Transformation of food and bio-based systems: the perspective of WUR social scientists

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Imagine a future where you eat food and wear clothes without worrying about the environmental and social costs. Well-thought through visions for the future exist—but how will we get there? What would be the costs and benefits of such a transition? And who will be affected most? To answer those questions is where the expertise of social scientists comes in.

This longread highlights the work of WUR social scientists that study system transformation and apply it in target countries, communities, and food systems to contribute to a better understanding of food and bio-based system transformations.

Box 1. Symptoms versus structure. Symptoms of current food and bio-based systems are very visible and receive ample (political) attention, while the underlying patterns, structures and paradigms that cause these symptoms to recur receive less social and academic attention. The same is true for the current EU Green Deal, and more specifically its Farm-to-Fork Strategy. It mainly aims to support ecosystem functions but does not devote specific attention to structural system changes.

Mathijs and Wauters, 2020

1. Towards a robust interpretation of transformation

Globally, there is intense debate on system transformation, but what is understood by 'transformation'? Given its complexity, it cannot be captured in its full extent by one definition. Yet, we start out from the following understanding (Box 2).

Box 2. What is transformation of food and bio-based systems? Transformation of food and bio-based systems is the process of fundamental shifts in their structures, processes, relationships, behaviours, and values. It involves reimagining entire ecosystems to align with sustainability and bio-based resource use. In addition, it extends to the adaptation to external pressures like climate change and habitat disruption.

Based on Meuwissen et al., 2019, Termeer and Metze, 2019, and Hoes et al., 2023

In Box 2 we refer to *ecosystems* as food and bio-based systems are part of complex networks of interconnected systems spanning domains such as energy, mobility, leisure, nature-based systems, or digitalisation.

Transformations address grand system challenges which may take a long time and large investments. They go beyond improving current sectors or adopting a single innovation. Transformations include a break-down and phase out of unwanted practices as well as the scale up of systemic innovations into the mainstream (Figure 1).

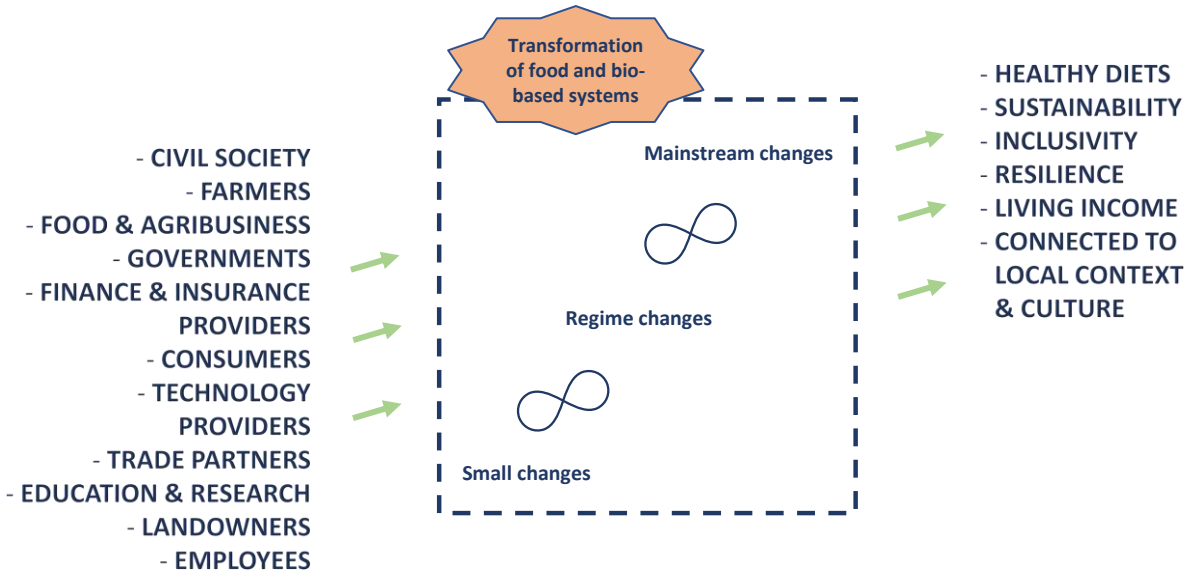

Figure 1: Transformation of food and bio-based systems relates to major changes. System actors (left-hand side of figure) are part of the change and/or play an incentivising role. Transformation generally targets higher-level system outcomes (right-hand side). The adaptive cycle symbols indicate that it is a dynamic process that takes time. Dotted lines indicate that food and bio-based systems are not closed systems, but they are part of interconnected systems such as mobility and energy systems.

