpose of this paper, we distinguish and use – to some extent artificially – the following terms:

Top-down processes and actors in food system transformation are processes initiated and directed by central public authorities and agencies usually to meet the needs of large, more diverse populations (Music et al., 2022). This usually involves governments (both at national, regional and local level), public research organisation and universities, international development agencies, who use policies, regulations, research and development activities, and interventions (Kalvelage et al., 2023; Patterson et al., 2017; Orr et al., 2022) to catalyse, enable or incentivise change towards new and more sustainable outcomes. For example, the European Commission recently adopted a mission-oriented approach to “solve some of the greatest challenges facing our world” (e.g., climate change, healthy oceans, climate neutral and smart cities) through a diverse portfolio of research, policy, and legislative actions that could not be achieved by singular initiatives (OECD, 2022).

Bottom-up processes and actors in food system transformation are processes that originate locally (Haxeltine et al., 2013), involving people at the community level to experiment with different types of (social, economic, technological, cultural and others) innovations, as a response to the interests and values of the communities involved (Seyfang and Smith, 2007). Key bottom-up actors are part of local communities (Rosol, 2010) – in our case, local food actors (e.g. farmers, cooperatives, small scale food processors), community and civil society based organisations, NGOs, trade unions, local religious organisations (e.g. church groups) (van den Berg et al., 2018). Examples of these initiatives can include urban farming to redesign city-level food systems, place-based ecovillages for implementing sustainable food production and consumption, or social food movements to realise food sovereignty (Alkon and Mares, 2012; Oja Da Silva, 2023; Ulug et al., 2021).

these cases, community-level actors such as farmers, civil society based organisations, Non-Governmental Organisations (NGOs), trade unions, local religious organisations and activists address sustainability issues with context-specific solutions, often retrieving traditional practices and experimenting with novel technical or social configurations, or both (Apostolopoulou et al., 2022; Pereira et al., 2020). While this broad actor involvement is a testimony of the need to transform the food systems, it also raises questions of legitimacy, accountability and responsibility (Conti et al., 2025; Klerkx et al., 2022; Moallemi et al., 2024). Debates are currently happening on if, and which combinations and interactions between top-down and bottom-up processes and actors can best deliver the fundamental and system level changes that are necessary to successfully lead food system transformations across the globe (Stone et al., 2024).

Proponents of top-down led processes argue that these are necessary to respond to global challenges and ensure that transformation remains directed towards the public good. Scholars also point to the ability of public agencies to address system failures, manage riskier ventures, and guide innovation towards social justice and environmental outcomes (Hall and Hays, 2021; Hekkert et al., 2020; Kok and Klerkx, 2023; Mazzucato, 2018). In contrast, proponents of bottom-up processes emphasize their potential to empower actors through greater representation and to open “unconventional” sustainability pathways (Haxeltine et al., 2013; Seyfang and Smith, 2007). These pathways include, for instance, moving away from capitalism and embracing radical ideas such as degrowth (Gibson et al., 2025). With a deep understanding of local conditions, these efforts might, with relatively lower investments, lead to the development of (cultural, technological, and other) innovations and ensure a transformation that is more aligned with local visions and preferences (Hambloch et al., 2022; Leach et al., 2012;

Scoones et al., 2015).

Yet, both types of processes have received criticism. Top-down processes have been accused of “cockpitness” (Hajer et al., 2015), or the illusion that moving from defining the issue to international agreement is a simple and smooth process. They have also been criticised for their inattention to alternative knowledge and value systems, for example, the failure to recognise what local people desire and value (Fletcher et al., 2021; Williams et al., 2023). Top-down processes have also been subject to corporate capture (Clapp, 2023; IPES, 2017) - as in the case of the UN Food System summit, where powerful coalitions of multinational corporations and donors trumped the efforts of international organisations to propose meaningful alternatives to industrial food systems and address the concerns of civil society (Anderl and Hißen, 2024; Anderson and Maughan, 2021; Canfield et al., 2021). On the other hand, bottom-up processes have often only succeeded in proposing alternative visions of food systems at the local level, and might have equally fallen prey to polarisation and been derailed towards less sustainable pathways (Guthman, 2004). The somewhat romantic belief that bottom-up action could be “best” for envisioning change (Medugorac and Schuitema, 2023), for example with the idea of relatively small-scale and local food networks challenging the current food system structures (Bui et al., 2016), might have overlooked the need for more system-level and organised action to restructure norms, practices, and values at all levels (e.g. through deep changes in policies and institutions) (Klerkx and Begemann, 2020). Bottom-up action might in this sense be insufficient to reach beyond the local scale and fulfil the extent of system-level change needed for transformation (Smith and Adrian, 2015), again raising the question of how transformation processes can be successfully steered and governed.

These different positions have, over time, contributed to the

solidification of a dichotomy (Cleaver, 1999), where top-down and bottom-up processes are conceived as incompatible alternatives for transforming food systems (see box 1). Studies of transformation processes have started revealing how bottom-up and top-down processes might in truth be intertwined and equally important for transforming the system (Loeber and Kok, 2024; Scoones et al., 2020). In these cases, both top-down and bottom-up actors may search for acceptable and viable sustainability solutions and develop shared agendas (Kok et al., 2023; Stone et al., 2024). Yet, evidence on the types of actions and interactions in these cases remains lacking.

We aim to address this gap and answer two key questions (RQ):

- i. RQ1: What processes (top-down or bottom-up) initiate transformations and how? Which actors are involved and what are their different roles?
- ii. RQ2: Under what circumstances do top-down and bottom-up processes intertwine, what are the features of these collaborations, how do they take place and with what results?

We answer these two questions by conducting a systematic review of food system transformation case studies across various geographies, some spanning several decades. The paper sheds light on how transformative processes can be initiated, and the evolving interactions between bottom-up and top-down actors and processes. Building on this analysis, the paper offers five different types of interactions observed in transformation processes. These five different types are used to suggest a new heuristic of how different contexts, actor roles and interactions demand different types of interventions and enablers to advance transformation of food systems. The discussion proceeds by suggesting a better consideration of the system functions needed to accelerate transformation, which actors and institutional arrangements could fulfil these functions and how these could be synchronised. Finally, we propose new venues for further research.

2. Methods

2.1. Selecting cases

The research questions outlined above were addressed through a systematic review of case studies related to food system transformations. We collected a diverse set of cases from scientific literature, following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines for systematic reviews (Moher et al., 2009; Tricco et al., 2018). Details on the databases searched, publication dates and keywords can be found in Fig. 1. Additional details can be found in Supplementary Materials I. The search yielded an initial 11,706 articles of which 977 were immediately removed due to being duplicates (10,729 papers). We screened the 10,729 articles based on inclusion and exclusion criteria, defined in detail in Box 2 and synthesized in Fig. 1. After screening, 33 articles, reporting a total of 40 case studies across 24 countries, were identified.

2.2. Coding selected cases

To uncover patterns of top-down and bottom-up interactions, we analysed the case studies thematically against the following features, drawing from the approach developed by Moallemi et al. (2023):

- *Initial context, processes, and actors involved in transformation.* This pertains to how transformation starts to take place in a specific context.
- *Evolving patterns of collaborations (or lack thereof) over time.* This pertains to the types of interactions that different actors (top-down or bottom-up) have in transformation -e.g., do the actors support, obstruct or ignore each other? We used the definitions of top-down and bottom-up according to Box 1 to identify these patterns in cases.

- *Types of roles carried out by different actors at different points in time* with regard to 12 pre-specified roles, synthesized from the literature. These included *setting joint priorities* (aligning goals for coordinated action), *de-risking experiments* (minimising risks of innovation through support), *building trust* (fostering credibility via transparent dialogue), *building networks* (enhancing collaboration and resource sharing), *convening multi-stakeholder collaborations* (uniting diverse stakeholders for integrated solutions), *facilitating access to technology* (providing tools, training, and infrastructure), *conducting R&D* (generating insights on innovations), *demonstrating new practices* (showcasing viability to encourage adoption), *funding* (providing financial resources), *championing policy change* (advocating for enabling institutional reforms), *generating knowledge* (expanding insights through research or experimentation), and *mobilising community* (engaging stakeholders to foster ownership and collaboration). Each role contributes to a holistic, inclusive transformation (see more role details in Supplementary Materials II). These 12 roles, while may not be exhaustive in capturing all roles actors could play, encompass a broad spectrum of key ideas related to types of roles carried out by different actors, based on earlier research on food system transformation (Loeber and Kok, 2024; Moallemi et al., 2024; Scheuermann et al., 2024; van den Akker et al., 2024; Williams et al., 2023).

