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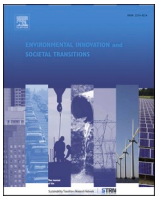

Research article

Configurations of leverage points for the deliberate acceleration of ideal-type transition pathways in the EU food system

Tom Kiel [a,*], Jeroen J.L. Candel [a], Erik Mathijs [b], Robbert Biesbroek [a]

[a] Wageningen University & Research (WUR), the Netherlands
[b] Department of Earth and Environmental Sciences, Katholieke Universiteit Leuven (KU Leuven), Belgium

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ABSTRACT

The complexity of the EU food system poses a significant challenge to the transition towards sustainable and healthy food consumption, as interdependent factors reproduce stable social structures that resist change. The concept of leverage points (LPs) helps identify strategic intervention points to stimulate system change. However, focusing on individual LPs often entails trade-offs between transformative feasibility and depth. Moreover, existing LP approaches tend to overlook the long-term co-evolution of interrelated social structures. To address this gap, we connect LP categories to mechanisms that accelerate progress along four transition pathways that predict potential future dynamics. We apply this synthesized framework to expert focus group data, demonstrating how specific LP configurations can deliberately accelerate system transitions. Taking innovations as entry points, we identify LP configurations that support the upscaling and spreading of these innovations throughout the system. Our findings suggest that blending deep and shallow LPs may help to overcome system inertia. Nonetheless, multiple, co-existing transition pathways across diverse subsystems may be required to fully confront the scale and urgency of sustainability and health challenges in the EU food system.

1. Introduction

The EU food system faces severe sustainability and health problems such as ecosystem collapse, soil degradation, freshwater scarcity and pollution, and rising obesity (Dudley and Alexander, 2017; EEA, 2018; Gianoli et al., 2023; McCallum, 2015; Rosengren, 2021). Overcoming these challenges is difficult because the system is governed through a regime that aims to maintain the current structure and associated lock-ins (Klitkou et al., 2015). The core structure of the food system consists of production, processing, distribution, retailing, and consumption of food, and these components are influenced by a complex set of external factors (HLPE, 2017). Despite changing circumstances, interlinkages within and between the core components render a robust system (Rotz and Fraser, 2015). This robustness stems from sunk costs, vested interests, institutionalized rules and standards, and entrenched mindsets or paradigms, which create dependencies that underpin resistance to change (Geels, 2010, 2014).

A large variety of innovations exist that offer technologies, alternative ways of interacting, or new mindsets or paradigms to support a sustainable and healthy food system transition. Despite this abundance of available innovations (El Bilali, 2018), regime resistance hampers their upscaling or wider adoption (Béné, 2022; Jager et al., 2022). To address this, governments may attempt to remove

* Corresponding author at: Hollandseweg 1, 6706KN, Wageningen, the Netherlands.
E-mail addresses: tom.kiel@wur.nl (T. Kiel), Jeroen.candel@wur.nl (J.J.L. Candel), Erik.mathijs@kuleuven.be (E. Mathijs), Robbert.Biesbroek@wur.nl (R. Biesbroek).

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barriers or implement incentives to accelerate the upscaling or diffusion of innovations (Herrero et al., 2020; Schagen et al., 2022). How to realize this transition, however, remains an ongoing topic of scholarly debate.

Scholars have pointed to a wide variety of leverage points to effectively change the food system (Dorninger et al., 2020). Leverage points (LPs) are strategic intervention points in complex systems where a modification can have a large effect on the system's functioning (Meadows, 2009). Research on LPs has led to diverse recommendations for policy interventions in food system domains, such as agriculture (Gil et al., 2022; Pérez-Ramírez et al., 2021), healthcare (Bolton et al., 2022), policy-making (Bryant and Thomson, 2020), industry (Strube, 2019), markets (Schanz et al., 2019), and finance (Jouffray et al., 2019). However, a shortcoming of the LP framework is that it does not provide the means to develop a long-term plan of how LPs may be addressed in combination (Magliocca et al., 2025). This lack of long-term focus may be problematic, as targeting a single LP risks either making only a limited contribution to a transition (Abson et al., 2017; Dorninger et al., 2020), or encountering backlash and lock-ins because the modification does not align with the broader institutional landscape (Herrero et al., 2021).

To fill this gap, this paper aims to answer the following research question: *How can configurations of leverage points deliberately accelerate ideal-type transition pathways towards sustainable and healthy outcomes in the EU food system?* To address this question, the study synthesizes the LP framework with ideal-type transition pathways to show how LP configurations can deliberately accelerate transitions. First, the dynamics of four ideal-type transition pathways are derived from exemplifying cases in the scientific literature. Second, the relevance of LP categories to transition pathways is shown by linking the frameworks based on their depth of restructuring. The framework thus demonstrates how leverage points may deliberately accelerate a transition by upscaling or spreading innovations. Third, the analysis illustrates the induction of LP configurations in the EU food system based on focus group data.

2. Relevance of leverage points to accelerate ideal-type transition pathways

To deliberately accelerate structural change towards sustainable and healthy outcomes, transition managers first need to pinpoint places in the system that enable system change. This is achieved through the leverage point framework, which identifies effective places for policy intervention in complex systems. Triggering LPs may create ripple effects throughout the system, and when multiple LPs are related, their knock-on effects may generate momentum in a particular direction (Leventon et al., 2021). This momentum may be utilized to accelerate transition pathways. Such acceleration can occur through four mechanisms: (1) by removing barriers (Whitney et al., 2020), (2) activating reinforcing feedbacks (Geels and Ayoub, 2023), (3) enabling shifts in social structures (Scharmer, 2009), or (4) renewing meaning-making structures (Evans et al., 2024). By targeting policies at LPs that relate to such mechanisms, LPs become actionable stepping stones of transition pathways, accelerating the pace of structural changes that occur in regimes by each step (Alem Fonseca et al., 2024; Roberts and Geels, 2019).

LPs can be linked to the mechanisms of deliberate acceleration through four LP categories: (1) *Parameters*, (2) *Feedbacks*, (3) *Design*, and (4) *Intent* (Abson et al., 2017). The first LP category, *Parameters*, can be used to remove barriers by pointing towards quantifiable and tangible parts of the system, such as subsidies, taxes, standards, and buffer sizes (Brock, 2023; Meadows, 2009). *Feedbacks*, such as delays and the strength of feedback loops, may unlock reinforcing mechanisms that speed up transition pathways. The LP category *Design* points to places in the system that shape access to information, system rules, and the actors who can modify them. The LP category *Intent* encompasses goals, values, and paradigms that determine how people make sense of their environments.

The four LP categories range from shallow to deep, going from shallow barriers to deep meaning-making structures. Depth refers to

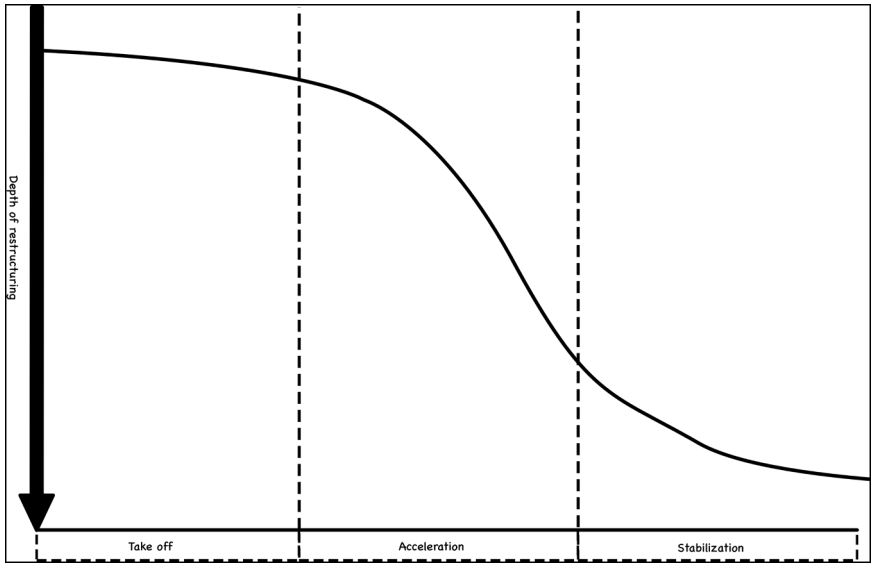

Fig. 1. Three phases of a transition (based on Rotmans, 2021).

profoundness of effects when change occurs in a LP category. Deep LPs shape social processes by influencing how people perceive and respond to external stimuli (Gaziulusoy et al., 2021). As a result, modifications in deep LPs may have system-wide effects. However, such profound change is difficult to achieve precisely because it has far-reaching implications. In contrast, shallow LPs are easier to trigger, as they pertain to tangible aspects of the system. Yet, their effectiveness may be limited since shallow LPs are more narrowly focused on specific system components. This creates trade-offs between depth, feasibility, and impact of particular LPs, which may be resolved by addressing related LPs in configurations that trigger knock-on effects.

