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Backcasting supports cross-sectoral collaboration and social-technical innovation bundling: case studies in agri-food systems

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There is a clear and urgent call to transform our food systems as a critical nexus to tackle ongoing global climate, biodiversity, equity, and nutrition crises. Many food and agricultural innovations are being developed and scaled but these innovations often target sector-specific problems and remain disconnected from the more complex demand for transformative change at scale. To bridge this demand for systemic change within the innovation ecosystem, initiatives are applying various approaches such as visioning, holistic assessments, innovation portfolio management and multistakeholder co-creation. Here we report on insights from applying a food systems tailored backcasting approach in a diversity of settings since 2021, including a national food system dialogue, a youth business innovation challenge, a landscape multi-stakeholder platform, a public-private sector co-learning session, an agroecological transitions program, and a hybrid food systems university course for graduate students and global professionals. We thereby build on existing literature and case studies of how change happens (or does not happen) and aim to use those insights to support food systems change makers. Across these settings, the backcasting approach asks participants to connect innovations with broader systems-change visions, to anticipate tradeoffs for multiple food system outcomes and population groups, and to cross sectoral boundaries. The use cases demonstrate that the backcasting process contributes to changes in views, practices and structures that participants work with. Specifically, it supports moving beyond "silver bullet" innovation approaches, the bundling of social

and technical innovations, and building action-oriented cross-sectoral bridges. Food systems change is complex and innovations alone are insufficient to address its complexity. But innovations can play a positive role if connected to more holistic systems-change processes and goals. Considering strengths and limitations of the backcasting approach, the diversity of practical applications supports its potential to connect innovations to holistic food systems visions, to strengthen cross-sectoral collaboration and to bundle social and technical innovations for desirable food systems change.

KEYWORDS

futures-thinking, backcasting, cross-sectoral, participatory, tradeoffs

1 Introduction

There is a broad recognition that we need to urgently transform our food systems as the ways we currently produce, process, trade, transport, consume and waste food are also a major cause of poor health, global environmental degradation, climate change, and large inequities (Béné et al., 2019; Willett et al., 2019; Schneider et al., 2023; von Braun et al., 2023; Wineman et al., 2024).

Transformative change can be described as 'a fundamental, system-wide reorganization across technological, economic and social factors, including paradigms, goals and values' (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2022). Transforming food systems thereby means fundamentally changing how they operate to dramatically improve environmental, health and livelihood outcomes for society at large. Food systems change is complex and is intertwined with climate, environmental, geo-political, and social-economic change. This requires fundamental changes in the behavior of consumers, producers, investors, agri-food sector firms, researchers and political leaders, and a shift in economic and social incentive structures (Woodhill, 2023).

Many food and agricultural innovations are being developed and scaled with a promise of contributing to sustainable food systems transformation (Barrett et al., 2020; Herrero et al., 2020; Innovative Food Systems Solutions Portal Initiative, 2024). An innovation consists of doing something new and different, whether solving an old problem in a new way, addressing a new problem with a proven solution, or bringing a new solution to a new problem (United Nations Innovation Network, 2019). Food system innovations include technical, institutional and governance innovations, ranging from changes in food production, waste management, land use and emissions, to changes in improved diets, food regulations, and social engagement. Innovations can be useful for the food systems change but these innovations often still operate in silos addressing specific needs, and often remain disconnected from unintended consequences and from the more complex demand for transformative systemic change (Geels, 2019; Campbell et al., 2022).

This has raised the question of how to better connect and leverage innovations for systems change (United Nations Food Systems Summit, 2021; Béné, 2022; Remans et al., 2022). Several efforts are addressing this question. For example, the Wild Futures Project, launched in 2019 and now hosted at Cornell University, has been developing tools to help inform food policy to harness the power of technologies and innovation, while also building in rail guards to try to avoid the worst unintended consequences of more radical change (Wild Futures Project et al., 2024). The international collaborative Foresight4Food Initiative, launched in 2017 and hosted through the Food Systems Group at the University of Oxford's Environmental Change Institute, provide mechanisms for better analysis and synthesis of key trends and possible futures in global food systems to support more informed and strategic dialogue between the private sector, government, science and civil society (Foresight4Food Initiative, 2024). Scaling Readiness at the CGIAR provides evidence-based step-by-step guidance for teams to take their innovations to scale to achieve their ambitioned impact and by supporting innovation portfolio management at organizational or program level (Schut et al., 2022; Scaling Readiness Research and Initiative, CGIAR, 2024). The national Food Systems pathways, coming out of the processes from the 2021 United Nations Food systems summit, integrate potential game changer solutions into transition pathways toward a longer-term vision (United Nations Food and Agriculture Organization, 2022; National Pathways Analysis Dashboard, United Nations Food Systems Coordination Hub, UNFAO, 2024).

Across several of these on-going efforts, it has been emphasized that leveraging the potential of agri-food innovations for positive change requires exploring food systems transition pathways and anticipating medium-and long-term trade-offs and synergies (Herrero et al., 2021; Thornton et al., 2024). Building on this beginning in 2021, the research team of the Innovative Food Systems Solutions Portal Initiative (IFSS Portal Initiative, 2024) in collaboration with the Wild Futures Project, developed a tailored backcasting process (Figure 1) to support the development of future food systems visions, considering multiple goals and complexities, and to create adaptable action pathways bringing in innovations, to achieve these visions (Pedersen et al., 2020). This approach builds on learnings and insights from visioning, backcasting, and a rich diversity of case studies of how change can happen or does not happen (Bennett et al., 2016; Fazey et al., 2020; Scoones et al., 2020; Leeuwis et al., 2021).