2.3. Limitations of case selection and coding

While the selected cases provided sufficient insight about diverse cases, we acknowledge that the case selection process and their coding had inherent limitations and potential biases. As such, the sample cannot be considered statistically representative of the full diversity of research and practice on food system transformation. First, the cases might have bias towards bottom-up initiatives. The growing focus on grassroots approaches in sustainability research may have led to an overrepresentation of bottom-up dynamics. We addressed this by ensuring that there are some cases with top-down elements in our sample even though they may not fully represent the diversity of top-down scientific processes in food and agriculture systems.

Second, the scope of transformation in the cases reviewed might be limited. Changes observed in cases often reflected local or community-level shifts, but this did not always lead to broader regional, national, or international impacts, potentially limiting the representation of wider systemic transformations. To address this limitation, we assumed that transformation is an ongoing process with different stages (Hebinck et al., 2022), and cases can focus on different stages of transformation (i. e., local cases may represent transformation in early, experimentation stage).

Third, relying solely on peer-reviewed literature, while ensuring academic rigor, may have excluded valuable insights from grey literature, conferences, and non-scientific perspectives (e.g., local practitioners, NGOs). This could also skew representation, as first authors often have affiliations in High-Income Countries, even when cases involve Low- and Middle-income countries. Further research is needed to incorporate transdisciplinary insights and broaden the understanding of top-down and bottom-up interactions.

Fourth, we are aware that the lines between top-down and bottom-up processes and actors within these processes are not always clear. One case could represent multiple processes and actor roles at the same time. We elected to assign only one (the most prominent and according to the definitions in Box 1) to each case for simplicity of analysis.

Databases searched:	Scopus, ScienceDirect, and ScienceWeb
Publication dates:	1 st January 1970 – 9 th May 2024
Keywords:	TITLE-ABS-KEY ((agri* OR food*) AND (transition OR transformation OR innovation) AND (case OR history) AND (grassroots OR niche* OR bottom-up OR top-down OR polic* OR regime OR governance OR institution* OR network* OR local OR communit* OR alternative OR indigenous)). <i>Note:</i> Query used with appropriate adjustments to the Boolean operators and wildcards to ensure maximum inclusiveness.
Languages:	Any language, additional publications in other languages identified through snowballing.

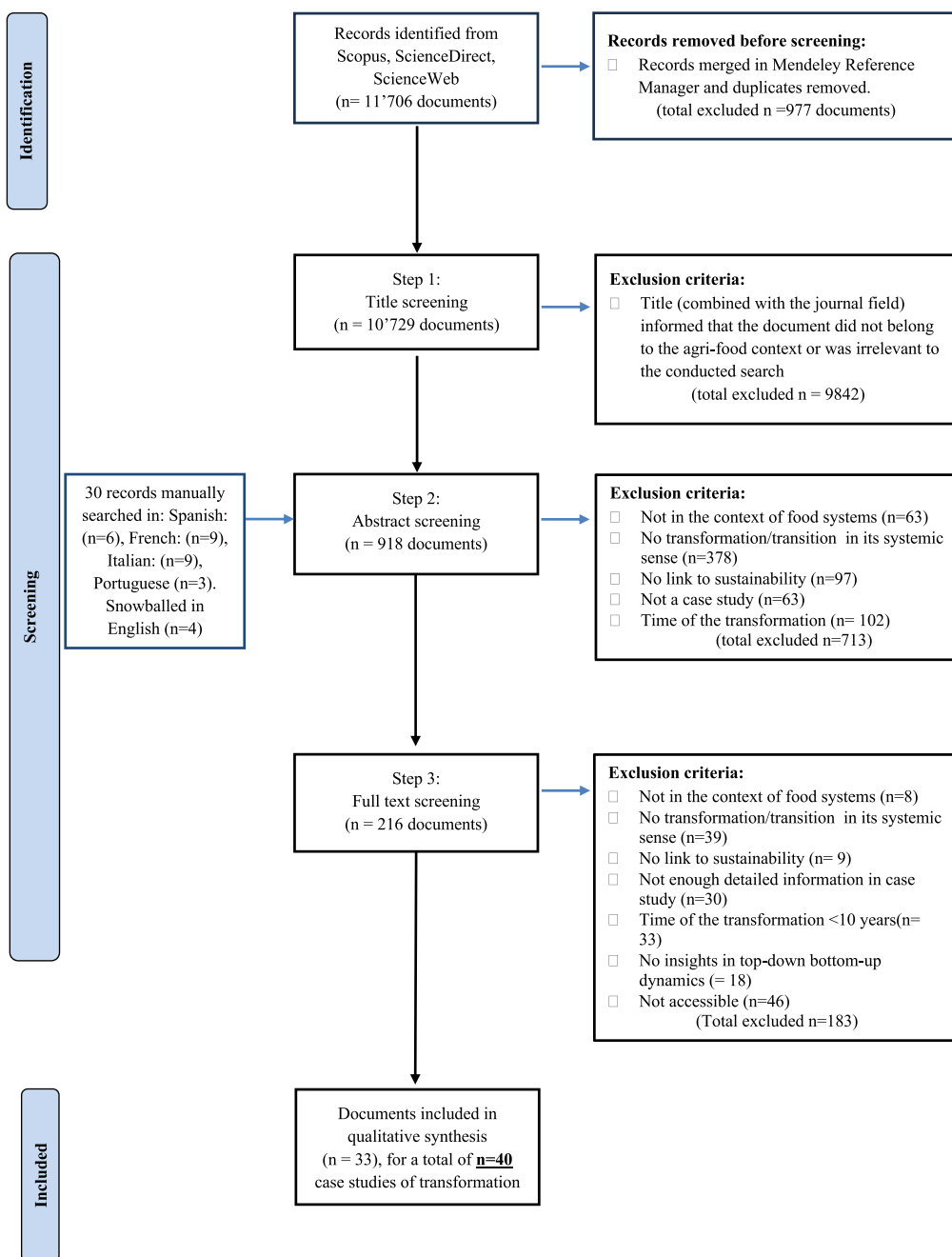


Fig. 1. PRISMA diagram. The figure below illustrates the details of the systematic search (databases searched, publication dates, keywords and languages) as well as different steps conducted for the systematic review. These steps were performed according to the PRISMA guidelines (identification, screening, included). Records were manually searched and added in Step 2. The boxes on the right briefly describe the exclusion criteria followed.

Box 2

A checklist for selection of food system transformation case studies

We defined ad hoc inclusion and exclusion criteria to ensure that the search was not only as inclusive as possible, but also identified meaningful transformation case studies that were specifically relevant to our research questions. The following criteria were used:

- *Relevance to food systems*: included studies that clearly link to food systems or address the food system as a whole, and excluded those focused only on specific components of food systems (e.g., phosphorus application) or unrelated sectors (e.g., chemistry, biology, psychology).
- *Focus on system transformation, transition, and system change*: included studies that address transformation, transition, or system change in its systemic sense, beyond incremental or component-level changes, and excluded studies that focus only on technical innovations or changes in individual system components without broader system-wide transformation.
- *Sustainability focus*: included studies with sustainability as a clear outcome of the transformation, and excluded those where transformation is aimed at other goals, such as economic profitability, not representing other dimensions of sustainability were excluded.
- *Duration of transformation*: included studies showcasing interventions or transformations that reflect the long-term nature of system changes, and excluded those with shorter durations that represent incremental change.
- *Case study detail*: included studies with sufficient information on case studies to address the research questions and accessible full-text documents, and excluded those lacking adequate detail or not presenting a case study or where the full text is unavailable.
- *Insights into system dynamics*: included studies that provide insights into both bottom-up and top-down dynamics within the transformation process, and excluded those lacking such insights.
- *Level of transformativeness*: included studies that are transformative as defined by Conti et al. (2021), requiring changes across multiple system components (i.e., technology choices, institutions and policies, attitudes and cultures, infrastructure, power and politics, infrastructure, research and innovation priorities, practices and narratives) to be transformed, and excluded studies focusing on incremental changes of single system components.