To hypothesize how long-term structural changes in regimes may occur, transition scholars often apply the multi-level perspective (MLP). This theory describes how innovations and external pressures challenge incumbents to adopt new ways of interacting. Typically, innovations that successfully challenge regimes involve technologies alongside the institutions that govern them (Geels, 2005). In this paper, we adopt a broader view on innovations, including meaning-making structures such as philosophies, mindsets, or values that may or may not be embedded in institutions (cf. Geels, 2019). Innovations provide alternative ways of functioning within the regime, but before they can be upscaled or spread, they must be sufficiently developed to gain legitimacy (Geels and Schot, 2007; Kanger, 2021). For this, an innovation must meet two key development criteria: it must demonstrate effectiveness in improving a certain functionality through experimentation, and small-scale examples must establish its social and economic viability (Christensen, 1997). Once these conditions are met, the innovation becomes an attractive alternative for regime actors (Roberts and Geels, 2019), who may then initiate structural changes to accommodate it, thereby accelerating a transition (Herrero et al., 2020).

The term ‘transition’ is understood as “a structural change in a societal (sub)system that is the result of a co-evolution of economic, cultural, technological, ecological and institutional developments at different scale levels” (Rotmans, 2008). A transition pathway refers to the trajectory of moving from one stable system configuration to another, over a period of approximately 25-60 years (Kanger and Schot, 2019; Rotmans et al., 2001). Transition pathways unfold in three phases that are depicted in Fig. 1 (Rotmans, 2021), where depth refers to the extent of restructuring in regimes (Schot and Kanger, 2018). Before the first phase starts, the system is in a state of dynamic equilibrium in which social structures remain relatively stable, despite increasing environmental or health problems and the development of potentially viable innovations (Rotmans et al., 2001; Wiskerke, 2004). Structural changes in the EU food system may gain momentum when regime pressures intensify, leading actors to seek out innovations (Scharnigg, 2024). This first phase, take-off, is characterized by experimentation among regime actors, who learn from small-scale examples of successful innovations (Roberts and Geels, 2019). Once innovations demonstrate economic and social viability, more regime actors adopt them, triggering the acceleration phase. During the acceleration phase, innovations are scaled and diffused. The increasing institutionalization of innovations by incumbents then leads to the stabilization phase, as new interlinkages re-establish a dynamic equilibrium (Rotmans et al., 2001; Schagen et al., 2022).

Although Fig. 1 may suggest that a transition follows a smooth trajectory, in reality transitions exhibit chaotic patterns (Rotmans, 2021). The process of upscaling or spreading an innovation is often accompanied by setbacks, lock-ins, or backlashes as the innovation challenges social structures (Allen and Malekpour, 2023). Transition scholars argue that these disruptions can be mitigated through the careful and timely implementation of policy interventions (Kemp et al., 2009; Meadowcroft, 2009; Roberts and Geels, 2019; Roberts et al., 2018). Policy-makers are key actors in steering transition trajectories, as governments and legislatures possess the authority to establish conditions and constraints for behavior, regulate resource distribution, or enforce modifications in institutions (Knill and Tosun, 2012). Though policy-makers may need the help of transition scholars to find optimal conditions for such policy interventions.

In this paper, we aim to identify key policy intervention points by distinguishing between four ideal-type transition pathways. These four transition pathways are ranked from shallow to deep: (1) Technological substitution pathway, (2) Transformation pathway, (3) Reconfiguration pathway, and (4) De-alignment and Re-alignment pathway (Geels and Schot, 2007). Each pathway follows distinct dynamics and outcomes, which are shaped by the characteristics of innovations. Some innovations necessitate the deliberate restructuring of deep, system-wide structures, whereas others can be more easily upscaled or spread. Fully developed innovations that do not conflict with the deeper structures of the system lead to shallower transition pathways. By contrast, deeper transition pathways arise from innovations that challenge deeper parts of the system. This creates the need to radically alter meaning-making structures that shape how people interpret and respond to external stimuli (Kanger and Schot, 2019). Due to the far-reaching implications of deep restructuring, deeper transition pathways are both more difficult to accelerate and slower to complete (Schot and Kanger, 2018; Termeer et al., 2017; Termeer et al., 2024).

Because ideal-type transition pathways are distinguished by the depth of deliberate restructuration they require, we can compare them to the depth of LP categories. This comparison allows us to determine the relevance of LP categories for each ideal-type transition pathway (see Table 1). The next section examines four ideal-type transition pathways from the scientific literature to establish their

Table 1
Relevance of leverage point categories for ideal-type transition pathways.

Ideal-type typology	Innovation characteristics	Parameters	Feedbacks	Design	Intent
Technological substitution pathway	Sufficiently developed	++	+	-	-
Transformation pathway	Under developed	+	+	+	-
Reconfiguration pathway	Multiple sufficiently developed innovations	+	+	++	-
De-alignment and re-alignment pathway	Multiple sufficiently developed innovations	+	+	++	+

++ Relevant LP category with extensive restructuring necessary.
+ Relevant LP category.
- Irrelevant LP category.

relevance to LP categories.

2.1. Technological substitution pathway

Fully developed innovations can provide a quick and effective replacement for practices that cause sustainability or health problems. When an innovation aligns with the deeper structures of the regime, the regime may integrate the innovation as a means of self-preservation. To accommodate the innovation, some adjustments in standards, subsidies, or material flows will be necessary, which corresponds to modifications at the level of *Parameters*. To accommodate the innovation, more and more resources are directed, which creates a reinforcing *Feedback*. However, deeper LPs are not triggered, as the innovation does not disrupt the regime's foundational structures and the regime is geared towards stability. Therefore, the LP categories *Parameters* and *Feedback* are relevant to a technological substitution pathway but not *Design* or *Intent*.

An exemplifying case of the technological substitution pathway occurred with the replacement of chlorofluorocarbons (CFCs) when they were found to be damaging to the ozone layer (Mäder et al., 2010). Since CFCs were readily replaceable with less harmful chemicals, hydrofluorocarbons (HFCs), the regime swiftly adapted by allocating increasing resources to the innovation. The Montreal Protocol was established to phase out CFCs and promote the adoption of HFCs (UNEP, 1987). Throughout this transition, the regime maintained its core functions, continuing to produce and distribute refrigerators and hairsprays, while integrating HFCs into their products (Zhao, 1999). Because only minimal structural reforms were required, this resulted in a shallow transition pathway, relying primarily on adjustments to standards, subsidies, and material flows to enable a rapid transition (Gareau, 2010). This case thus demonstrates how the technological substitution pathway preserves deeper structures while facilitating change through relatively superficial modifications.

2.2. Transformation pathway

In the transformation pathway, the regime lacks sufficiently developed innovations. In response to sustainability challenges, the regime invests in research and development to advance an innovation (Geels and Schot, 2007). This process begins with the co-evolution of restructured information flows, and experimentation, which requires subsidies for development and the reallocation of material flows. Thus, *Parameters* and *Design* serve as critical LP categories in the early stages of a transformation pathway to support innovation development.