Transformation is mostly assumed to be positive, i.e. targeting higher-level system outcomes. However, in practice, trade-offs between outcomes (functions) may exist, for example between higher levels of resilience due to more buffers in a system, and the associated immediate costs. Also, the distribution of costs and benefits needs to be considered, as well as the subsequent question whether this transformation is socially/ethically just (Timmermann, 2020).

Box 3. Food and bio-based systems. Food and bio-based systems include all the elements (environment, people, inputs, processes, infrastructure, institutions, etc.) and activities that relate to the production, processing, distribution, preparation, and consumption of food and bio-based products, and the outputs of these activities, including socio-economic and environmental outcomes.

Fresco et al., 2021

2. Transformation is not always "makeable" or intended

What can be done to steer or influence food and bio-based system transformation? Different routes exist, ranging from actively providing incentives towards transformation to transformation that emerges spontaneously as a result of the interplay between multiple factors (Figure 2).

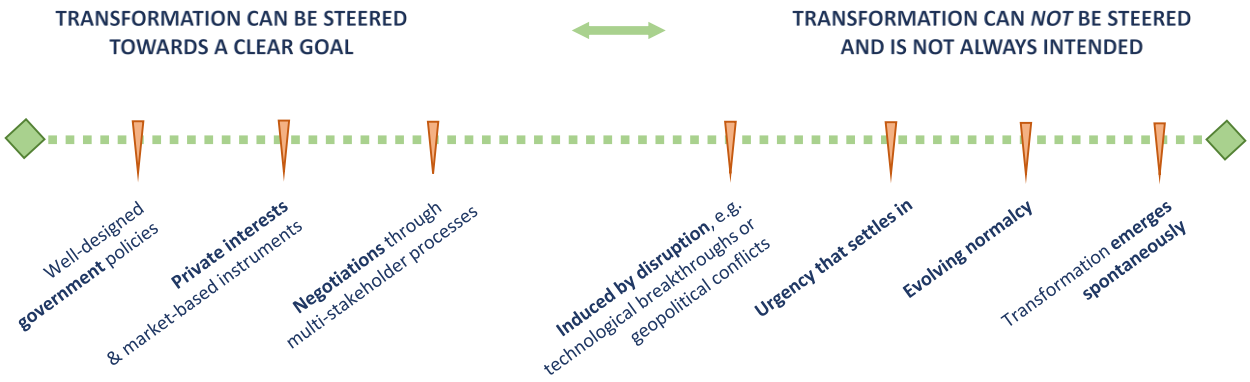

Figure 2: Transformation can occur through multiple routes ranging from targeted steering to a spontaneous process. The arrow indicates that in practice combinations of different routes occur.

2.1 Active steering of transformations

The concept of active steering of transformations is based on Dengerink et al. (2022), who assume that actors can influence transformation processes, e.g. through well-designed government policies or private interests which drive changes. They also see a role for multi-stakeholder negotiation processes which try to reconcile the inherent conflicting interests of different actors. Table 1 provides examples of strategies and instruments which aim to influence or induce transformation.

Table 1: Examples of strategies to influence or induce transformation, underlying assumptions, and examples from practice.

Strategies	Assumption	Examples
Transition funds	Compensations for firms who want to change.	Supporting design of biomass energy initiatives to minimise the use of firewood.
Legal measures	Taxes and subsidies to stimulate change.	- Sugar tax. - Soil fertility treatment subsidies.
Government incentives	Governments appeal to private firms to act more responsibly through corporate social responsibility, and collectively through covenants and labels.	- Textile covenant. - Reducing plastic waste. - Healthy diet labels.
Lobbying and advocacy	Firms and other organisations in power influence politics, both resisting or initiating change based on their interests. Shifts in power happen and shape food system narratives and space for change.	- 1950-60s: Government (Mansholt). - 1960-70s: Agri-cooperatives. - 1970-80s: Retail multinationals. - 1980-00s: Multinationals. - 2000-now: Upcoming environmentalist movements.
Multi-stakeholder dialogues	National dialogues on the future of food systems create transparency about stakeholder interests and how these influence food system performances. The pathways that are agreed upon will ideally influence policy and investment.	- National dialogues. - Agriculture for nutrition and health (A4NH) addresses the triple burden of nutrition nationally and regionally.
Funders, philanthropy	Funding addresses capacity gaps so that systems can shift faster/deeper.	- Rockefeller Foundation. - Bill & Melinda Gates Foundation.
Market-based instruments	Incentivise change through premiums and penalties ('carrot & stick').	- Banks: interest rates based on sustainability measures.