3. Results**3.1. Overview of the case studies**

The analysed case studies are diverse and represent different geographical locations, with an almost equal number of case studies¹ from High-Income Countries (n = 18) and Low- and Middle-Income Countries (n = 22), covering a total of 24 countries (see Fig. 2). These cases represent food system transformation across various scales to better capture the diversity of roles and actors in bottom-up and top-down processes. These included diverse scales, ranging from case studies that represented a more localised form of transformation situated at the community-level (see Holtkamp, 2023; Ravazzoli et al., 2019), to or more mainstream, regionally or nationally (see Ojha and Hall, 2021; Rover et al., 2016). To demonstrate a few examples of these cases, in India, tribal women established Self-Help Groups and a producer company to promote sustainable farming through non-pesticide management, leveraging new practices, markets, and networks to shift consumption patterns in a more local food system (Saxena and Prasad, 2024). In Senegal, civil society organisations and NGOs addressed rural service gaps by supporting agroecological practices, leading to technological shifts, sustainable R&D, and policy influence through platforms like the Thinking and Action Framework on Land Governance (Bottazzi and Boillat, 2021). In Izmir, Turkey, in a more urban scale, municipal policies fostered bottom-up movements, funding sustainable practices rooted in Indigenous knowledge and enabling local associations to build networks, participatory systems, and consumer awareness of locally produced foods (Özatağan and Karakaya Ayalp, 2021). Each case highlights a different pathway for transforming food systems towards more sustainable approaches (see Supplementary Materials II for other case studies' details).

Only three publications date from before 2015. This is in line with prior observations, suggesting that interest towards transformations has started to emerge over the last decade, possibly sparked by international commitments towards more sustainable societies (also reflected by the Sustainable Development Goals inception and the Paris Agreements) (El

Bilali, 2019; Melchior and Newig, 2021). All publications used qualitative methodologies to capture, describe and analyze the transformation process. Qualitative analysis was always accompanied by quantitative measures to support the argument for transformation. Many case studies (n = 17) were investigated through the lens of the Multi-Level Perspective (MLP) (see box 1) as a guiding framework. The next two sections answer RQ1 and RQ2.

3.2. Bottom-up, top-down and “hybrid” processes and roles for initiating transformations

For most of our case studies (n = 24 out of 40), bottom-up processes aimed at solving sustainability challenges. These processes commonly targeted several issues, some of which were forgotten or ignored in policy agendas (Chebroly and Dutta, 2021; Rover et al., 2016). Environmental issues included soil depletion, decreases in soil productivity and concerns over pesticide use (Chebroly and Dutta, 2021; Vila Seoane and Marín, 2017). Economic issues included social marginalisation or unemployment in farming communities (Polita and Madureira, 2022; Ravazzoli et al., 2019). Equity issues included discrimination in land access and use due to colonial history (e.g. Rover et al., 2016; van den Berg et al., 2018), or a desire to move away from capitalism (Sherwood et al., 2016). In this context, bottom-up actors initiated transformation processes by experimenting with context-relevant socio-economic or technical innovations. For example, communities in the Italian Alps, increasingly concerned about agricultural sustainability and unemployment, began experimenting with different practices and the establishment of new local services (Ravazzoli et al., 2019). Simultaneously, the uptake of these innovations required these bottom-up actors to engage in advocacy and community mobilisation, building the capabilities of farmers, consumers and communities more broadly to introduce and enable new patterns of production and consumption. Often, public agencies were minimally involved.

Sometimes, the unresponsiveness or disinterest to community concerns is due to government agendas, where vested interests or power dynamics (e.g., election donors, international investments (Clapp, 2025; Clapp et al., Forthcoming)) make the continuation of status quo food systems more advantageous to these incumbent powers. In those cases, the state was often aware that at the grassroots level, farmers, consumers, and activists were looking for new ways of producing and consuming

¹ From here onwards, we always refer to the total number of case studies (n = 40), rather than number of articles (n = 33).

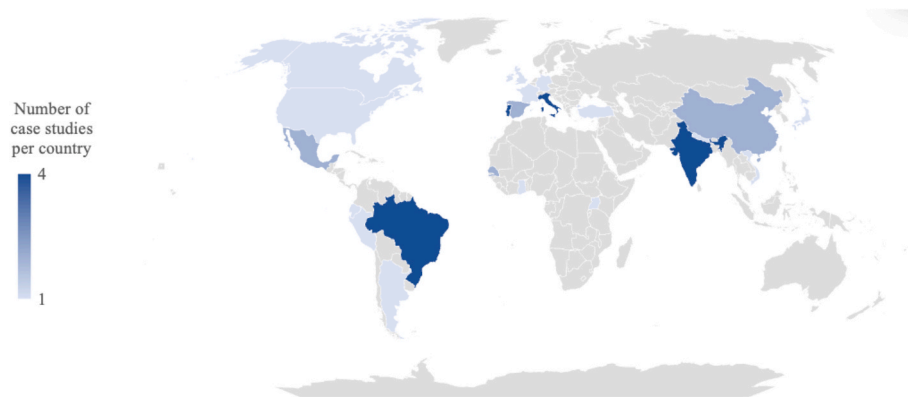


Fig. 2. Number of case studies per country. image credits ©Australian Bureau of Statistics, GeoNames, Microsoft, Navngo, Open Places, OpenStreetMap, TomTom, Zenrin.

food, but did not perceive their concerns and efforts as sufficiently important to act, often either ignoring (e.g., [Smith, 2006](#)) or even discrediting them ([Conti et al., 2024b](#)). In these cases, bottom-up actors often built strong networks of trust that over time allowed these new practices to become more mainstream, and even gain visibility and value in the eyes of often initially skeptical institutional actors. A case illustrating the uptake of organic agriculture in the UK described how the government refused to acknowledge farmers practicing organic agriculture for decades, instead focused on more industrial agriculture and national priorities to further intensification ([Smith, 2006](#)). Only when their networks grew, and consumers became increasingly interested in organic foods, did the state endorse and support this practice.

In other case studies, it was not disinterest, but lack of institutional capacities (financial but also human) to support the generation and or uptake of alternatives. In Senegal, the state's limited financial capacities prevented the government from being able to provide farmers with extension services or other forms of support to guide them in the uptake of more sustainable production practices. Instead, several civil society organisations and NGOs stepped in and trained farmers in sustainable agriculture practices ([Bottazzi and Boillat, 2021](#)).

The results of the review also show cases of transformation initiated by top-down processes, although these were found less frequently ($n = 6$). These are cases in which public agencies foresee or face impending environmental, economic and social issues, often similar to the ones mentioned above, e.g., unsustainable production and consumption practices ([Sartison and Artmann, 2020](#)), unemployment ([Özatağan and Karakaya Ayalp, 2021](#)) or risks to populations ([Bui et al., 2016](#)). According to some cases, top-down processes are motivated by the issues gaining traction in international policy agendas - as in the case of widespread and harmful water pollution from agriculture in France, where efforts were spurred by European Union concerns and recommendations ([Bui, 2021](#)). Public authorities might consequently introduce policies to subsidize alternative, more sustainable practices, as in the case of conservation efforts that led to a new result-based payment scheme for high natural value farmland in Ireland ([Moran et al., 2021](#)). In other cases, these top-down processes might be propelled by the presence of a government that is more attentive to the voices of the people and more aware of the social and environmental repercussions of not addressing sustainability concerns ([Goulet, 2021](#); [Özatağan and Karakaya Ayalp, 2021](#); [Sartison and Artmann, 2020](#)). For example, in Brazil the Planapo initiative was launched because of government concern over continued use of toxic agrochemicals. A national plan was then set up for the implementation of agroecology and organic agriculture ([Goulet, 2021](#)). However, these efforts may be vulnerable to being reversed or scaled back if a more conservative government comes into power ([Goulet, 2021](#)). In the case of Planapo initiative, once Bolsonaro came to power, the initiative was forced to shift its focus from agroecology, labelled as a “communist approach” towards

market-oriented organic production, leading farmers to be pushed towards a more industrial productivity-oriented agricultural regime.