Once the innovation proves effective and viable in small-scale experiments, a learning process unfolds, leading more regime actors to shift their focus towards the innovation. Regime actors intensify investments to remain competitive, thereby reinforcing *Feedbacks*. As the innovation gains traction, it increasingly challenges existing standards, prompting regime actors to exert both structural and discursive power to control access to the innovation (Roberts, 2017). This necessitates modifications in system *Design*, though power struggles may emerge over who controls these changes. These struggles can result in either backlash and lock-ins or in the successful upscaling and spreading of the innovation. In the latter case, *Parameters* are triggered again to institutionalize the innovation, marking the transition's stabilization phase. This makes *Parameters, Feedbacks* and *Design* relevant LP categories for a transformation pathway.

The transformation pathway is exemplified by the Dutch horticulture transition (Berkers, 2011; Geels et al., 2016). In response to global challenges such as population growth and globalizing markets, regime actors proactively adopted new technologies to remain competitive, including grow lamps and heating, controlled watering, and optimized fertilization. These technological innovations required adaptations in rules and institutions to manage production and farm operations, replacing traditional knowledge about seasonal influences on agricultural output. This required modifications in system *Design*, but only to the extent that supported the economic interests of regime actors.

2.3. Reconfiguration pathway

In a reconfiguration pathway, multiple symbiotic innovations are already fully developed. The regime does not need to invest in R&D, but faces challenges integrating these innovations due to conflicts with existing rules, information flows, or power structures. In response, the regime seeks to remove barriers and gradually adopts multiple innovations as add-ons to the existing system. As these innovations gain traction, they alter the regime's *Design* by restructuring information flows, shifting incentives structures, or becoming more autonomous with the ability to self-organize (Geels, 2002).

Policy interventions can play a crucial role in breaking down these barriers within the system's *Design*. Changes in *Design* affect *Feedbacks*, which may reshape the competitive landscape if innovations successfully eliminate barriers to growth or secure resources that facilitate their spreading and upscaling. When an innovation effectively supplements the regime, it becomes institutionalized through production standards and the establishment of stable material flows. This marks the transition's stabilization phase, triggered through modifications in *Parameters*. Thus, in a reconfiguration pathway, three categories of leverage points are relevant: *Design, Feedbacks*, and *Parameters*.

The low-carbon transition of passenger mobility in Great Britain between 1990-2016 is an exemplifying case of a reconfiguration pathway (Geels, 2018). Innovations included railway travel, electric cars, cycling, and buses. In the automobile sector, design barriers such as the availability of electric car charging points were eliminated through policy interventions. The *Intent* of the system remained intact, as travelling by car remained the norm for most citizens. In sectors where systemic *Intent* proved a barrier for change, such as cycling, a transition did not occur because citizens maintained a mindset that cycling is not a viable alternative for commuting (Geels, 2018). Railway travel increased in response to urbanization, despite policy-makers refusing to address *Design* barriers and instead

focusing on only shallow subsidies. The railway regime remained relatively intact, whereas the automobile sector was incrementally restructured.

2.4. De-alignment and re-alignment pathway

The De-alignment and Re-alignment pathway occurs in response to multiple pressures on the regime, when incumbents start experimenting with multiple developed innovations. Regime actors search for new alliances and supportive meaning-making structures. This requires modifications in *Intent*, as regime actors need new ways of thinking and valuing. Experiments with multiple innovations take off, each challenging the *Design* of the current regime. A struggle to become dominant arises. The innovation that is most successful in attracting growth-promoting resources is upscaled or spread quicker, thereby triggering *Feedbacks* in the system. One innovation thereby becomes dominant and starts to consolidate a new order through the gradual institutionalization of *Parameters*. As such, the De-alignment and Re-alignment pathway is the deepest pathway; requiring restructuring in all four LP categories.

The transition in the electricity sector showcases a de-alignment and re-alignment pathway (Verbong and Geels, 2008; Verbong and Geels, 2010). As oil prices continue to climb, regime actors lose faith in fossil fuels for generating electrical energy. New goals of the energy industry include sustainability, which start to influence most of the regime's structures. A variety of alternatives start competing for dominance: solar, wind, nuclear. A characteristic of these technologies is that electricity is produced in a more decentralized way, which causes large shifts in *Design* such as incentives for stakeholders in the system, as well as in the power to self-organize the system. Solar energy succeeds in attracting resources because it can be more easily implemented than other innovations, and thereby gains traction quickly by triggering *Feedbacks* that drive the acceleration phase. *Parameters* of the system change accordingly because new materials are necessary for producing electricity, which also creates new structures within the regime such as production standards, investments, and subsidies granted by the government.

3. Methods

To pinpoint LPs, we built on previous work (Mathijs et al., 2025), where EU food subsystem maps were constructed that show interrelations between diverse components of the system (see supplementary materials). Because the dynamic equilibrium of regimes is rendered through reinforcing and balancing feedback loops (Capra and Luigi-Luisi, 2014), we conducted a soft systems analysis to showcase interrelations through causal loop diagrams (CLDs). The EU food system map was constructed following an abductive research design (Mathijs et al., 2025). Macro-level drivers of the EU food system were explored using a combination of literature review, theoretical reasoning, and validation through expert interviews, and were ultimately displayed through the software Kumu. The construction of CLDs involved qualitative mapping of complex drivers in five subsystems: production systems, storage & distribution, retail & markets, processing & packaging, and overarching trends (HLPE, 2017). This was done through a targeted literature review focused on 21 trends in macro-level drivers of the food value chain. This included both system-wide trends, such as scale increase and market concentration, as well as subsystem-specific trends, such as the emergence of new business models, land abandonment and alternative agricultural systems. The resulting 353 feedbacks between drivers were depicted in an EU food system map. A total of 15 expert interviews were conducted with experts from four subsystems. In a next step, we comprised this complex food system representation into five separate EU food subsystem maps: health, environment, political-economic, innovation & infrastructure, and socio-cultural (HLPE, 2017). Each subsystem map depicted a complexity of drivers linked to the core components of the system. The core of the system was the same for each subsystem and consisted of input systems, production systems, processing & packaging, storage & distribution, retail & markets, and final consumption (Lawrence et al., 2015). A summary of the findings can be found in the supplementary materials.

In this study, we use these EU food systems maps as input for identifying configurations of LP to deliberately accelerate ideal-type transition pathways. This comprised the first of five research steps, which we have outlined in Fig. 2. The second step comprised data collection in five focus groups, to which a diverse range of experts was invited. Each focus group was moderated by at least two of the authors, so as to ensure balanced discussions. The experts were selected based on their relevant expertise and their work experience for either the European Commission, a European research institute focused on food systems, a food and beverage producer, or an NGO involved in sustainability or health-related topics in the EU food system. This resulted in 5-10 participants per focus group, each of which focused on one subsystem map. Participants of the focus groups were instructed to advise on promising innovations and pinpoint leverage points that could help upscale or spread these.

The focus groups comprised a two-hour program in which participants were gradually guided through a range of exercises. Moderators started the focus group with a presentation that explained the EU food subsystem map and outlined the following steps. Experts were asked to familiarize themselves with the map, and validated it through a plenary discussion. Participants subsequently brainstormed about potential innovations that may improve outcomes in the EU food system. The innovations were ranked based on feasibility and depth with red and blue pens. Each participant could cast six votes in total, three for feasibility, and three for depth. The innovation with the most votes was selected for further inquiry (see Appendix A). Then, participants were asked what system elements may be changed in an effort to upscale or spread the selected innovation through the subsystem. This resulted in a brainstorming session in which a longlist of proposed LPs was made, to help trigger a transition to a healthy and sustainable EU food system (see supplementary materials). Finally, each focus group concluded with the selection of one recommended leverage point per participant, based on feasibility, depth, and impact. This resulted in a shortlist of recommended LPs.