Backcasting is a planning method that begins with defining a desirable future and then working backwards to identify the steps, stakeholders, innovations, and key policies and programs that can connect that specified future to the present (Robinson, 1990; Quist and Vergragt, 2006). Using this methodology can increase the likelihood of managing socially, politically and ecologically complex issues in a coordinated and more systematic way (Holmberg and Robèrt, 2000). The IFSS Portal Initiative backcasting approach tailored

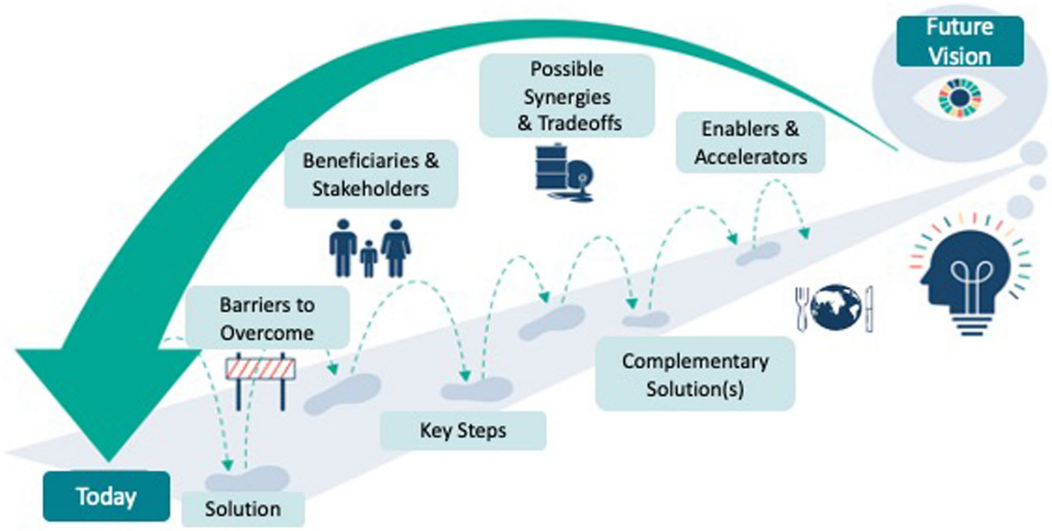

FIGURE 1
Visual schematic of the core idea and core elements of the backcasting approach.

to food systems complexities, provides a process to question food system and innovation related assumptions, anticipate risks and manage tradeoffs and synergies to optimize sustainability across different goals, including human nutrition, equity, and environmental sustainability. Articulating visions helps illustrate a diversity of thinking and a diversity of assumptions (Fazey et al., 2020; Leeuwis et al., 2021). Applications of backcasting to food and agricultural development and rural transitions are increasing and serve as entry points for participatory strategy development, modeling and quantitative cost and benefit analysis (Vervoort et al., 2014; Vermeulen et al., 2018; Mangnus et al., 2019; Leeuwis et al., 2021; Haddad et al., 2022).

In this paper, we describe six different cases and contexts in which the IFSS Portal Initiative food systems backcasting approach has been applied, mostly as a participatory co-creation process, and what some main insights and lessons learned are from its application. We make available related facilitation tools (Supplementary materials 1–3, 5), an overview of the use cases (Supplementary material 4) and many of the resulting vision statements and backcasting maps are published as open access co-learning materials on the IFSS Portal Initiative website (IFSS Portal Initiative, 2024).

2 Methodology

2.1 A tailored backcasting approach

2.1.1 Steps of the tailored backcasting approach

The IFSS food systems backcasting process includes four core steps that can mutually strengthen each other in an iterative process (Figure 2). These steps are structured around a set of meta questions summarized here below, and further supported by additional guiding questions, detailed further in Supplementary material 2:

1 *Visioning* – What do you imagine a desirable future will look like? What are critical elements of change in this vision as compared to business-as-usual? What are different roles for different stakeholders and actors? How does this compare to desirable future visions of others?
2 *Exploring bottlenecks and possible solutions* – From your perspective, what are potential innovations or solutions to achieve this vision? What are major bottlenecks or constraints and mitigation strategies to overcome these to achieve this vision?
3 *Pathway building* – What are key steps toward this vision? In what order could they be most effective? What are the major assumptions underlying these steps? What are potential unintended consequences? What are key partnerships?
4 *Reflection and adaptation* – How can progress be accelerated? How to monitor for adaptive management? How would you adapt your vision further?

To support facilitation across a diversity of settings, we developed guidance and complementary worksheets (Supplementary materials 1–3). The backcasting process can be conducted in an online or in-person format. The online format can be facilitated by the use of collaborative digital learning tools such as software hosted by Miro, Mural, Google Jamboard or others. The in-person format can be facilitated through the use of hard-copy materials and flipcharts. A hybrid format can be facilitated with a combination of digital online collaboration tools and in-person hard-copy materials, depending on what's practical, efficient and most appropriate for the target stakeholders and participants and based on context, accounting for maximal inclusivity.

2.1.2 Set of good practices in the backcasting facilitation process

Across the diversity of applications, we developed a set of five good practices to enhance facilitation, enrich the outcomes of the process, and consider power dynamics that might hinder open discussion and sensitivity. These include:

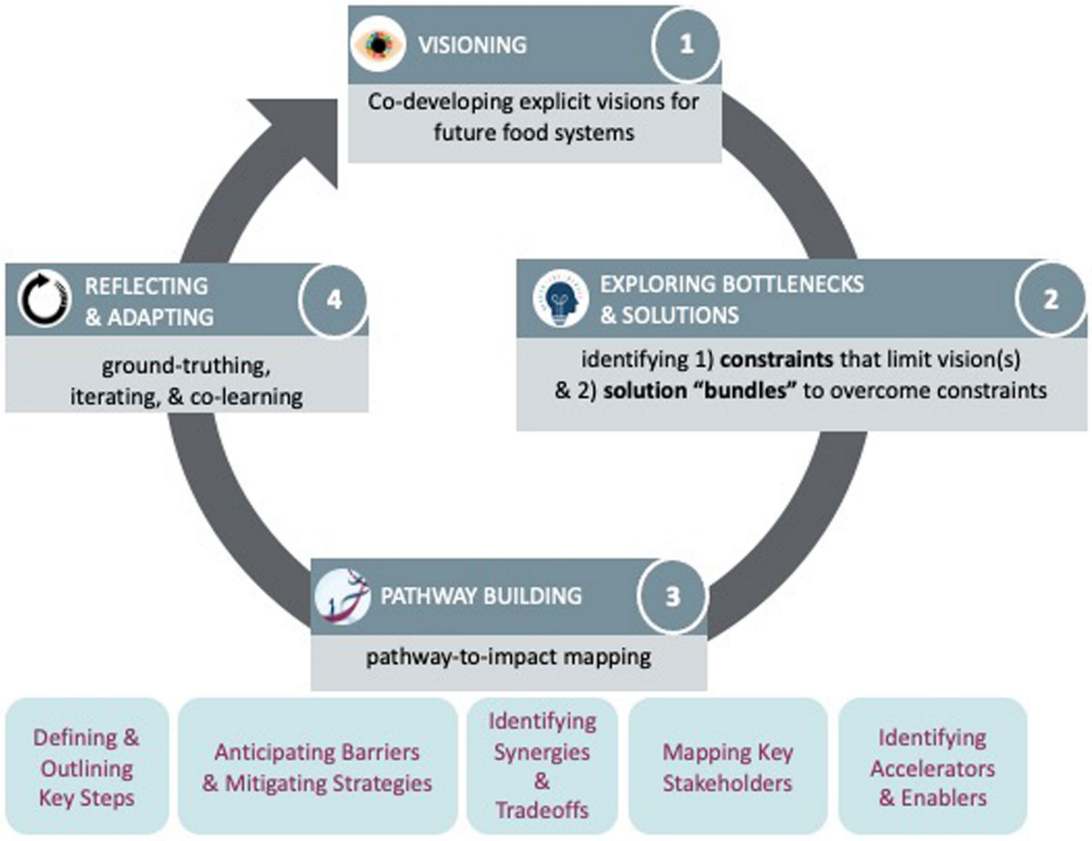

FIGURE 2
Summary of the 4 core process steps in the tailored food systems backcasting approach of the Innovative Food Systems Solutions (IFSS) portal.

1 *Ensure participant diversity* – Engaging a diversity of participants, representing different (including marginalized) voices as relevant to the sensitivities of the topic and context, enriches the process and the outputs.
2 *Clarify scope* – Clarifying the scope of the process as a co-creation and co-learning process, creates space for open-mindedness, team work, and learning from the other participants, rather than pushing one's own agenda.
3 *Foster active listening* – Including some time for the participants to connect with each other and with the facilitator group and further understanding each participants' background and interests helps in guiding the dialogue and in facilitating active listening amongst the participants. This can be done using fun and interactive exercises in between core working sessions that also connect to the process, for example role plays on distractive vs. active listening, collecting favorite words of one's native language, portraying some of the steps/solutions, etc. Also, airing assumptions about different stakeholder visions and goals early on in the process can be powerful and often leads to unblocking barriers and identifying unexpected synergies.
4 *Optimize participant engagement* – For each step of the tailored backcasting process, it has been important to allow time for individual brainstorming first and then bring ideas together in breakout groups in a structured roundtable or similar format, to ensure all participants are engaged and can provide their inputs. The process works well in breakout groups of 6 to 10 participants to optimize interactivity and inclusion.
5 *Tailor to context specificity* – Further tailoring the process for each specific context and application, included articulating specific objectives, setting a relevant visioning time horizon, targeting a number and considerate diversity of participants, contextualizing guiding questions, and logistical set up. For example, a backcasting process as part of national food systems dialogues in Denmark, focused on providing concrete building blocks for the national food systems transformation pathway, brought together experts and practitioners related to specific challenges in the Danish food system, and was run as an online session using Miro during 3 h. The backcasting process integrated into a 4-week university course focused on collaborative learning among students and professionals from different disciplines, was run in person and spanned over 3 days plus 1 day of sharing outputs and presentations. A backcasting process as part of an integrated landscapes program, started with a 2-day co-creation process with a multi-stakeholder group and was then further refined online over a period of 3 months. We further detail examples of specific tailoring in the case studies overview table (Supplementary material 4).

Two key challenges in applying this approach are worth expanding on and addressing. First, the power dynamics of – and relations within

and between – particular stakeholder groups must be understood and accounted for in this process in order to ensure genuine inclusion of underrepresented or undervalued groups. Without transparent, thoughtful and more equitable stakeholder engagement and inclusion in meaningful ways, the risk of "business continuing as usual" is high and the potential of aligning competing visions of desirable futures may remain unrealized. To explicitly address power dynamics and desirable shifts in power dynamics for transformative change, specific questions can be added to the backcasting process, as tested and suggested by Rutting et al. (2023). Second, acknowledging that transformational food system change is unlikely to be positive for everyone at all times is important. Building in planning and possible mitigation strategies for the short/medium/long term (as necessary) for groups that may feel the negative impacts of change at different points in time is critical to account for to improve equity and sustainability for the long term.

2.2 Case study settings

Here we provide background on the six case studies, spanning different contexts and geographical settings. An overview of the descriptive details of the six cases is further provided in Supplementary material 4.

2.2.1 Danish national food systems dialogue pre-2021 food system summit (in year 2021, in Denmark)

In April of 2021, the government of Denmark convened a facilitated backcasting process in preparation for the September 2021 UN FAO Food Systems Summit (Country Dialogue Report: Denmark, 2021). The Global Alliance of Improved Nutrition's (GAIN) Nordic office was engaged to support this process and worked with the IFSS Portal Initiative collaborative research team based at the Alliance of Bioversity-CIAT to facilitate a 3 h intensive online working session. This working session used backcasting to ground food system dialogues and guided participants in discussing potential pathways for food systems innovations to contribute to the SDGs. Session participants included a mixed stakeholder group of 90 individuals convened by the Danish government, including global professionals from around the world and across the food system, as well as national and international private sector actors. The group of 90 participants was divided into 8 breakout groups, supported by an IFSS facilitator. This interactive session was used as a collaborative tool to guide participants in developing pathways-to-impact for what they determined are potential game-changing food system transformation solutions, and to describe and elaborate on how selected specific game-changing solutions can be moved toward reaching potential positive impact(s) by 2030. A broad range of voices were engaged in the dialogue through four breakout group discussions in order to promote an open and frank discussion.