When top-down processes are used to initiate the transformative change, top-down actors assume their policy-making function ([Moran et al., 2021](#)), but can also make active efforts to fund on-ground interventions. For instance, public agencies might encourage local authorities to assist in the switch to more sustainable practices by providing information and support to farmers ([Moran et al., 2021](#)). They might also purposefully direct new research priorities towards the creation and diffusion of more sustainable practices, such as in the case of the Brazilian Agricultural Research Corporation participating to the development of solutions for pest control, nutrition and conservation ([Goulet, 2021](#)).

Other cases were initiated by top-down and bottom-up actors *collaborating* to achieve certain sustainability outcomes. When an initial threat is perceived by both actors, they might start to act jointly and showcase a hybridity of processes and roles for addressing impending challenges. This pattern is relatively common in the identified cases ($n = 9$). For example, in Brazil, issues of colonial history, environmental degradation and social struggles led communities to seek the establishment of novel patterns of land redistribution and ownership. Almost simultaneously to these efforts, research centres, extension services and universities ([van den Berg et al., 2018](#)) started to support communities in finding new ways to regenerate soils, adopting agroforestry and switching to indigenous and more varied crops, and accessing markets. In France, the formation of farmers cooperatives for implementing organic agriculture was accompanied by favourable policies and consistent government funding, which over time enabled the initiative to gain legitimacy and expand at the regional level ([Bui, 2021](#)). In these more hybrid cases, bottom-up and top-down actors might more or less explicitly coordinate in certain functions and accelerate the implementation of different solutions for sustainability, as the two cases just described suggest. Top-down actors might invest (e.g., in research activities) and set-up policies, while bottom-up actors experiment with innovations (often backed by formal research institutions) at the ground level and generate trust around those innovations within their communities. This type of more collaborative endeavour – further explained in section 4 – usually facilitates the identification and implementation of shared priorities.

3.3. Evolving circumstances in transformation: hybrid interactions under necessity

Whereas the section above sheds light on how transformation processes are usually initiated (i.e. by bottom-up or top-down or hybrid processes), answering the second research question demands a closer analysis of how bottom-up and top-down processes and interactions evolve over time.

Although hybrid collaboration emerged at the inception of the transformation processes for only a small number of cases ($n = 9$), our second research question reveals that collaboration was present in many other cases ($n = 19$), but appeared at a later point and had distinct features based on the depth and purposes of engagement of the different actors.

We were not able to identify any meaningful collaboration in 13 cases. Within these cases, bottom-up actors did not believe in the value or possibility of successful interactions with top-down actors. This might be due to multiple reasons, such as lack of trust in the government to take action (Chebrolu and Dutta, 2021), lack of opportunities (Salavisa et al., 2021) or misaligned expectations (Zhang, 2024), nor was there any reported attempt of public authorities to engage in community-based transformation processes. Bottom-up actors instead experimented with sustainable practices independently, forming tight networks to produce and consume more sustainable products, as in the case of the Seikatsu Club Consumer Cooperative in Japan (Hatanaka, 2020). Actors in these cases might not wish to trigger broader system changes.

In other cases, collaboration takes the form of broad agreement on sustainability pathways, but do not go any further in terms of joint action. For instance, governments can introduce certain sustainability-oriented policies, but then leave their implementation in the hands of bottom-up actors. This is the case of policies for herbicide use reductions in Portugal. Once the national government passed a set of regulations on herbicide, it was up to the local farmers to adopt them. This led farmers in the Douro Valley to independently experiment with herbicide reduction methods in viticulture, forming a network to share knowledge and experiences and expanding new practices to other neighboring communities (Polita and Madureira, 2022).

Broad agreement on certain sustainability objectives can also lead actors to informally coordinate on their respective roles. For instance, top-down actors can devise and facilitate the implementation of supportive policies, and bottom-up actors can mobilise communities to respond to these new policy objectives. A specific example comes from Irish national policies for nature conservation. As policies were too generic for farmers to independently adopt them, supportive local advisors and administration services ensured that these policies found resonance and were implemented by farmers (Moran et al., 2021).

Finally, some cases showcase much more proactive mutual support and intimate collaboration. In these cases, collaboration is more formal or even enshrined in policies, with the government “allying,” with local community needs for sustainability. This has several consequences, in terms of re-formatting of actors’ goals (i.e. industrial versus sustainable agriculture) and, more importantly, roles for sustainability, with a clear agreement on what tasks bottom-up and top-down actors respectively carry out for transforming the food systems in question (Bui, 2021). An illustrative case is from Ghana, where increasing sustainability concerns initially at the community-level were then recognised by the government. Over time, both top-down and bottom-up actors agreed that organic agriculture needed to be implemented swiftly to make cocoa production sustainable. This agreement spurred responses from both sides. While the organic cocoa initiative emerged through a bottom-up process from farmers experimenting with new practices and mobilising networks around this new modes of production, top-down support became equally necessary. The government mobilised research and infrastructure for implementing organic practices, legislated for favourable organic prices and set clear mechanisms that would de-risk and protect farmers accessing new markets. Over time, this led to what the authors themselves defined as “hybrid governance,” where top-down and bottom-up actors had complementary and interconnected roles. In this and other cases, the need for hybrid action and complementarity led to important “alliances” (Bui, 2021), where a virtuous circle forms: initial bottom-up expansion leads to political and legal endorsement, and political and legal endorsement leads to further on-the-ground expansion.

4. Types of interactions in transformation

Differences in initial processes and roles, and their evolution over time, allowed us to identify a number of distinct types of interactions in transformation processes: Autonomous bottom-up (13 cases); Collaborative Bottom-Up (6 cases); Top-Down Struggles and Resourceful Bottom-Up (6 cases); Collaborative Top-Down (5 cases); Transformation Alliances (9 cases) (see Table 1 for brief summary and visualisation).

These types of interactions are based on the thematic analysis of the publications (see Section 2) and described according to: the initial setting where the issue is perceived (e.g., at either the community or beyond the community level), the resulting conditions and actors’ roles (Fig. 3 and Supplementary Materials II), the evolution of these processes and roles over time and the outcomes of these processes.

Clearly, all case studies are different and have their own unique features. However, what these types of interactions are based on is the identification of distinct and characteristic processes unfolding over time.² Each type is described below based on the level of interaction (from the least to the highest amount of interaction) between top-down and bottom-up actors, complementing a conceptual delineation with empirical material from the case studies (each summarised separately in Supplementary Materials II).

4.1. Autonomous Bottom-Up

Thirteen of our cases depict instances where certain sustainability issues emerge at the community level. In response, the community develops and deploys several social or technological innovations to address these issues. Here, the community is not interested in involving top-down actors nor changing norms and behaviours at a broader scale. Sometimes, communities fear that engaging with public agencies might reduce their potential to move away from the status quo. This disengagement with top-down actors leads bottom-up actors to build independent and alternative arenas of sustainability action.

For these independent arenas to be viable at the community scale, bottom-up actors, mainly farmers, consumers and civil society organisations generate new knowledge and experiment with “new ways of doing things” to solve impeding challenges, while building networks and trust that mobilise communities towards new sustainability pathways (Holtkamp, 2023; Yacamán-Ochoa and García-Llorente, 2020). For example, farmers might create networks to produce more sustainable products, build shorter value chains and ensure that these products reach a relatively smaller group of consumers, as in the case of local food markets in Bologna, Italy. Here, an NGO promoted sustainable production practices and consumption of local foods, while establishing a more ethical and ad hoc participatory self-certification system to sell these sustainable products to consumers invested in sustainability (Alberio and Moralli, 2021). Thanks to context-adapted innovations, strong networks of trust amongst actors and more inclusive local governance structures (Hatanaka, 2020; Saxena and Prasad, 2024) – often set-up by local NGOs and associations (Alberio and Moralli, 2021; Zhang, 2024) – these movements see new, localised food system flourish, which “secede” from the existent system.