The focus groups were audio and video recorded and automatically transcribed through Microsoft Teams. Qualitative data were collected by photographing written materials after each session. Photographed materials included validated subsystem maps,

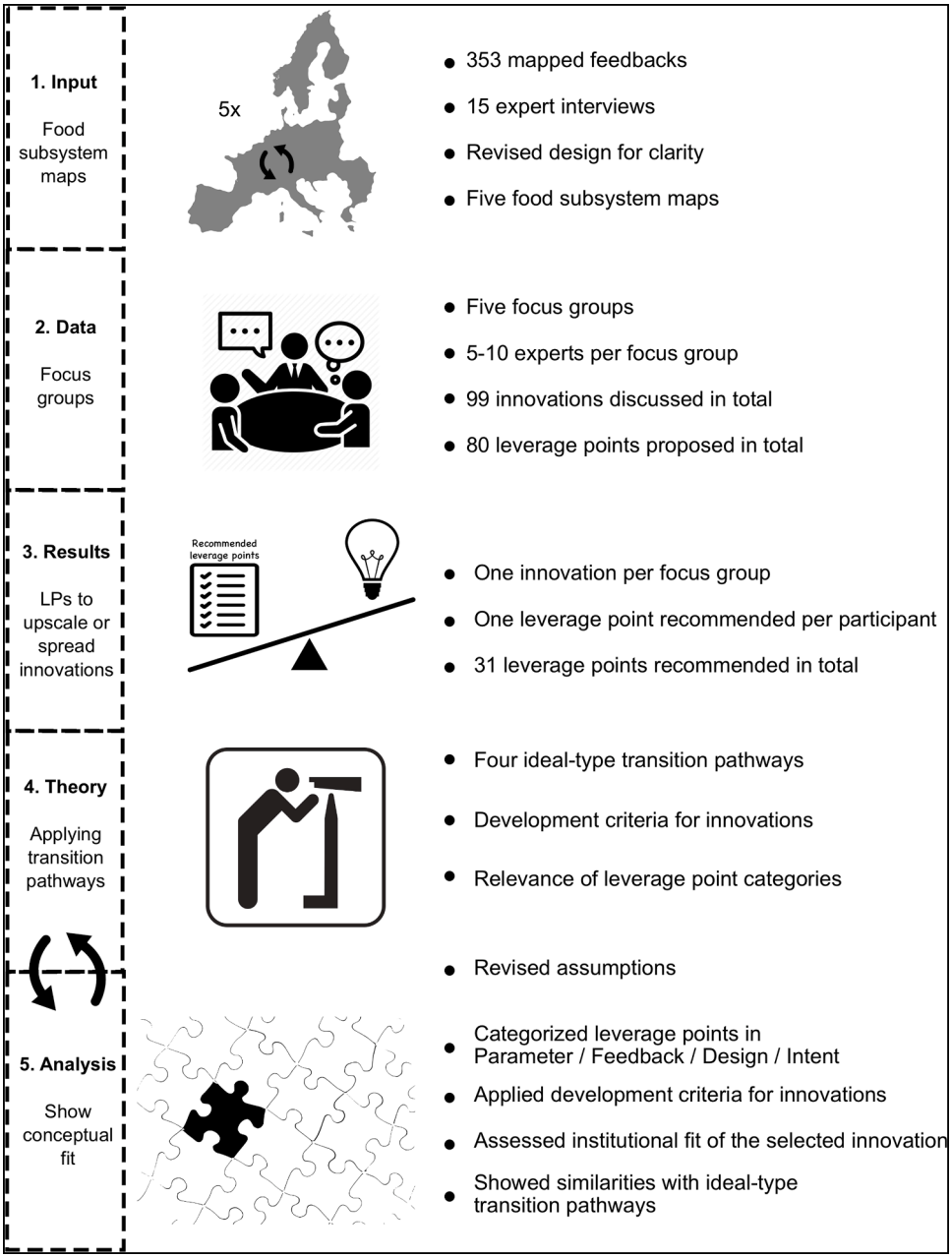

Fig. 2. Visualization of methods.[1]

[1] Icons of Fig. 2 were illustrated by Illustrade (Pixabay), Icon Library, The Noun Project, Steamline, OpenIcons, and Willi Heidelbach, who provided those under Creative Commons License.

discussed innovations, proposed LPs, and recommended LPs. These materials were pseudonymized and safely stored before analysis. Some of the LPs were renamed during the analysis to better suit participants' descriptions during the focus groups.

The focus group materials were analyzed by first drafting a description of the recommended innovation from each focus group. An assessment of the recommended innovation was done through two development criteria for innovations: (1) proven effectiveness, and (2) small-scale examples demonstrating social and economic viability. A hermeneutical approach was chosen to determine the institutional fit of recommended innovations (Thompson, 1997; Stewart and Shamdasani, 2015), which was triangulated through a check in the scientific literature. The innovations were thereby categorized as 'sufficiently developed' or 'not yet sufficiently developed' to inform the conceptual fit of ideal-type transition pathways.

Table 2
LP configuration to accelerate a transformation pathway by upscaling and spreading true cost accounting (TCA).

#	Category	Leverage point	Description
1	Parameter	Consumer Wealth	*Making sure that people can afford true costs of foods*
2	Parameter	Input System Wealth	*Increase taxes on products such as pesticides*
3	Parameter	Processing & Packaging Wealth	*Covering costs of making sustainable and healthy foods palatable*
4	Feedback	Policies Production Systems	*Phasing out environmentally harmful subsidies*
5	Design	Health Policies	*Policies aimed at making food products healthier by regulating permissible amounts of ingredients*
6	Design	Redistribution Policies	*A system of taxes to achieve a more even distribution of margins throughout the food value chain*
7	Design	Liberalization	*International trade agreements that require similar production standards for products*

Next, recommended LPs were categorized into four types: *Parameters, Feedbacks, Design*, and *Intent* according to the operationalization presented in sections 2.1 to 2.4. Categorized LPs were compared to the relevance of LPs per transition pathway as showcased in Table 1. By assessing the development status of the recommended innovation and applying Table 1 to categorized LPs, the conceptual fit of ideal-type transition pathways is discussed. The analysis thereby showcases how innovations may be accelerated through a dedicated configuration of LPs following ideal-type trajectories.

4. Results

Focus group participants suggested a total of 99 potential innovations to address sustainability and health problems in the EU food system during a brainstorm exercise. Each focus group selected one innovation through a ranking exercise, leading to a total of five recommended innovations: True Cost Accounting (TCA), Subsidies and Taxes for Ecosystem Services (STES), Broad Re-valuing of Food (BRF), Alternative Proteins (AP), and Community-Based Initiatives (CBI). In the following section, each recommended innovation is separately discussed. An overview of the recommended innovations, the number of votes per participant in the focus group, the motivation for their vote (deep/feasible), and a brief characterization of their development status is presented in Appendix A. The innovations vary from new technologies to shifts in values, which is why each innovation requires a different set of leverage points in distinct configurations, following ideal-type trajectories. An overview of the resulting LP configurations per innovation is presented in Appendix B.

4.1. Transformation pathway with true cost accounting

The Health focus group selected True Cost Accounting (TCA) as their recommended innovation, with all participants casting a vote for this innovation. One of the participants described TCA as a way of "internalizing external costs", meaning that the price of food reflects its impact on natural resources and health, whilst profits are evenly distributed amongst beneficiaries. Another participant noted that "we, as consumers, don't pay what we should pay." The cheapest foods are generally not the most sustainable or healthy. TCA is proposed to address those issues.

A few pioneering supermarkets have conducted naturalistic experiments with TCA on a limited number of products (Taufik et al., 2023). However, the per-item true costs are still unknown for the majority of products. Therefore, TCA does not meet the development criterion of proven effectiveness, meaning that the innovation has to be developed further before it can be upscaled or spread. The status of TCA as insufficiently developed was reflected in the votes of participants, none of whom indicated it was an especially feasible innovation.