2.2.2 EATSafe food safety innovation challenge (in year 2022, in Nigeria and Ethiopia)

From April to October of 2022, the USAID-funded, "Feed The Future Initiative, EatSafe: Evidence and Action Towards Safe, Nutritious Food (EatSafe)," launched a call for applications for the EatSafe Food Safety Innovation Challenge, co-hosted by the GAIN and the SUNBusiness Network (Eat Safe Food Safety Innovation Challenge, 2022). This innovation challenge aimed to (1) enable lasting improvements in the safety of nutritious foods in Ethiopia and Nigeria, and (2) identify and support promising young innovators and SMEs in improving food safety in their countries. Additionally EATSafe looked to test and validate the use of backcasting as a methodology to strengthen food systems thinking and approaches of participants in the innovation challenge. Over 750 applications were received across both countries. After two screening rounds, a group of 20 finalist applicants from each country (40 shortlisted participants in total) took part in a facilitated training workshop with IFSS researchers to use the backcasting approach to help improve the conceptualization of their innovations, taking a futures-thinking and food systems approach. The online workshop series, "Backcasting: Moving Ideas Towards Actions for Impact," was conducted for each country cohort independently as 2 training sessions (90 min each) held 2 weeks apart. In the first session, an overview and walkthrough of using the methodology and the online IFSS Portal Initiative tool for self-guided pathway-to-impact mapping was shared. Participants then had 2 weeks to use the online tool and to develop vision statements and backcasting pathway-to-impact maps related to their pitch concept. In the second session, participants dove deeper into the methodology and reflected on the process with the IFSS Portal Initiative researchers to get feedback on their pathway maps generated from the IFSS Portal Initiative pathway-building tool, which were then included in their third round pitch submissions. These pathway-to-impact maps developed by each SME were reviewed in the final round of submissions by an expert panel convened by GAIN, the SUNBusiness network and USAID.

2.2.3 Professional development and graduate level course, hosted by Wageningen University & Research (in years 2022, 2023, 2024, in the Netherlands)

In February and March of 2022, 2023 and 2024 Wageningen University and Research (WUR) and Wageningen Centre for Development Innovation (WCDI) offered a blended graduate level course, "Food Systems for Healthier Diets" in a hybrid online/in-person format for a combination of students and practitioners (Wageningen University & Research, Wageningen Centre for Development Innovation, 2023). The overall objective of the course focused on developing food systems thinking and exploring transformations in the food system from a dietary perspective. The course further served to test and fine-tune how the IFSS Portal Initiative backcasting approach can be included as a co-learning capstone component to support transdisciplinary learning and to help encourage systems thinking, incorporating perspectives from different disciplines and experiences. The course has been designed by researchers at WUR and WCDI to bring together WUR graduate students and mid-career global professionals from public and private sectors from the global south in Africa, Asia and Latin America in the fields of food and nutrition, food science, economics, agriculture, or a related field of study in a 4-week intensive learning process. In 2022, the IFSS Portal Initiative food systems backcasting approach was integrated into the course as a 2 day online/in-person hybrid format facilitated by IFSS Portal Initiative researchers for 75 participants (50 students, 25 professionals from 8 countries) divided into 10 small groups (of 6 to 8 participants per group). In 2023 this was modified

and conducted as 3 day in-person set of facilitated group working sessions with 100 participants (50 students, 50 professionals from 21 countries) that were divided into 16 small groups (of 6 to 8 participants per group). In 2024 the in-person facilitation was continued and further fine-tuned as a 3 day process with a group of 60 participants (40 students, 20 professionals from 17 countries) divided into 10 small groups of 6 participants per group.

2.2.4 The central highlands ecoregion foodscape (CHEF) development (in year 2022, in Kenya)

From July 2022 through November of 2022 the Nature Conservancy and partners across the Mount Kenya region engaged in developing a pioneering, long term, collaborative landscape scale strategy to drive regenerative agriculture and food systems transformation for benefiting people and nature. The Central Highlands Ecoregion Foodscape (CHEF) in the central highlands region is a hotspot for wildlife on one hand and a hotspot of land use change, population growth and livelihood changes on the other hand. CHEF is taking an approach that connects multiple actors, challenges, activities, programs and goals in the foodscape, and that facilitates co-creation and co-learning among these actors. A food systems backcasting approach was applied together with representatives from producer associations, water use associations, local governments, businesses, NGOs, conservation communities, and researchers, to co-create a joint CHEF vision and pathways to get to those visions. Based on an initial stakeholder mapping, an in-person workshop was hosted in July 2022, including a visioning and pathway building session. This was further expanded upon during a follow up process with stakeholders, to fine-tune the vision and pathway during 3 months, leading to a more detailed theory of change for the CHEF program.

2.2.5 Business fights poverty global summit (in year 2023, in UK and global)

On June 22, 2023 a 90 min intensive hybrid in-person (London) and online (global) interactive workshop, "Partnerships for Systemic Change: Practical Approaches in Food Systems," was included as part of the Business Fights Poverty Global Summit 2023. The emphasis for the workshop was on the significance of collaboration and collective action in addressing complex challenges. The session was organized and supported by Nutrition Connect of the Global Alliance of Improved Nutrition (GAIN), the IFSS Portal Initiative, and the social enterprise, Glocolearning. 120 participants from around the world were in attendance, representing a diversity of private sector partners as well as non-profit and public sector partners. Through an interactive and informative session, participants (1) gained insights into backcasting as a practical approach for creating lasting systemic change in food systems and (2) contributed their experiences in various contexts related to the backcasting with a specific focus on accelerators of change (used in steps 3 and 4 of the IFSS Portal Initiative backcasting approach and adapted from Herrero et al., 2020).

2.2.6 Agroecological transitions program, Ucayali (in year 2023, in Peru) and Addis Ababa (in year 2024, in Ethiopia)

As part of work conducted by the CGIAR for building resilient and inclusive agricultural and food systems, backcasting was integrated as a collaborative learning and co-creation approach between public and private sector partners in Peru and Ethiopia as part of the Agroecological Transitions Program – Private Sector Incentives and Investments (ATP-PSii) project. This project aims to contribute to filling persistent knowledge gaps to better align public and private incentives, investments, and technical support to enable climate-informed agroecological transitions in low-and middle-income countries. In Peru, in November of 2023, 28 participants from across the agrifood system – from producers to agroindustry (transformation) actors, to consumers – were brought together to explore and co-create future visions and related incentives and investments for agroecological transitions in the Ucayali region. This region is a hotspot for biodiversity, and tense interactions between farming and Amazonian rainforest management are ongoing. Local government actors, producer associations, SMEs, NGOs, and researchers participated in a 2-day in-person workshop series, applying the food systems backcasting approach considering food consumption, processing and production in the region of Ucayali, Peru. An evening session focused particularly on engaging further with private sector partners and was hosted by the Chamber of Commerce in Pucallpa, Peru. Similarly in Ethiopia, in April 2024, 29 participants from across the agrifood system, participated in a 2-day in-person workshop, to backcast from future visions with a specific focus on co-creating incentives and investments. In Ethiopia, this process feeds into an on-going development of an agroecological policy framework at national level, and into on-going agricultural transition programs in the Doyogena area.