² A “deviant” case, which would deserve a separate category, is the one of an organic transformation in China, which could be considered as a “totalitarian” transformation (Thiers, 2002). The paper in fact describes how the government alone, without any linkages with either producer’s communities nor NGOs managed to implement organic agriculture. However, this effort could succeed only because the government coerced farmers to switch to organic under the threat of forceful relocation. Even if this ultimately made the transformation successful, we do not include this as a category because such process would not easily be replicated in other parts of the world.

Table 1

Visual representation of the different types of interactions, with brief description, relevant references, and countries represented. The large arrow in the centre represents transformation from the old system to the new one. The icons at the top and bottom indicate top-down and bottom-up dynamics, respectively. The row of smaller arrows shows where top-down or bottom-up forces are at play in the transformation. Four small arrows indicate both long- and short-term effects, whilst two arrows represent effects from later stages only. The half-circular arrows on the sides illustrate whether top-down forces are driving the bottom-up dynamics (arrow pointing from top to bottom), or the bottom-up forces are influencing the top-down dynamics (arrow pointing from bottom to top). Note: References might appear in different rows when presenting >1 case studies showcasing different types of interactions. The references are allocated after the analysis carried out by the authors. However, this allocation is not rigid and could be subject to interpretation.

Type of interaction	Description	References	Country(ies)
Autonomous Bottom-Up	Bottom-up actors create independent sustainability platforms, experiment with innovative solutions and build trust-based networks.	(Alberio and Moralli, 2021; Chebrolu and Dutta, 2021; Hatanaka, 2020; Holtkamp, 2023; Ravazzoli et al., 2019; Salavisa et al., 2021; Saxena and Prasad, 2024; Vila Seoane and Marín, 2017; Yacamán-Ochoa and García-Llorente, 2020; Zhang, 2024)	Italy (3); India (2); Japan (1); Portugal (4); Argentina (1); Spain (1); China (1)
Collaborative Bottom-Up	Bottom-up actors mobilise independently, but later recognise the need to engage with top-down actors for legitimacy, thus fostering evolving collaborations.	(Bui et al., 2016; Ilieva and Hernandez, 2018; Polita and Madureira, 2022; Rover et al., 2016; Sarabia et al., 2021)	France (1); Brazil (2); Spain (1); Portugal (1)
Top-Down Struggles and Resourceful Bottom-Up	Bottom-up actors assume a number of different roles to address top-down inability to fulfil these roles. They are then increasingly recognised by the latter who support them via governance practices.	(Bottazzi and Boillat, 2021; De La Cruz and Dessein, 2021; Isgren and Ness, 2017; Nelson and Tovar, 2017; Smith, 2006)	Senegal (1); India (1); Peru (1); Uganda (1); Mexico (1); UK (1)
Collaborative Top-Down	Top-down actors lead the change process, but they ensure alignment with bottom-up priorities.	(Bui et al., 2016; Conti et al., 2024b; Goulet, 2021; Moran et al., 2021; Özatağan and Karakaya Ayalp, 2021; Sartison and Artmann, 2020)	Ireland (1); France (1); Brazil (1); Turkey (1); Germany (1)
Transformation Alliances	Combined efforts of both top-down and bottom-up actors drive changes, championed by both policymakers and communities.	(Alex, 2013; Bui, 2021; Glin et al., 2015; Gretter et al., 2019; Ilieva and Hernandez, 2018; Ojha and Hall, 2021; Sherwood et al., 2016; van den Berg et al., 2018)	India (1); France (1); Ghana (1); Senegal (1); USA (1); Nepal (1); Ecuador (1); Brazil (1)

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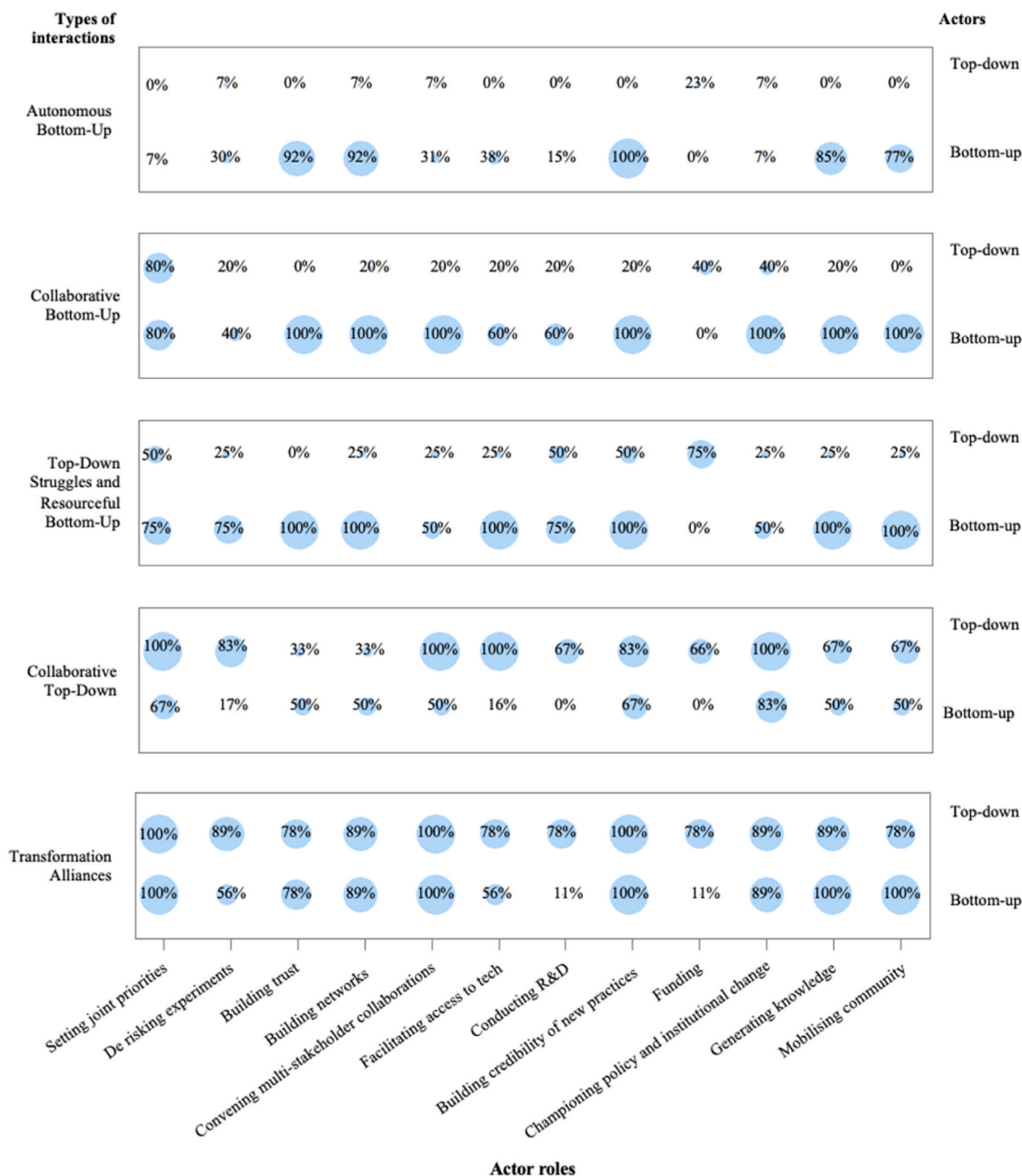


Fig. 3. Different actor roles in the different types of interactions. An explanation of each role is provided in Supplementary Materials II. The order of the roles in the figure does not imply any specific hierarchy. The percentages are based on the number of times an actor (top-down or bottom-up) had that specific role in a given article.