Since TCA is not yet sufficiently developed, accelerating a transition pathway requires the assistance of regime actors for further development, which shows a conceptual fit with a Transformation pathway. Participants recommended several LPs to help accommodate TCA (see Table 2). One of those recommended LPs is *Input Systems Wealth*, which was described as a tax on products like pesticides. Participants identified subsidies for the livestock sector as a potential barrier for TCA implementation, and recommended gradually phasing them out to avoid backlash. In this way, the LP *Policies Production Systems* is employed as a *Feedback* that controls the delay of the acceleration phase. This gives regime actors ample time to plan for the gradual implementation of TCA. Some participants raised concern that some producers would outsource production to regions outside the EU in an attempt to avoid TCA implementation. This is why the LP *Liberalization* is recommended, to modify the *Design* of the food system that currently allows for competition between products with varying production standards.

A major concern of TCA is that implementing additional requirements for the production of foods will lead to higher food prices. Therefore, participants have recommended the LP *Consumer Wealth*, referring to household purchasing power. The question arose of who may benefit and who should pay for external costs or profits. Participants discussed that the processing and packaging industry will likely be confronted with the costs of making healthy and sustainable foods palatable, whereas the benefits of making those foods attractive to consumers may be widespread. This is why participants have recommended the LP *Redistribution Policies*, to help spread profits more evenly across the food value chain. The LP *Health Policies* is recommended to promote the production of healthier foods, thereby diminishing the long-term costs of non-communicable diseases such as diabetes. Participants thought that those recommended LPs would work well in conjunction to the LP *Processing & Packaging Wealth*. That LP is recommended because the processing and packaging industry will likely have to invest in renewed factory plants that produce healthier foods. Participants thought that, together, those recommended LPs would support a courageous long-term vision that accommodates TCA by gradually making changes

in the institutional landscape and thereby directing costs to the actors who are causing them.

4.2. Reconfiguration pathway with subsidies and taxes for ecosystem services (STES)

The Environment focus group discussed two closely related innovations: payments for ecosystem services and the combination of taxes and subsidies to improve food system outcomes. Both received a relatively high number of votes compared to the 28 other options. Given their strong compatibility, the focus group participants agreed to combine those into one recommended innovation: Subsidies and Taxes for Ecosystem Services (STES).

Ecosystem Services entail benefits that people obtain from nature, including biodiversity for food system resilience, freshwater provision, and pollination of crops (Carpenter et al., 2006; Du Preez et al., 2020). STES can address multiple sustainability and health challenges by flexibly supporting specific socio-ecological interactions. A range of subsidies and taxes can co-exist without one becoming dominant, meaning STES may be employed as a series of symbiotic innovations that can function as add-ons to the existing regime, and thereby gradually modifying the system's incentive structures. This makes STES a highly versatile innovation, reflected in the votes by participants who recommended STES for both feasibility and depth. STES is already implemented to some extent, with numerous successful examples described in the scientific literature (Le et al., 2024), some of which are within the EU's Common Agricultural Policy (CAP). While these criteria indicate that multiple symbiotic innovations are sufficiently developed, participants indicated that restructuring the system would be necessary to accelerate the upscaling or spreading of STES. This suggests a conceptual fit with a Reconfiguration pathway.

In a Reconfiguration pathway, regime actors must explore ways to integrate multiple innovations as add-ons to the existing regime. To enable acceleration of STES, participants recommended adjustments to the EU food system's Design aimed at accommodating the innovation. Clear criteria for *Climate Change* will resolve ambiguity, which should be linked to the recommended LP *Production Systems* by farm-level specifications. In addition, participants recommended the LP *Retail & Markets Wealth* as a means of generating funds for a change in agricultural production.

A current barrier to an agricultural transition is posed by private financiers being reluctant to invest in more sustainable modes of production, since return on investment is lower and the risks of innovative earning models are higher. Transition managers may accelerate STES by implementing incentives for private financing, thereby creating a positive feedback loop between the recommended LP *Input Systems* and *Production Systems*, which may drive acceleration of a Reconfiguration pathway through increasing available funds. Additional transparency requirements throughout the food value chain would allow for the involvement of consumers, who would then be in a better position to actively choose sustainable or healthy products, which may lead to increased support for ecosystem services. The LP *Final Consumption* is recommended by participants, who argued that meat and dairy consumption should be discouraged, whilst ensuring affordability of healthy and sustainable meals. Participants thus recommended to trigger the LPs *Consumer Wealth* and *Final Consumption* in conjunction with each other.

Participants did warn for a potential backlash against the sudden removal of subsidies, as this has already caused widespread farmer protests in the EU. To avoid backlash against accelerating a transition pathway too quickly, one participant proposed the LP *Sunset Clause* as a means of providing a clear timeframe. Such *Feedbacks* may be important in balancing the timeline for acceleration, minimizing the extent to which conservative incumbents may be antagonized, while maintaining momentum for upscaling and spreading STES. Given that no other *Feedbacks* were recommended, the proposed LP *sunset clause* is added to the LP configuration in Table 3.

The acceleration phase of a Reconfiguration pathway may be stabilized by employing a wide range of proposed tax and subsidy measures. Participants specifically proposed taxes targeting: feed, pollution, sugar, slaughtering animals, and food processing. Subsidies were deemed essential in supporting more vulnerable actors, such as people with low socioeconomic status (SES) and farmers. Transition managers may choose to supplement the LP configuration in Table 3 with these proposed LPs (see Appendix B).

Table 3
LP configuration to accelerate a Reconfiguration pathway by upscaling or spreading Subsidies and Taxes for Ecosystem Services (STES).

#	Category	Leverage point	Description
1	Parameter	Consumer Wealth	*Subsidy to make sustainable meals affordable*
2	Parameter	Processing & Packaging Wealth	*Sugar tax & levy on slaughter houses*
3	Feedback	Sunset Clause*	*Addressing the stranded assets of unsustainable modes of agricultural production over time through a sunset clause*
4	Design	Production Systems	*A stoplight system for farmers to distinguish sustainable from unsustainable modes of agricultural production*
5	Design	Climate Change	*Clear benchmarks for ecosystem services and earmarking of funds*
6	Design	Input Systems	*Sustainability & health incentives for private financing*
7	Design	Final Consumption	*Start to get people consuming less meat and dairy*
8	Design	Retail & Markets Wealth	*Generating money flow backwards from retailers towards primary producers through transparency requirements for STES*

*Proposed LP that was added to the configuration in order to complete the conceptual fit

4.3. De-alignment and re-alignment pathway with broad re-valuing of food (BRF)

The Political-Economic focus group ranked Broad Re-valuing of Food (BRF) as the most promising innovation with 4 votes for the depth of the innovation. According to the participant who proposed BRF, it refers to societal values that incorporate a holistic perspective on food as a means of maintaining health, as a cultural phenomenon that may bind people together, and as a way of reconnecting people to their environments. Such values are thoroughly grounded in academic contexts, and are present in small-scale projects such as community-based initiatives that show social and economic viability (Balázsi et al., 2019; Pérez-Ramírez et al., 2021). BRF is therefore categorized as sufficiently developed.

However, BRF offers multiple innovations in meaning-making structures that clash with deep parts of the regime, and clash with one another. The various values that are offered by BRF show trade-offs between each other, such as between anthropocentric values and more-than-human values (Srinivasan and Kasturirangan, 2016). This means that BRF can only make a conceptual fit with the De-alignment and Re-alignment pathway, since it consists of multiple innovative values that clash with the *Intent* of the system and with each other.

To upscale or spread BRF, the *Intent* of the system should be modified. Participants recommended *GDP growth* as a LP in that category. When *GDP Growth* is modified, it allows for more qualitative focus on economic performance that includes a broader conception on human wellbeing. To support changes in the *Intent* of the system, some institutional modifications in the *Design* of the system will be necessary to resolve lock-ins, that are created by institutionally embedded values such as shareholders that demand quarterly growth. Recommended LPs to break robustness in financial parts of the system include *Health, Branded Products*, and *Marketing*. According to participants, those recommended LPs can support spreading of BRF by allowing for the inclusion of health and sustainability within current institutional arrangements (see Table 4).