3 Results

Specific outputs and highlights per each use case are provided in the Supplementary material 4. Here we structure results cutting across the six different use cases of tailored applications of the food systems backcasting approach.

3.1 Articulated visions and pathway maps

A specific output of the backcasting process is an articulation of future visions and of transition pathways to get to these visions. Figure 3 provides examples of future visions and pathways to get there. The IFSS Portal Initiative website currently hosts 58 open-access pathway-to-impact maps, created through the backcasting approach (IFSS portal 2024). This cross-cutting approach has allowed for co-learning of how to build pathways for impact. For example, SMEs in the EAT-Safe challenge used existing examples on the portal to inspire their pathways. Further, it allowed for more systematic assessment of future visions and pathway thinking. The EAT-Safe jury used the developed pathways of participants to select for most promising systems approaches. The expert panel assessed these submissions according to the following criteria: (1) impact on food safety, (2) potential nutritional benefit, (3) adaptability to food systems in low-and middle-income countries, (4) scalability, and (5) environmental sensitivity.

Assessing visions and pathways across use cases, it is observed that:

- a diversity of food system actors play a role in future visions and change pathways. While in public debate, food and agricultural

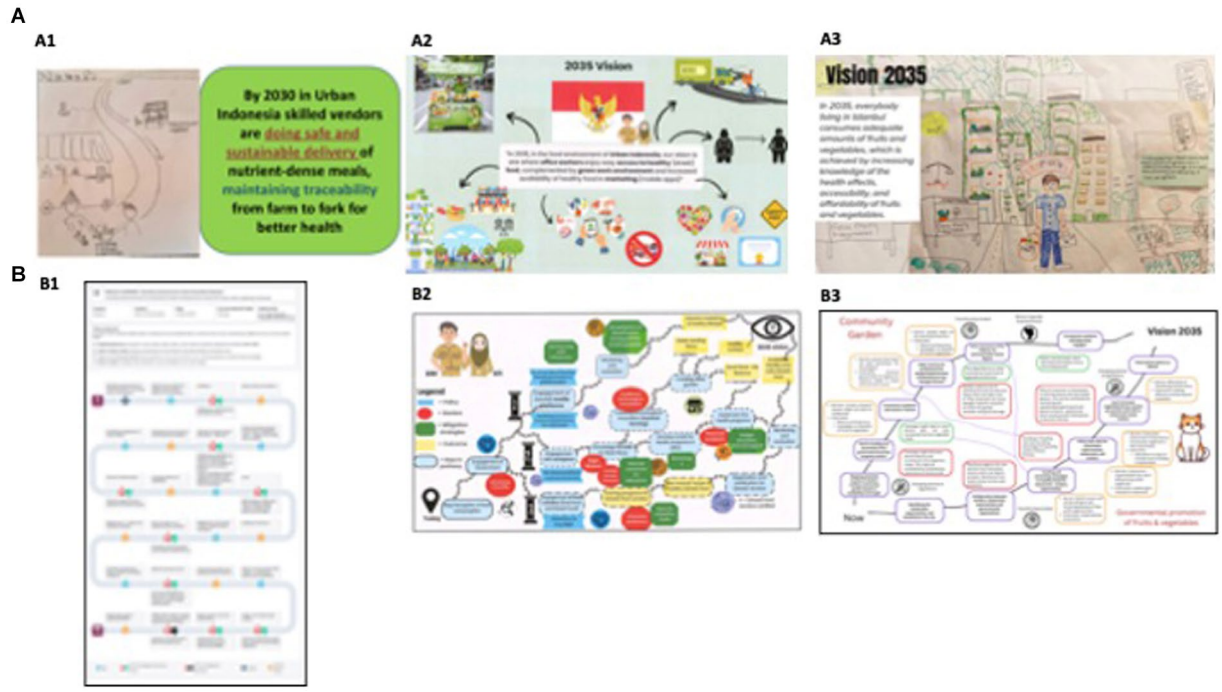

FIGURE 3
Examples of co-created visions and pathway maps. **(A)** Visions for food systems in urban Indonesia 1 **(A1)**, urban Indonesia 2 **(A2)**, and urban Turkey **(A3)**. **(B)** Examples of visualization of corresponding pathway maps for food systems change in urban Indonesia 1 **(B1)**, urban Indonesia 2 **(B2)**, and urban Turkey **(B3)**. Examples are from the WUR use case in 2023 **(A1,B1)** and 2024 **(A2,A3,B2,B3)**. **(B1)** Represents an example pathway output generated by the IFSS Portal Initiative. This output can be developed using the online self-guided pathway-building tool (including downloadable worksheets for use in internet unstable settings) on the IFSS Portal Initiative website. A gallery of over 50 pathway to impact maps created using this online tool can be found here: https://ifssportal.nutritionconnect.org/moving-to-action/backcasting-tool/explore. More examples of visions and pathways are also available upon request.

systems change is often still focused primarily on producers, taking a food systems approach in this backcasting process, emphasizes the potential role for a much broader set of actors for food systems change.

- barriers vary broadly across contexts but limited coordination among different food systems actors is a barrier that cuts across many of the pathways
- articulating barriers as well as anticipating synergies and tradeoffs for multiple goals, and then thinking of ways to overcome these barriers or manage for synergies or tradeoffs, pushes participants to explore and bring in innovative solutions which many are often not yet familiar with
- pathways are often complementary to each other and have common action points (e.g., longer-term contracts for enabling transitions, better policy integration between human health and environment). This underscores that multiple complementary pathways are possible and needed to contribute to positive change. When pathways were brought together for a specific context [e.g., CHEF, Agroecological transitions program (Peru & Ethiopia), synergies and tradeoffs between pathways could be explicitly discussed].
- articulating visions brought out differences and commonalities in future visions. While respecting differences and embracing plurality, sets of common elements in future visions could also be identified in each of the use cases.