4.2. Collaborative Bottom-Up

This type of interaction refers to cases in which bottom-up movements are initially mostly autonomous, as the government is not interested or does not perceive certain challenges are priorities. An essential aspect of this type of interaction is that bottom-up actors start organising and mobilising independently for sustainability, exploring context-relevant innovations, generating new knowledge, and building trust and networks among a usually growing number of local actors (in a similar fashion, to some extent, to the Autonomous Bottom-Up case).

However, as they progress, these movements understand the necessity of engaging with top-down actors to gain legitimacy and traction

(Bui et al., 2016). While generating knowledge and promoting networks is important, bottom-up actors feel that this is not sufficient to address sustainability issues that are anchored at the system level. Instead, these issues need to be concomitantly addressed – and possibly resolved – through novel political and legal measures. For example, the Ecovida network in Brazil (Rover et al., 2016) initially emerged bottom-up to promote agroecology, and demonstrated the viability and benefits of agroecology, forming a nation-wide network of committed farmers, consumers and communities. However, once the value of new practices was established, agroecology needed to be enshrined in public regulations to become a truly viable alternative to industrial agriculture. Consequently, bottom-up actors – that are generally organised through

NGOs or community organisations – started to engage with top-down actors to convene collaborations and influence public policy regulations. This led to the establishment of national public regulations on organic production standards and norms, and led authorities to create new market infrastructure for organic produce. Therefore, evolving collaborations lead to a new configuration where novel, more sustainable modus operandi proposed by bottom-up processes, are then endorsed and safeguarded through formal mechanisms (e.g., laws).

4.3. Top-Down Struggles and Resourceful Bottom-up

This type of interaction refers to a situation in which the state struggles, for different reasons, to provide the necessary support to producers. Consequently, this leaves a “vacuum” (Bottazzi and Boillat, 2021) for civil society organisations or NGOs to step in and play multiple roles, mainly to solve a broad range of environmental sustainability and social well-being issues. The reasons for the vacuum can be multifaceted. For example, in Senegal, Uganda, Mexico and Peru, the state did not have financial or organisational stability *and* capability to provide services to farmers – such as education on suitable or sustainable practices, market information, or certification that would create a price premium for certain products (Bottazzi and Boillat, 2021; De La Cruz and Dessein, 2021; Isgren and Ness, 2017; Nelson and Tovar, 2017). In these cases, NGOs often step in to help generate and deploy context-relevant innovations, e.g., generating new knowledge or providing technical assistance, as in the case of agroecology adoption in Peru (De La Cruz and Dessein, 2021) or organic agriculture in Mexico (Nelson and Tovar, 2017). They can also help organise farmers and communities in cohesive and self-governed networks making autonomous decisions on their food system, or even shift consumers towards consumption of healthy food (Conti et al., 2024b).

Once bottom-up actors demonstrate the versatility of their roles and ability to tackle impending challenges, top-down actors usually become increasingly aware of these movements and start to support and endorse the bottom-up actions as viable for enabling transformation. For example, in India, the government was grappling with sustainability challenges and did not have the financial resources, nor the research capacities needed (again, in terms of funding but also in terms of researchers who could test and help implement different production practices) to implement sustainable agriculture. Thus, an NGO stepped in to equip farmers with knowledge on alternative production methods (Non-Pesticide Management), set-up cooperatives where farmers could control their own collection, processing, storage, distribution and retail facilities (Conti et al., 2024b) and generate consumers’ awareness and establish a certification body for sustainably-produced foods. Over time, the government increasingly endorsed the NGO, that now plays a role as national advisor in sustainability policies both at the regional and national level. Cases in Uganda and Senegal also signal that the government might end up highly relying on NGOs and cooperatives to provide knowledge on sustainability that then informs new political priorities. Simultaneously, to carry out these new priorities, top-down actors might still need the support and action of the NGOs, who are endorsed as versatile, multi-functional agencies providing different services, such as extension services to farmers or acting as certifying agents (e.g. for organic) (Isgren and Ness, 2017; Nelson and Tovar, 2017).

Therefore, advantages of these collaborations go both ways. As in the type of interaction above, political involvement might not be initially desirable for bottom-up actors, but “at the same time it’s necessary” (Nelson and Tovar, 2017) for them to gain more visibility and traction. On the other hand, governments might have preferred to rely on their own research and extension services to implement sustainable agriculture. Yet, they might not have the knowledge or capacities to do so, leaving NGOs to play multiple critical roles in “help[ing] governments in transitioning towards economically viable and ecologically sustainable agriculture” (Conti et al., 2024b). Therefore, once again, collaborations between top-down and bottom-up actors emerge as a need to foster the

quest for sustainable food systems.

4.4. Collaborative Top-Down

The core feature of this dynamic lies in initial top-down interventions that aim to solve certain sustainability related challenges, such as environmental (Moran et al., 2021) and social (Sartison and Artmann, 2020) concerns. In this type of interaction, top-down actors are the ones who direct the change process, through new policies, new research priorities, new investments and funding. However, in all these case studies, public authorities never act completely unilaterally, rather, they ensure alignment with bottom-up priorities.

This alignment can happen more or less spontaneously. For instance, in the city of Izmir, Turkey, the government acknowledged social and environmental struggles and directed municipal funding and investments towards sustainable practices (Özatağan and Karakaya Ayalp, 2021). Efforts from public agencies to establish more sustainable food systems – based on organic production and consumption – were, since their inception, envisioned in a way that involved local communities. These efforts not only promoted the creation of local food production cooperatives and raised awareness for consumers to choose how and what they wished to consume, but also enacted specific laws to maintain local authority on the territory (Özatağan and Karakaya Ayalp, 2021). Sometimes, this involvement came later, as in the Irish case, where only an initial failure in implementing sustainable legislation led top-down actors to set up local services and local advisory (Moran et al., 2021).

As top-down efforts find anchorage and acceptance amongst bottom-up processes, this leads to increased mobilisation, both at the political and legal level (e.g., new sustainability policies) (Bui et al., 2016), and as increasing bottom-up mobilisation, as in the case of Brazil, where initial efforts by the public research institution (EMBRAPA) to take into account farmers’ needs and priorities led to broad technology legitimization and uptake amongst farmers’ communities (Goulet, 2021). In all cases, however, once collaborations were in place only then could concrete progress towards sustainability be achieved (Bui et al., 2016; Sartison and Artmann, 2020).

4.5. Transformation Alliances

Transformation Alliances (n = 9) emerge when challenges are perceived (approximately at the same time) by both top-down and bottom-up actors. Cognisant of the magnitude of the urgency of solving those issues, these actors work together towards sustainability (Sherwood et al., 2016; van den Berg et al., 2018). The key feature of this type of interaction lies in the mutual efforts and responses of both actors – top-down and bottom-up – to work and find solutions together.

For example, in Senegal, the Ecovillage movement for alternative food systems was supported by public authorities’ efforts to ensure Ecovillages can have access to solar power, seeds, infrastructure for irrigation, and technical support (Ilieva and Hernandez, 2018). Top-down actors set certain activities into place, such as research on new technologies and subsidies to ensure uptake (Goulet, 2021). Meanwhile, bottom-up actors generate locally specific knowledge to successfully deploy these technologies, and mobilise a growing number of farmers, communities, or consumers to shift towards greater sustainability. For instance, in Ecuador, it was not sufficient that the government and research organisations develop new knowledge on sustainable production methods – it was equally necessary that these methods were tested and refined locally (Sherwood et al., 2016). Over time, this process leads to increasingly joint priority setting, where top-down actions for sustainability are informed by bottom-up needs and vice versa. Policy changes, thus, become desired and championed by policymakers and activists alike (Ilieva and Hernandez, 2018). In the case of New York City, the success of community efforts to preserve urban gardens and implement urban agriculture was “attributable to the timely and effective reframing of the key issue at stake and [...] on the

mayoral agenda” (Ilieva and Hernandez, 2018).