Participants of the Political-Economic focus group proposed to employ *Long-term Investments* as a *Feedback* to help shift focus away from short-term shareholders. *Long-term Investments* may help align financial incentives with sustainability. This *Feedback* was not recommended, but given that no other *Feedback* is proposed, it is included in the LP configuration. Participants discussed how companies may become a partner in a transition when *Product Composition* aligns with longer-term sustainability and health goals. That is why the LP *Product Composition* is recommended. Participants however warned that production costs may rise when sustainability criteria are added. To mitigate this risk, the *LP Consumer Wealth* was recommended to ensure that healthy and sustainable meals remain financially attractive. Some supplementary *Parameters* may prove necessary to influence the price of certain types of foods through taxation and subsidies, but those are not included in the LP configuration. To further accelerate spreading of BRF, companies could employ the discursive power of their marketing departments to advertise sustainable and healthy foods. Participants thought that the combination of the LPs *Long-term Investments, Branded Products*, and *Marketing* will accommodate BRF by allowing for a shift in focus towards sustainability and health in the private sector.

4.4. Reconfiguration pathway with alternative protein (AP)

Participants of the Innovation & Infrastructure focus group voted for alternative protein (AP) as both a feasible and deep innovation. AP offers protein rich foods as alternatives for meat from the livestock sector. Technologies to produce AP range from plant-based meat substitutes, to new technologies such as precision fermentation or cultured meat. One participant noted that AP is not always more healthy, as this depends on the product composition. The main advantage of AP is that it may have less impact on natural resources by reducing the amount of required land and mitigating methane emissions (Kumar et al., 2022). Still, the environmental impact is not necessarily positive, as AP depends on the amount of energy and materials required and the way those are produced (Kumar et al., 2022).

Some products made from AP are already available in supermarkets, such as bean burgers. Precision fermentation is somewhat less developed, as some companies are experimenting with the financial viability of large-scale production plants (Eastham and Leman, 2024). The development status of plant-based protein and precision fermentation indicate that a take-off stage has been initiated, which means that a transition pathway may be accelerated through triggering LP configurations. Cultured meat is not yet sufficiently developed because it requires approval by the European Commission as a novel food (Broucke et al., 2023). As a consequence,

Table 4
LP configuration to accelerate a de-alignment and re-alignment pathway by upscaling or spreading broad re-valuing of food (BRF).

#	Category	Leverage point	Description
1	Parameter	Consumer Wealth	*Provide vouchers for healthy & sustainable foods*
2	Feedback	Long-term Investments*	*Shifting focus of investments in innovations from short-term shareholder value to long-term sustainable production*
3	Design	Branded Products	*Sector agreements on adjusting product compositions so that foods are composed of more sustainable ingredients with overall health benefits*
4	Design	Marketing	*Employing marketing to drive food consumption towards sustainability and health*
5	Design	Health	*Reinforce habits of consumers to choose whole foods that require cooking; combined with educational means*
6	Intent	GDP Growth	*Better connect societal value and monetary value by distinguishing between necessary and unnecessary production*

*Proposed LP that was added to complete the configuration

companies cannot start with small-scale trials to test the economic viability of cultured meat. This renders cultured meat insufficiently developed.

A reconfiguration pathway shows conceptual fit, as AP consists of multiple developed innovations that can be employed as add-ons to the existing system. In a Reconfiguration pathway, the three innovations will be added to the existing food system to each tailor a specific group of consumers. Regime actors will have to find ways to fit the innovations in the existing regime, thereby relying on modifications in the *Design* of the system. Participants mentioned that it will be important to address the LP *Processing & Packaging*, as factory plants have large sunk costs of industrial machines that process one particular type of food, and not others. Modifications in the *Processing & Packaging* industry may thus be necessary to overcome lock-ins and accommodate AP. Since the sustainability of AP depends on the type of energy used, The LP *Smart Energy* is recommended. A smart energy grid can allocate and redivide resources to private actors, ensuring that demand does not exceed the production of electrical energy. A *Feedback* to manage the gain of acceleration is recommended by a participant who advises to agree on a long-term plan that outlines in what timeframe the livestock sector will be phased out. Therefore, the LP *Production Systems* is recommended to employ as a *Feedback*. The LP *Production System Wealth* is recommended to further accelerate the transition pathway by providing a subsidy for producers to adopt AP. Participants thought this may support an acceleration changes in the market that are geared towards plant-based diets (see Table 5).

4.5. De-alignment and Re-alignment pathway with Alternative Protein (AP)

AP may also result in a deeper De-alignment and Re-alignment pathway when cultured meat, plant-based protein, and precision fermentation start competing against each other, instead of each supplementing the regime. Regime actors would then start searching for modifications in *Intent* to determine what innovation should become dominant. Participants of the Innovation & Infrastructure focus group recommended the LP *Social Norms* to help restructure deeper parts of the system (see Table 6). By aiming for this LP in the category *Intent*, the social acceptability of a particular type of AP may be influenced. The struggle for dominance may be further influenced through proposed LPs such as *Environmental Awareness* or *Health Awareness*, as those may be used as add-on criteria to determine acceptability of one innovation over the other (cf. Appendix B).

Feedbacks are an important LP category in a De-alignment and Re-alignment pathway because they can influence the specific timeframe within which an innovation is upscaled or spread, thereby determining which innovation succeeds in becoming dominant first within the window of opportunity. Phasing out livestock by addressing the LP *Production System* as a *Feedback* is recommended, as this would slowly tilt the playing field towards AP in a balanced way that manages lock-ins and potential backlash. Participants discussed the extent and speed with which energy use, carbon emissions, and food miles can be reduced. Those *Feedbacks* may be decisive in determining the struggle to become dominant, as the current resource intensity of cultured meat would mean that a quick reduction in carbon emissions of food will likely tilt the playing-field towards precision fermentation. The same competition on environmental and health impact may occur between plant-based protein and precision fermentation, as their impacts are highly dependent on the technologies used in production and processing plants. A recommended innovation subsidy may influence a struggle between plant-based protein and precision fermentation by influencing cost-efficiency of competing innovations.

4.6. De-alignment and Re-alignment pathway with Community-Based Initiatives (CBI)

Participants of the socio-cultural focus group voted for Community-Based Initiatives (CBI) as the most promising innovation because of its deep potential. Multiple types of projects are included in CBI, such as community-supported agriculture, community kitchens, and food cooperatives. Since a wide variety of such projects are already available, CBI is categorized as sufficiently developed. A participant noted that it is not possible to upscale CBI because the initiatives are locally tied to a demarcated community, so instead a strategy of spreading CBI throughout the EU food system would be necessary. Given that each type of CBI requires extensive cooperation from final consumers, it is likely that the innovations will start competing with each other to become dominant in specific communities. Focus group participants discussed explicitly how LPs may enable the acceleration of the spreading of CBI towards other societal groups.

A De-alignment and Re-alignment pathway shows a conceptual fit with CBI, since multiple developed innovations are included that will likely compete with each other. A De-alignment and Re-alignment pathway would be characterized by a struggle between types of

Table 5
LP configuration to accelerate a Reconfiguration pathway by upscaling or spreading alternative protein (AP).

#	Category	Leverage point	Description
1	Parameter	Production System Wealth	*Subsidies for investments in the technologies necessary to produce AP*
2	Parameter	Production system wealth	*Divestments in the technologies that underpin animal protein production*
3	Feedback	Production Systems	*Providing time for unsustainable producers to exnovate and phase out livestock*
4	Design	Smart Energy	*Decentralize renewable energy production to balance availability and awareness of demand*
5	Design	Processing & Packaging*	*Modify production lines of food processors and packaging companies so those are suited to process and package foods made from alternative protein*

*Proposed LP that was added to complete the configuration

Table 6
LP configuration to accelerate a De-alignment and Re-alignment pathway by upscaling or spreading Alternative Protein (AP).