3.2 Social-technological innovation bundling

All of the pathways developed during the tailored backcasting process included an integration of social and technological innovations. This was very explicit – and is perhaps not surprising – for the landscape approaches [CHEF, Agroecological Transitions Program (Peru & Ethiopia)], that at landscape scale bring together social (e.g., nested innovation hub structure, specific policy innovations for regenerative practices), with technological innovations (e.g., specific regenerative practices, changes in waste management, …) toward common visions. But this was also the case for more specific innovation-focused initiatives. For example, in the EATSafe Innovation Challenge case, an SME that focused on solar-powered cold chains in Nigeria, included several social innovations in its pathway toward its future vision, e.g., active feedback and learning loops with communities and local leaders, and new partnerships with local interest groups. Similarly, a group from the WUR course that focused on a social innovation bundle, i.e., youth ambassadors and women support groups, integrated several technological innovations, e.g., food safety tracing and green-energy empowered cold chain, toward its vision. Both judges of the EATSafe Innovation Challenge and assessors of the WUR course noted that participant proposals were enriched with clear and explicit linkages to between social and technological innovations, through anticipating barriers and risks

(e.g., possibly shifting power dynamics or market pressures, the dependency on infrastructure investments, regional political stability issues), and identifying beneficial opportunities outside of their initial innovation or business pitch (e.g., engaging more women and youth, building awareness, shifting mindsets). This illustrates that the backcasting process can concretely support bundling of social and technological innovations as called for by the expert panel on innovations to build sustainable, equitable, and inclusive value chains (Barrett et al., 2020).

3.3 Cross-sectoral collaborations

The purposeful inclusion of participants from various backgrounds and the food systems approach facilitated enhancing understanding, identifying joint strategies, concrete actions, and ways for addressing potential conflicting goals, across sectors. All resulting visions and pathway-to-impact pathways involve more than one discipline or sector, and all group-work facilitated processes included participants from more than two disciplines or sectors. This multisectoral collaboration resulted in various additional cross-sectoral outputs, depending on the use case. For example, in CHEF, the process has contributed to co-investment in the CHEF program and the establishment of a cross-sectoral innovation hub, by public and private sector partners active in environment, agriculture, climate, and nutrition, and also to the development of a common glossary to better understand specific terms across sectors. In the Business Fights Poverty process, public and private sector partners brought together lessons learned and ways forward for building partnerships for systemic change (Business Fights Poverty Insights Summary, 2023). The food systems dialogue in Denmark directly fed into a cross-sectoral national food systems pathway as part of the UN Food Systems Summit process (Reference to Danish food systems pathway). In the Agroecological Transitions Program (Peru & Ethiopia), the backcasting workshops contributed to a set of building blocks on incentives across sectors (gastronomy, processing, agriculture), that can enable agroecological transitions in the specific contexts, and to the planning of a series of follow-up co-learning activities that address specific issues across sectors (e.g., desired shifts from informal to more formal markets).

Using a food systems approach, the tailored backcasting approach asks participants to explicitly consider potential conflicting goals and unintended consequences across multiple food systems outcomes, including human nutrition and health, equity, and environmental health, and across multiple population groups, time and spatial scales. While not all tradeoffs can be managed or reduced, the process asked participants to explicitly articulate and anticipate them, supporting longer-term cross-sectoral anticipation. Many hands-on examples of this can be found in the pathways. For example, an SME participating in the EATSafe Innovation Challenge, that works on increasing food safety through meat delivery at the consumer's residence, identified as potential tradeoffs (1) that promoting this innovation could, possibly lead to an unhealthy increase in meat consumption, (2) that the transport might increase traffic and risks for the product transport drivers delivering the meat from farm to market, and (3) that unsold meat might be leading to increased food waste. Therefore they additionally planned to (1) include communication on raising awareness around healthy dietary guidelines and balancing meat intake according to recommendations, (2) providing protection gear for drivers and increasing awareness around limiting speed, and (3) to invest in storage capacities for managing a buffer quantity. Using the food systems tailored backcasting process, the SMEs in this case testified that they were triggered to plan for and consider multiple food systems outcomes, beyond only using their initial "strictly bottom line" financial balance sheet model that they entered the competition with, and that this made their business models more sustainable in the long-term.

3.4 Accelerators of change

A set of 10 accelerators (Supplementary material 5), adapted from Herrero et al. (2020) and Thornton et al. (2024) has been used in steps 3 and 4 of the applied backcasting process. The use cases validate the usefulness of this set of accelerators as a set of critical elements to consider in building a pathway-to-impact map and as a framework to help structure key steps in the process. In the initial use cases (2020–2022), these accelerators were brought into step 4, to reflect and adapt the pathways, and thereby map the accelerators to identified steps, barriers and ways to overcome those. Participants thereby pointed out that it would be helpful to have this set of accelerators as supporting guidance for building the pathway. Therefore in the later use cases (2023–2024), these accelerators were brought into step 3, to support already in building the pathway. Participants confirmed that the set of accelerators provided helpful guidance to identify critical steps working toward the visions. Further systematic assessment across pathways can explore and compare how each accelerator is pragmatically addressed in a given context, identify patterns and cross-pollinate between backcasting processes. This is outside the scope of this study and subject to future research.

3.5 Reflections from participants

As the application of the tailored backcasting approach across the diversity of use cases happened organically, we captured learnings and reflections from participants in varying ways.

A Mentimeter survey used as part of the WUR course (Figure 4), provided insights that the process particularly contributed to food systems thinking, as well as to exploring new ideas, critical thinking, problem solving and learning from others.

A survey of participants in the Danish food systems dialogue, captured reflections at the end of the session, and results emphasized two key value-adds of this approach, namely that (1) the tailored backcasting methodology helped to spark high levels of creativity and diversity of options by each of the 8 breakout groups, and (2) that the collaborative backcasting exercise served as a holistic and more democratic way of creating transformational pathways-to-impact with actionable steps for making progress across the focus areas, as compared to more static expert panels and strategy drafts.