Witnessing increasingly complementary roles, this type of interaction opens the way for increased trust and coordinated actions towards shared goals, and often leads to the establishment of much more democratic and inclusive governance structures. Over time, this creates a favourable cycle of “positive reinforcement” and continuous improvement for a new (sustainable) food system, progressively supported through intertwined top-down and bottom-up processes.

5. Discussion

5.1. A new heuristic of transformation processes

This systematic review reveals that food system transformation processes can be initiated, and unfold, in many ways. Above, we identified several types of interactions describing different initial circumstances, roles and responses for a variety of top-down and bottom-up processes. We showed how transformation processes may begin as independent efforts to address community-specific sustainability issues (as seen in the Autonomous Bottom-Up pattern) or be driven by top-down actors seeking solutions to broad societal challenges (as in the community-engaged top-down type). Often, the level at which the issue is perceived (for example; very locally versus nationally) determines which actors respond and how. When the issue is very prominent locally (Ravazzoli et al., 2019), the challenge is frequently tackled by bottom-up actors. On the contrary, top-down can have a more proactive role and deploy financial and political means to address the problem when perceived as a regional or national priority (Sartison and Artmann, 2020). From this, a variety of responses, and ensuing developments can be identified, exemplified through the different patterns of interactions. This is a particularly important finding in light of the relative rigidity of many transformation frameworks that might overlook different patterns of interactions evolving over time. Food system transformation frameworks may invertedly create a bias towards certain (bottom-up or

top-down) processes and their inherent value (McKercher and Moyle, 2025). In particular, until now, studies examining top-down led efforts might have failed to fully appreciate possible emerging efforts of local actors for sustainability (Moran et al., 2021). In contrast, studies examining more bottom-up processes (many of which, in our selected publications, drawing on the MLP framework) might have solely focused on the merits of local actions for achieving change, and in doing so might have failed to give due credit to public agencies undertakings for sustainability (for example; R&D, funding).

This systematic review has shed light on the inadequacy of using either bottom-up or top-down processes (and supporting narratives) alone to achieve transformation. This finding contrasts with a number of the polarised positions propagated in some of the literature (Stone et al., 2024). Certainly, cases such as the Autonomous Bottom-Up type, do show that locally, independent and community responses can successfully solve certain local-scale challenges. However, what all the types of interactions illustrate is that the hybrid and complementary engagement (either earlier or later on) of both actors in the process is crucial for transformation and appears to be an essential ingredient in achieving system level changes. Even in cases where bottom-up actors have an essential role to play – for example, favouring the uptake of new practices, mobilising local communities, forming networks, and even substituting for the state in proving services – without a top-down endorsement of some kind, these effort on their own are insufficient to yield system-level changes. Similarly, top-down actors can try to implement critical actions for transformation, but without a strong bottom-up backing, policies and interventions may fail to enrol the broader participation needed for transformation.

The review demonstrates that no actor has the capabilities, alone, to orchestrate all the interconnected changes - in technologies, infrastructure, policies, patterns of behaviours and others (Conti et al., 2021)– needed for transformation. The case studies do not showcase a “completed” transformation as food systems have no final destination and are in a continuous process of evolution and transformation (Conti,

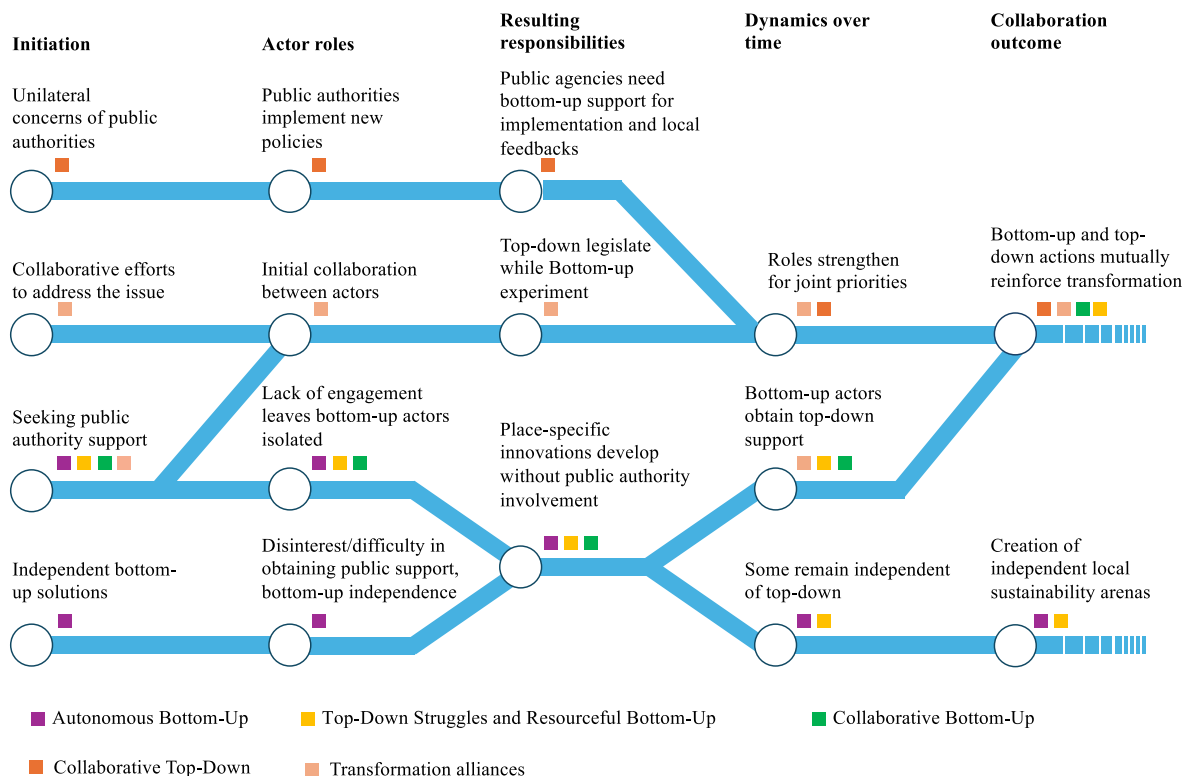


Fig. 4. A new heuristic of how transformation processes commence, the initial responses and actor roles. Independent of whether challenges emerge within or beyond the community, the transformation could unfold following multiple paths as represented in the figure.

2023; Hall and Clark, 2010; Mausch et al., 2024). However, they do report system changes and a shift towards a more sustainable direction of food system development. The cases also indicate that this shift could not be designed or implemented unilaterally by a single set of actors (whether top-down or bottom-up).

This finding, while dismantling some existing dichotomies in the literature as already described above, also helps consolidate a number of existing lines of argument in the broader literature. For instance, the innovation system literature suggests that transformation involves “numerous alliances” amongst different stakeholders to integrate institutional and technological dimensions of the system innovation process need for transformation to occur (Hall and Dijkman, 2019). Relatedly, literature on mission-oriented innovation systems stresses the need to engage diverse actor groups across governance levels in setting the directionality of transformative change (Janssen et al., 2021; Klerkx and Begemann, 2020). The food system governance literature emphasizes the need for much more proactively fostering linkages between communities, policymakers and academics as indispensable element for (food) system change (Hammelman et al., 2020; Tschersich and Kok, 2022). Studies on the political economy of food systems have equally identified a need for more collaborative approaches to disrupt dominant foodscapes (Harris et al., 2019; Leach et al., 2007). Similarly, political ecology and food system justice debates have highlighted the need for equitable and democratic dialogue (Kaljonen et al., 2024; Moore and Milkoreit, 2020), for instance implementing more learning-based and synergistic efforts towards transformation, advocating for more “horizontal” collaboration between top-down and bottom-up actors (Anderson et al., 2019; León-Bravo et al., 2017).