#	Category	Leverage point	Description
1	Parameter	Production System Wealth	*Subsidies for investments in the technologies necessary to produce AP*
2	Parameter	Production System Wealth	*Divestments of the technologies that underpin animal protein production*
3	Feedback	Production Systems	*Providing time for unsustainable producers to exnovate and phase out livestock*
4	Design	Smart Energy	*Decentralize renewable energy production to balance availability and awareness of demand*
5	Intent	Social Norms	*Planning the way how the innovation fits into and shapes acceptable behaviors*

CBI to become dominant, with regime actors losing faith in the existing regime and starting to search for modifications in the *Intent* of the system. Currently, the food environment is dominated by for-profit companies like supermarkets, while a large part of their products are unhealthy (Vandevijvere et al., 2023). To help decrease this market-based dominance in favor of CBI, a modification in the LP *Food Environment* is recommended by influencing which types of food retailers may be present in certain areas. A modification in *Intent* will be necessary to help determine which organizations can re-align in a renewed regime. Participants therefore recommended a focus on *Social Norms* to make CBI more socially desirable. Participants for example discussed that health and sustainability may be presented as a social commitment, rather than an individualistic lifestyle objective. Renewed *Social Norms* may lead to the projects being perceived as 'hip', which would dramatically increase their chance of spreading. Still, consumers would also require available time to participate in CBI. Therefore, *Labor Market Participation* is proposed, as currently the time people spend working provides a major barrier for people to join CBI. A 'hip' image and available leisure time may still not be sufficient, as the decision to become and remain a member of CBI hinges upon the extent to which people feel they belong to a community. *Social Cohesion* is therefore a recommended LP to promote local cooperation. As local cooperation in CBI requires the availability of food, the LP *Physical Food availability* was recommended to ensure the project can meet demand. Moreover, an increased focus on the availability of healthy and sustainable foods in people's environments might benefit CBI over for-profit companies. Participants did warn that people with low social-economic status might not be able to join CBI for financial reasons, which is why *Ability to Pay* was recommended to ensure the economic viability of CBI (see Table 7).

5. Discussion

As our study shows, leverage points (LPs) can help identify series of strategic intervention points to accelerate system change. Our newly synthesized framework employs LP configurations as a means to overcome systemic inertia and facilitate the upscaling or spreading of innovations. Characteristics of innovations shape their potential trajectories, and LP configurations should therefore be contextualized within these trajectories to effectively navigate shocks, setbacks, or potential backlashes. The discussion yields several key insights regarding the strategic use of LPs to support transition pathways.

A first key insight is the importance of addressing both deep and shallow LPs in conjunction to generate system momentum. This integrated approach helps to balance short-term feasibility with the ambition for long-term transformative change (Termeer et al., 2024). While participants recommended a mix of shallow and deep LPs, the overall pattern supports deeper transition pathways that necessitate modifications in the system's *Design* or *Intent*. Interestingly, although the role of *Feedbacks* in steering the pace and direction of transition pathways was frequently discussed, participants often gravitated toward more concrete LPs, such as *Parameters* or *Design*, when asked to select a single recommendation. However, *Feedbacks* can play a pivotal enabling role by setting the stage for subsequent changes in *Design* and/or *Intent* (Geels and Ayoub, 2023). To reflect this dynamic, we supplemented three LP configurations with proposed *Feedbacks* to strengthen their conceptual coherence.

Second, none of the recommended innovations followed a shallow technological substitution pathway. This suggests that shallow approaches are insufficient to address the depth and breadth of contemporary sustainability and health issues. While some scholars acknowledge that shallow pathways may not tackle root causes (De Jong-Van Lier et al., 2023), they argue that such pathways can still generate incremental progress through "small wins" (Termeer, 2019) and potentially evolve into deeper pathways over time (Kanger and Schot, 2019). Through economic developments, such incrementally deep pathways may kickstart the institutionalization of a new subsystem that arises from the previous regime (Papachristos at al., 2013). However, in our research, participants consistently emphasized that meat and dairy consumption pose a core problem, which demands a fundamental and deliberate restructuring of EU

Table 7
LP configuration to accelerate a De-alignment and Re-alignment pathway by spreading Community-based Initiatives (CBI).

#	Category	Leverage point	Description
1	Parameter	Ability to Pay	*Making community-based initiatives financially accessible to a broad public*
2	Parameter	Physical Food Availability	*The type of food (products) that is present is people's neighborhoods*
3	Feedback	Labor Market Participation	*How much time consumers have to spend working and how much is left for acquiring and preparing foods*
4	Design	Food Environment	*Laws and regulations that determine what businesses or foods are allowed to be present in consumers' surroundings*
5	Design	Social Cohesion	*Promoting the extent to which people have collectivistic interrelations*
6	Intent	Social Norms	*CBI should be made hip so that people will more easily accept it as an alternative*

diets to remain within planetary boundaries (Cué Rio et al., 2022; Sala et al., 2020).This need for deliberate deep restructuring towards plant-based diets was reflected in the focus group data in two distinct ways: (1) recommended innovations directly or indirectly reduce the livestock sector's impacts, and (2) recommended LPs such as *Final Consumption, Social Norms*, and *Whole Foods Cooking* are aimed at reducing consumers' animal protein intake. Participants in the Technology & Infrastructure focus group selected Alternative Protein as a technological alternative to meat and dairy consumption. Still, this did not result in a shallow transition pathway, as participants recommended to intentionally trigger deep LPs to prevent problem shifting and to promote social acceptance of plant-based diets. This finding echoes the conclusions of other scholars, who argue that the sustainability of alternative protein depends on the mode of energy production and consumption, and that technological innovations must be implemented alongside social innovations (Green et al., 2022; Guzmán et al., 2012). A shallow technological substitution pathway thus appears inadequate.

Third, we find that even if policy-makers would succeed in accelerating a deeper transition pathway, this may prove insufficient to fully address sustainability and health issues. The EU food system is highly interlinked across multiple subsystems, and none of the recommended innovations addresses all of these simultaneously. True Cost Accounting, for example, may improve outcomes in the political-economic system, while Community-based Initiatives may target the socio-cultural system. But these innovations do not offer solutions for the environmental or health subsystems. Therefore, it is likely that multiple transition pathways must be accelerated across multiple subsystems in order to truly achieve sustainable and healthy outcomes (Duluins and Baret, 2024; Springmann et al., 2018). By accelerating multiple transition pathways, synergies can be created across different subsystems of the food system (Herrero et al., 2020). Upscaling or spreading alternative protein may thus be done simultaneously with a transition pathway involving True Cost Accounting, Subsidies and Taxes for Ecosystem Services, and/or Broad Re-valuing of Food. Accelerating multiple pathways may create trade-offs, which is why more research is needed to better understand synergies and trade-offs between ideal-type transition pathways.

Fourth, attitudes of actor coalitions will be essential in co-determining the feasibility of various transition pathways (Roberts et al., 2018). Transition managers may therefore continue to learn through cycles of experimentation and adaptation to understand how actor groups respond to innovations (Geels and Kemp, 2007; Loorbach and Rotmans, 2010). The fact that all focus groups recommended the LP *Consumer Wealth* suggests that experts consider affordability of food essential for maintaining support for a transition. However, this does not mean that all food prices must remain unchanged. Price incentives may still be an effective and feasible means of steering consumer diets towards sustainable and healthy food consumption (Stuber, 2023), as long as overall diets remain affordable for diverse societal groups.

Each transition pathway will have unequal socio-economic impacts, which means that the decision to accelerate a particular pathway is inherently political (Fesenfeld et al., 2022). Given the large market concentration of Big Food, it is likely that incumbents continue to exercise structural and discursive power to resist deeper change (Béné, 2022). At the societal level, the political framing of sustainability issues often leads to a focus on capital-intensive innovations that support industrialized agriculture, thereby favoring shallow transition pathways (Omar and Thorsøe, 2023). This occurs despite growing efforts among sustainability scholars to promote system-wide transformation to reduce environmental impacts of food consumption (Hallström et al., 2022; Marrero et al., 2024). Given that these choices are deeply political, legitimacy in transition management will benefit from the involvement of a broader range of actors. The role of actor coalitions in adopting innovations limits the ability of transition managers to steer the trajectory of transition pathways from the top down (Rotmans et al., 2001).