Video testimonials are available from EATSafe Innovation Challenge finalists (IFSS Portal Initiative, 2024). Participants testified that they highly valued the backcasting approach as a process to think of the food system beyond their own business. As an example, one participant shared that, "the backcasting process was an amazing experience to help me think through the process from where we are

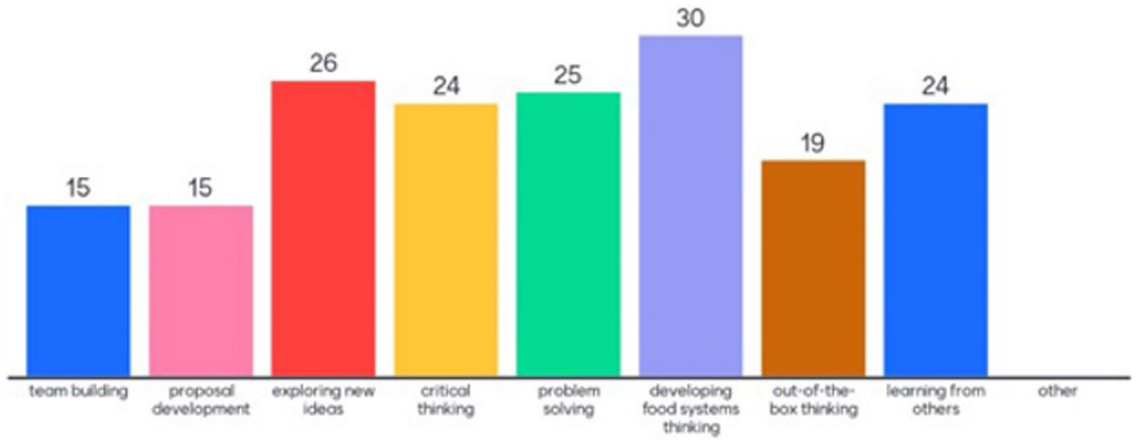

FIGURE 4
Example of mentimeter results on perceived added value of backcasting process for their work and study among participants of the WUR 2022 course. The question raised was 'From your perspective, to what parts of your work or study does this backcasting process add value?'

at now as a start-up to where we would like to be in the next 10 years. I loved the various ideas and how the pathway map is set up to make us think of the system outside of our business. I encourage every entrepreneur out-there, if you are thinking about starting a business, go through the pathway map backcasting process!" In the final project report, additional testimonials are documented and shared (Global Alliance for Improved Nutrition (GAIN) and the Scaling Up Nutrition (SUN) Network, 2023).

A Mentimeter survey, together with a roundtable of reflection in CHEF, illustrated that 100% of participants learned something new during the process that was relevant to their work, and 92% of participants explicitly noted that the process "changed their way of thinking," related to their understanding of both food systems and opportunities in the region. This was similar for the Agroecological Transitions Program (Peru & Ethiopia), where in a roundtable of reflections, 100% of the participants shared something they learned during the process. Learnings varied widely from more clearly seeing the connections between sectors, gaining a better understanding of certain terms and vocabulary (e.g., agroecological), to learning about the visioning and backcasting process itself.

Moving forward, we are developing a more standardized approach to systematically capture learnings, reflections and recommendations from participants.

4 Discussion

This study describes the application of a tailored backcasting approach with a food systems lens to six diverse use cases, including a national food system dialogue, a youth business innovation challenge, a landscape multi-stakeholder platform, a public-private sector co-learning session, an agroecological transitions program, and a hybrid food systems university course for graduate students and global professionals. Across the six agri-food use cases, innovations are linked to broader food systems thinking and visions. Several consistent insights emerge that contribute to the literature on visioning and participatory scenario building in other social-ecological systems work (Bennett et al., 2016; Fazey et al., 2020; Scoones et al., 2020; Rutting et al., 2023).

For food systems change, participatory futures thinking and visioning serve as a powerful means of communicating values of food systems actors. Building more explicit visions illustrates a diversity of thinking and a diversity of assumptions that is easily lost when a structured, co-learning process for articulating these visions is not included in planning approaches. Creating this space for pluralism and explicitly stating these assumptions are considered important aspects for transformative change governance (Visseren-Hamakers et al., 2021).

Further, critical tradeoffs were most clearly identified as different stakeholder viewpoints are shared early in the backcasting process. This can allow for the resulting pathways-to-impact maps to account for different areas of impact such as nutrition, environmental health, and equity, as well as considering impact for different population groups (Herrero et al., 2021). Articulating potential tradeoffs and synergies contributes especially to the bundling of innovations, partner engagement and collaborations, and around making investments of time and resources, when large uncertainties exist around longer term possible futures (Herrero et al., 2021; Barrett et al., 2022). Accounting for a diversity of stakeholders and plausible trade offs and synergies can inform practical anticipatory and adaptive governance (Herrero et al., 2021; Visseren-Hamakers et al., 2021).

Building narratives thereby provides a pragmatic way of deep engagement with future uncertainty, laying out important dependencies and connections in food systems that surface underlying values and logic of how this future came to be and functions. The potential and need for shifts in power dynamics is thereby also an important part of transformative change that is often not made explicit (Rutting et al., 2023). To address this more explicitly and systematically, core questions on power dynamics can be added to the process as tested and recommended by Rutting et al. (2023).

While future forecasting methodologies can be important statistical tools for short-to medium-term (~5 years) projections, when one is relatively certain that the future is going to follow the same patterns and exist under the same assumptions as past conditions (i.e., business as usual), these methods do not take into account unforeseen events or innovations, nor large uncertainties in social,

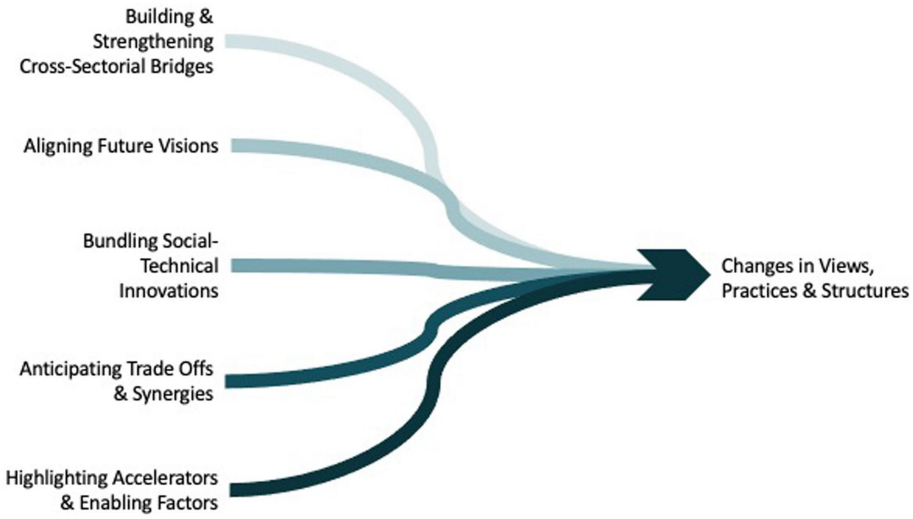

FIGURE 5
Five mechanisms through which the backcasting process contributes to changes in views (e.g., aligning visions), practices (e.g., bundling social and technical innovations), and structures (e.g., cross-sectorial) based on the experiences of the use cases.