Thus, the need for more collaborative democratic and multi-actor processes to deliver sustainability is not new. However, this systematic review consolidates this finding and moves it a step further by providing a heuristic that enables a much deeper, if still schematic, understanding of transformation actors and interactions (Fig. 4). This heuristic captures the variety (i.e., types) and the hybridity (i.e., evolving and the different interactions) of transformation processes, showing different “paths” that the transformation process can take based on initial circumstances, responses and roles. This heuristic, while not to be considered a monolithic and universally true representation of all possible interactions and outcomes of top-down and bottom-up processes in transformation, is however a useful representation of different and evolving transformation pathways.

Constructing this new heuristic is not simply a conceptual exercise. Instead, the heuristic itself could help inform and guide insights and decisions in empirical transformation processes. By looking at real-world and ongoing transformation processes through the lens of the types of interactions, more informed decisions could be made in terms of which actors can do what and when more effectively. For example, recognising that some issues are very local and can be better tackled by communities themselves, public funding can be targeted and directed towards building independent sustainability arenas that can quickly and with relatively less resource deal with impending problems. In other cases, top-down action may be impossible because of lack of resources, so attention could instead be focused on promoting and supporting (for example, through political endorsement) the action of a local NGO. Reflecting on possible and “most viable” paths for transformation can help think through possible actions that facilitate and accelerate these different transformation paths.

5.2. From a debate about roles and collaboration to a debate about context-relevant transformation functions

Another until-now ambiguous aspect of transformation processes, already highlighted in the introduction, is a tension in terms of actors’ roles and responsibilities for achieving transformation. The review not only reveals that actors often have complementary or hybrid roles for achieving transformation. It also reveals that some (either top-down or

bottom-up) actors tend to play certain roles. Some roles can be played by either top-down or bottom-up (for example, knowledge generation) and certain roles can only be played jointly.

As illustrated in the different types of interactions, bottom-up actors usually assume the role of generating and experimenting with locally adapted innovations. This often happens relatively quickly when a sustainability issue emerges, as compared to possible actions from top-down actors. Even if these actions can be equally prompt (as in the transformation alliance case) they might take a slightly longer timespan to take effect – for example, even if funding for R&D is unlocked, developing new and relevant technologies might still take time. Besides, in almost all case studies, bottom-up actors have shown their comparative advantage in building local trust and forming networks that facilitate the mobilisation of farmers, consumers, and communities more broadly, towards new patterns in production, not only locally, but also regionally and nationally (Alberio and Moralli, 2021; Hatanaka, 2020; Isgren and Ness, 2017).

Top-down actors perform a different set of equally important roles, including de-risking experiments, for instance setting subsidies in place for farmers to switch to different practices, or designing a mechanism that protect producers from possibly volatile or competitive markets (Rover et al., 2016). They can also facilitate access to new technologies, and provide funding for these new technologies to be developed or refined through formal R&D (often informed by locally acquired knowledge (Goulet, 2021)). Public funding can also be provided directly to local initiatives to support the experimentation process (Ravazzoli et al., 2019). All these actions are, as shown in many case studies, essential to ensure transformation processes can successfully endure.

Finally, certain roles require top-down and bottom-up actors to work together. For example, top-down actors can help champion policy and institutional change (Sartison and Artmann, 2020), but such policy change is usually more effective when accompanied by equal support from bottom-up actors (Moran et al., 2021). Simultaneously, setting joint priorities (this can be both in terms of policy priorities, but also in terms of action priorities) requires a top-down willingness to draw from local knowledge, and bottom-up trust in the role of public agencies to deliver the public good. In some instances, convening collaborations is done more bottom-up (for example, in the case of Collaborative Bottom-Up), whereas in other instances these collaborations are initiated top-down (as in the Collaborative Top-Down case). However, regardless of who initiates the collaboration, a willingness from both sides is needed to see it to fruition.

Emerging from our analysis of the respective roles of top-down and bottom-up actors are glimpses of system functions or capabilities that are essential to different stages of the transformation process, and which transcend the actions and roles of individual actors. Whereas the idea of roles explored in this paper refers to the different behaviours and responsibilities that actors have in transformation, the idea of functions shifts the focus to the broader system capabilities that need to be in place to enable systemic changes in food systems. This aligns with the recent calls to focus on the knowledge and capabilities needed to achieve food system transformation (Oliver et al., 2021), including the need to put in place institutional arrangements that support system reflexivity (Mausch et al., 2024) and system scale direction setting (Hall and Dijkman, 2019; Herrero et al., 2020). Here, these can be thought of as “transformation functions” of a food system and are analogous to the concept of functions of an innovation system as emergent capabilities of the system rather than individual roles or activities (Hekkert et al., 2007).

Some of these transformation functions may well fall along traditional role demarcation, such as the top-down function of setting appropriate regulations and policies (Béné and Abdulai, 2024) or the bottom-up function of filling the vacuum left by ineffective state action (Rossi, 2017). Knowledge creation can be performed by formal R&D process but equally valuable knowledge generation can be performed by bottom-up actors (Lacoste et al., 2021; Reid et al., 2021). However, on

closer inspection, who or how these functions are fulfilled seems less important. Instead, ensuring that a particular function or multiple functions are in place to enable transformation processes seems much more pivotal. For example, a function of setting national directions for food system transformation can be achieved through a variety of top-down and bottom-up configurations and supporting institutional arrangements. A function of developing learning and trust networks across the food system could be initiated in a variety of ways depending on an array of contextual factors. Either way, our case studies suggest that both functions need to be in place to make progress towards food system transformation.

Exhaustively identifying and defining what these transformation functions might be is beyond the current analysis, but, clearly, this could be a significant new avenue of research. However, two aspects stand out. Firstly, focusing on functions allows an agnostic position to be taken on how and by whom these functions are enacted. This helps avoid the pitfalls of ideologically framed debates on the respective role of top-down and bottom-up actors (El Bilali, 2019; Stone et al., 2024). Secondly, our cases that display close alignment between top-down and bottom-up processes and actors seem to suggest that a synchronising function is at play that enables joint priority setting, planning, investment and action. As it has been found in the innovation studies literature in relation to brokering and coordination function (Klerkx et al., 2009), the apparent need for a synchronising function raises similar questions around the costs and responsibilities for ensuring that this function is in place. It is not possible to explore here the range and nature of transformation functions and how they are enacted, but it is clearly a critical enabler of systemic change processes and as such worthy of much deeper investigation.

6. Conclusions: synchronising processes and functions - where do we go from here?

The review has shed light on the processes initiating and intertwining in transformation, the roles of different actors in these processes, and the types of interactions of different top-down and bottom-up interactions can be drawn. We propose a new heuristic that could help navigate different transformation paths in a way that is appropriate for different initial and emerging circumstances. The discussion around the actor roles instead demands a shift of attention towards the idea of transformation functions. Moreover, if synchronisation is indeed a critical transformation function as our case studies and other recent studies (Conti et al., 2021, 2024a) suggest, how can this be enacted? What are the costs, capabilities, responsibilities and organisational configurations needed to perform this? And how does the synchronising function interact with other transformation functions? Answering these questions could go a long way in helping define the suites of actions needed to strengthen the system capabilities needed to accelerate food system transformation.

CRedit authorship contribution statement

Costanza Conti: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Andy Hall:** Writing – review & editing, Writing – original draft, Supervision, Formal analysis, Data curation, Conceptualization. **Enayat A. Moallemi:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Data curation. **Amar Laila:** Writing – review & editing, Validation. **Christophe Bene:** Writing – review & editing, Formal analysis. **Jessica Fanzo:** Writing – review & editing, Supervision. **Matthew Ford Gibson:** Writing – review & editing, Visualization, Methodology. **Line Gordon:** Supervision, Project administration, Funding acquisition. **Christina Hicks:** Writing – review & editing, Supervision. **Kristiaan Kok:** Writing – review & editing, Writing – original draft. **Nitya Rao:** Writing – review & editing, Supervision. **Ramanan Laxminarayan:** Writing – review & editing,

Conceptualization. **Daniel Mason-D’Croz:** Writing – review & editing, Supervision.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT in order to spell-check some parts of the manuscript. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.gfs.2025.100833>.

Data availability

No data was used for the research described in the article.

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