The results of this study should therefore not be viewed as a definitive roadmap for achieving desired outcomes (cf. Frissen, 2023), particularly since our operationalization of LP configurations relies on previous case studies. Critics argue that such cases are often analyzed in retrospect and that there is uncertainty about their transferability to future pathways (Genus and Coles, 2008). This limitation may affect the robustness of the projected pathways, as innovations tend to interact with regimes in more dynamic ways than the MLP framework typically assumes (Smith and Raven, 2012). To strengthen these insights, complementary approaches, such as ex ante analyses and systematic reviews of visions, missions, and foresight in transitions, may provide additional insights into alternative future trajectories (Geels, 2019; Sovacool, 2019).

6. Conclusions

In this article, we synthesized the leverage point (LP) framework with the multi-level perspective to show the relevance of LP categories for ideal-type transition pathways. A total of 31 LPs were recommended by experts in focus groups, and an additional 49 LPs proposed. By applying our framework, the analysis resulted in six ideal-type transition pathways that accelerate the upscaling or spreading of five innovations: True Cost Accounting (TCA), Subsidies and Taxes for Ecosystem Services (STES), Alternative Protein (AP), Broad Re-valuing of Food (BRF), and Community-Based Initiatives (CBI). These innovations are taken as a starting point for a transition.

Five LP configurations indicate which LPs may enable upscaling or spreading of their respective innovation (see Tables 2–7). These configurations are linked to four mechanisms of acceleration: removing barriers, activating reinforcing feedbacks, enabling shifts in social structures, or renewing meaning-making structures. Altering these mechanisms through policy interventions may break the robustness of the existing system and thus allow for acceleration. LPs help direct attention to parts of the system that are expected to be particularly effective for deliberately accelerating transition pathways through policy interventions. Additionally, transition pathways help to provide long-term focus to configurations of LPs, by taking into account the co-evolution of interrelated social structures.

Each of the induced ideal-type transition pathways follows a distinct dynamic, that employs LP configurations as stepping stones towards sustainable and healthy outcomes. The trajectory of each pathway depends on the willingness of actor coalitions to adopt changes, meaning that the future development of these pathways remains highly uncertain. Moreover, since each pathway will

generate different outcomes for various societal groups, political contestation is likely to emerge over which pathway(s) to follow. As such, cycles of experimentation are necessary to manage potential setbacks or backlashes, and to navigate toward more sustainable and healthy outcomes.

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CRediT authorship contribution statement

Tom Kiel: Writing – original draft, Visualization, Validation, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jeroen J.L. Candel:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Erik Mathijs:** Writing – review & editing, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Robbert Biesbroek:** Writing – review & editing, Validation, Methodology, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Jeroen Candel reports a relationship with Dutch Council for Animal Affairs that includes: consulting or advisory. The other 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.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.eist.2025.101041.

Appendix A

Table 8

Table 8
Recommended innovations by focus group participants, based on a vote cast with 3 votes for feasibility and 3 votes for effectiveness per participant.

Innovation	Description	Votes (v) per participants (p)	Primary motivation for votes	Development status
True cost accounting (TCA)	Method to make external costs apparent, so that per-item food prices can be calculated based on their impacts on natural resources, social equity, and health	4v / 4p	Depth	Not yet sufficiently developed
Subsidies and taxes for ecosystem services (STES)	Combining a set of financial (dis)incentives to promote nature-based solutions	8v / 7p	Feasibility & depth	Sufficiently developed
Broad re-valuing of food (BRF)	Incorporating social and extra-human values in the food system so that people start collaborating with each other and their environments	4v / 7p	Depth	Multiple developed innovations
Alternative protein (AP)	Protein production that bypasses the livestock sector through plant-based production, precision fermentation, or cultured meat	4v / 4p	Feasibility & depth	Multiple developed innovations
Community-based initiatives (CBI)	Localized social projects that link groups of people more directly to the source of their foods, such as community-supported agriculture, food forests, community kitchens, and food cooperatives.	4v / 5p	Depth	Multiple developed innovations

Appendix B

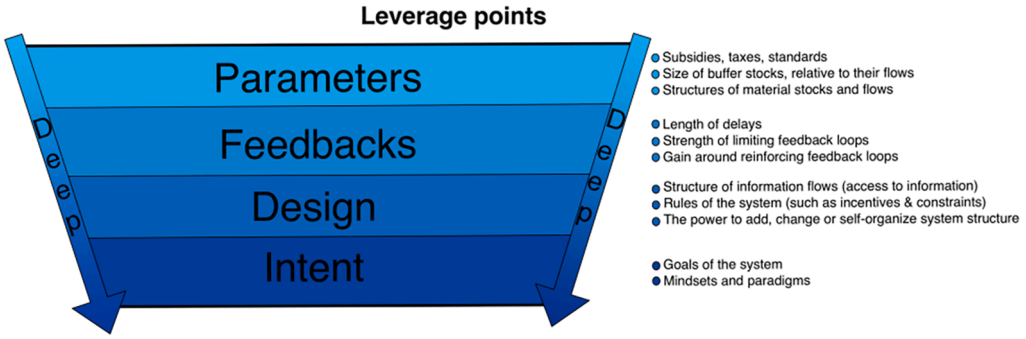
Participants of the focus groups have discussed which interactions between components on a EU food subsystem map should change in order to arrive at more sustainable and healthy outcomes. Each time a participant has mentioned any component on the map, this is noted as a proposed leverage point. Some of these proposed leverage points have only briefly been mentioned. In a later stage of the focus group, each participant is asked to select one of the proposed leverage points that they think is especially effective (in terms of feasibility/impact/depth). That selection is labelled as recommended leverage points, and those are taken up in the LP configurations that are presented Tables 2–7, including a description of each leverage point. Table 9 gives an overview of all leverage points that were mentioned by participants in the focus groups.

Table 9
Proposed LPs per focus group and LP category.

Focus group	Parameters	Feedbacks	Design	Intent
Health	• Consumer wealth • Input Systems Wealth • Processing & Packaging Wealth • Fruit & Veg Tax Break • HS Fluids Tax	• Policies Production Systems	• Wealth distribution policies • Health policies • Payments for Ecosystem Services • Foreign Direct Investment Mergers	• Social norms on home cooking • Liberalization • Social Awareness • Health Awareness
Environment	• Production system wealth • Environmental Pollution Tax • Air Pollution Tax • Processing & Packaging Wealth • Consumer wealth • Environmental Innovation Tax Break • Farmers Subsidy • Food Processors Tax	• Sunset Clause • Reducing the Number of Unsustainable Products	• Transparency Requirements • Production Systems • Clear Environmental Benchmarks • Retail & Markets Wealth • Incentives for private financing • Governmental Guarantees for Loans • Final consumption • Market-Based Instruments for Ecosystem Services • Soil Health Certification	• Social Norms for Meat & Dairy Consumption
Political-economic	• Consumer wealth	• Long-term investments	• Health • Branded products • Marketing • Community-supported agriculture • Transparency requirements • Sustainable innovation • Sustainability & health competition • Speculative trading	• GDP growth • Health awareness • Social norms on cooking & organic food • Physiological needs • Environmental awareness
Innovation & Infrastructure	• Production System Wealth subsidy • Production System Wealth divestment • Storage & Distribution Subsidy • Reducing Refrigerated Transport • Consumer Wealth	• Decrease Food Miles • Production Systems • Decrease Carbon Emissions • Decrease Energy Usage	• Smart Energy • Renewable Energy • Processing & Packaging • Storage & Distribution	• Environmental Awareness • Social Norms
Socio-cultural	• Physical Food Availability • Ability to Pay • Processing & Packaging Tax • Production System Subsidy • Storage & Distribution Subsidy • Input System Tax • Local Food Storage Subsidy	• Labour Market Participation	• Social Cohesion • Food Literacy • Community Kitchens • Politicize Processing & Packaging • Food Environment Policies • Intermediaries • Level of Education	• Health Awareness • Social Awareness • Social Norms

Appendix C

Leverage point handout that was used during focus groups to help participants pinpoint leverage points on EU food system maps showing complex interactions.



Data availability

Data will be made available on request.

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