political, economic and/or environmental factors (Zurek and Henrichs, 2007; Wright, 2013; Milojević and Inayatullah, 2015). Different from future forecasting, backcasting allows for a holistic and creative approach to exploring a wide range of plausible futures and helps to create adaptable action pathways to achieve these visions from where we are today (Quist and Vergragt, 2006; Vervoort et al., 2014; Kanter et al., 2016). This is where some of the most critical tradeoffs may be identified as different stakeholder viewpoints are articulated, shared, discussed and assessed (Mason-D'Croz et al., 2023).

It is important to consider various limitations of the study and the backcasting approach. This approach is a qualitative process developing hypothetical, desirable futures and pathways, and not a quantitative forecasting of the future nor project workplan. It can serve as a starting point (or multiple) for scenario modeling and for more quantitatively monitoring and tracking of anticipated tradeoffs and synergies (or their proxies) as a pathway map moves from an imagined, hypothetical toward implementation moving into the future. It is thereby complementary but not an alternative to future forecasting.

Another limitation is that the IFSS food system backcasting approach has been evolving over time and continues to evolve. Through each instance of introducing, teaching and facilitating the use of this approach, the process itself has been tailored to the specific context, objectives, and the practical needs of the stakeholders involved. It is therefore not a fully standardized process, which limits systematic comparison between resulting pathways-to-impact maps and across use cases themselves. However, lessons learned across these use cases have allowed us to identify the most essential elements: visioning, considering social and technological innovative solutions as bundles or in combinations, anticipating tradeoffs and synergies, and mapping and connecting stakeholders and actors in a particular context. Toward future applications, explicit questions on desirable shifts in power dynamics will also be added (Rutting et al., 2023). Without transparent, thoughtful and more equitable stakeholder engagement and inclusion in meaningful ways, the risk of "business continuing as usual" is high and the potential of changing dominant harmful paradigms may remain unrealized. It is therefore important to investigate and explicitly consider relevant power dynamics that might hinder change, in advance to the process and to thoughtfully apply good practices of facilitation to include a diversity of voices, and where useful, adapt or add additional good facilitation practices to the ones described here.

Considering these strengths and limitations, we have found that the applied backcasting process, when considering good practices of facilitation, can contribute to changes in views, practices and structures, as part of food systems transformation, through five mechanisms: aligning futures visions, building and strengthening cross-sectoral bridges, highlighting accelerators and enabling factors, anticipating tradeoffs and synergies, and bundling social and technological solutions together (Figure 5). Pragmatically, the use cases illustrate that the backcasting approach can be feasibly integrated as a co-creation and co-learning process into innovation challenges, program development, policy development, multi-stakeholder platforms, and business development. More systematic analyses of the pathways-to-impact resulting from this approach can provide a way to compare and identify trends and further strengthen steps in the backcasting process itself.

5 Conclusion

The six different use cases illustrate how a food systems tailored backcasting process can be applied to a diversity of settings and integrated into a diversity of programs. Multiple types of immediate outputs have resulted from this process, including the pathway to impact maps, and learnings from participants. Also more fundamental processes for food systems change consistently emerge, such as social-technological bundling of innovations, concrete cross-sectoral collaborations, systematic consideration of accelerators and enablers for change, and strengthening food systems-and innovative solution-thinking among a diversity of participants. The qualitative nature of backcasting requires careful consideration of facilitation practices and power dynamics among participants. In addition, explicit questions on desirable shifts in power dynamics can be further integrated into the approach.

Data availability statement

The pathway datasets presented in this study can be found in an online repository at https://ifssportal.nutritionconnect.org/moving-to-action/backcasting-tool/explore.

Author contributions

RR: Conceptualization, Funding acquisition, Investigation, Methodology, Writing – original draft, Writing – review & editing, Formal analysis, Supervision. HZ: Conceptualization, Data curation, Investigation, Methodology, Software, Writing – original draft, Writing – review & editing, Formal analysis, Visualization. DM-D'C: Writing – review & editing, Methodology, Project administration, Validation, Funding acquisition. CK: Writing – review & editing, Methodology, Project administration, Investigation. PT: Writing – review & editing, Validation. CP: Conceptualization, Funding acquisition, Project administration, Methodology, Writing – review & editing, Supervision. FC: Writing – review & editing, Investigation, Methodology, Formal analysis. DS: Writing – review & editing, Validation, Funding acquisition, Resources. IB: Writing – review & editing, Validation, Funding acquisition, Resources. DB: Writing – review & editing, Validation, Funding acquisition, Resources. TB: Writing – review & editing, Validation, Investigation. SM: Writing – review & editing, Validation, Investigation. YI: Writing – review & editing, Validation, Investigation. JS-C: Writing – review & editing, Validation, Investigation. JM: Writing – review & editing, Validation, Investigation, Funding acquisition, Supervision. NB: Writing – review & editing, Validation, Investigation. DT: Writing – review & editing, Validation, Investigation. YB: Writing – review & editing, Validation, Investigation. ME: Writing – review & editing, Validation, Investigation. MM: Writing – review & editing, Validation, Investigation. BS: Writing – review & editing, Validation, Investigation. RM: Writing – review & editing, Validation, Investigation. EA: Writing – review & editing, Validation, Investigation. MH: Writing – review & editing, Supervision, Funding Acquisition.

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Conflict of interest

Authors RR, HZ, FC, TB, SM were employed by company Glocolearning.

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

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2024.1378883/full#supplementary-material

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