Strategies	Assumption	Examples
		- Dairy processors: milk premium based on planet-proof practices.
Niche initiatives	Niche initiatives likely scale up, deepen, broaden, or spread.	- 'Heerenboerderij' and other community-driven activities. - Community tree planting and agroforestry initiatives.
Citizen actions including protests	- Through changes in individual behaviour, citizens influence the behaviour of other stakeholders such as private firms. - Mobilising target populations with the aim of achieving collective behavioural change.	Changes in political landscape through elections.
Changing consumer behaviour	Through changes in individual behaviour, consumers influence the behaviour of other stakeholders such as private firms.	Consumer demand for plant proteins.
Political economy	Blaming & shaming strategies by NGO and other interest groups raise the sense of urgency for change.	- 'Wakker Dier'. - Greenpeace. - Oxfam. - African Union Great Green Wall initiative; focuses on ending or reversing land degradation and loss of biodiversity in African drylands.
Living labs	Findings from experiments are taken up by practice.	- Demonstration farms. - Urban Living Labs (AMS Institute)[1]. - Food System Labs across Sub-Saharan Africa.

[1] Brons et al. 2022.

Box 4. Transformation is not easy. The difficulty of achieving system transformations is that people know the existing situation and it offers benefits for many, while there is uncertainty about the costs and benefits of an alternative, more sustainable future economy. This uncertainty is higher if viable alternatives and adaptations are still under development.

Based on Köhler et al., 2019, and Hoes et al., 2019

More in general, discussions about future transformations are cumbersome due to various factors, such as human mental models which tend to focus on maintaining the status quo, overly narrow perceptions of imaginable futures, experts being educated mostly towards improving efficiency, and a series of vested interests, mutual dependencies, and institutional path dependence creating lock-in situations.

Meuwissen et al., 2020

2.2 Transformations are not always intended

In contrast to active steering, transformation may also occur as the result of a spontaneous process and the unintentional interplay between multiple factors. Four examples illustrate the ways in which this may happen.

Change induced by disruption refers to relatively abrupt changes that can occur because of events such as natural disasters, geo-political conflicts, or technological breakthroughs. These disruptive events can have a significant impact on the food and bio-based system and can drive rapid changes in practices, technologies, and policies. Yet, disruptive changes may also occur due to shifts in the power balances in a system.

Vested interests may be protected by those stakeholders having most (and different forms of) power, therefore resisting changes that challenge their interests. Yet, changes in power dynamics may overcome such conservative powers, and catalyse rapid changes which may become disruptive to the system. An example are the court cases won by Dutch environmental agencies after the adoption of EU legally endorsed national guidelines for nitrogen emissions.

Transformation can also emerge from an ***urgency that settles in***, not only as a deliberate or intentional process, but as a response to various (simultaneously occurring) factors that drive change. An example is the ongoing energy transition, simultaneously driven by the need to reduce greenhouse gas emissions and increase energy security, as well as by political protest to the war in Ukraine. Similarly, in the case of food systems, we observe how a growing urgency to address issues such as food insecurity, diet-related health problems, and environmental degradation, is complemented by various additional factors, such as high inflation, pandemic disruption, and geo-political conflicts, that together drive the transformation of the food system. This urgency may be further stimulated by increasing public awareness and engagement, changes in consumer behaviour, advances in technology, and shifts in government policies and regulations.

Evolving normalcy can refer to gradual changes that occur over time, such as changes in consumer preferences or advancements in technology. These changes can drive the development of new practices, technologies, and policies, leading to a transformation of the food and bio-based system. With populations becoming increasingly diverse, systems are evolving to accommodate varied needs and preferences. Combined with technological innovations, this changes food system dynamics.

Transformations can also emerge ***spontaneously***, without being the direct result of a deliberate goal. Sometimes, change occurs as a result of complex interplays between various factors, such as economic, social, cultural, and political factors, as well as technological advancements, natural disasters, and other unpredictable events. In such cases, transformation can be seen as an emergent property of complex systems, rather than the result of a single cause or intentional action. However, it's worth noting that even in the absence of a deliberate goal, individuals and organisations can still shape and influence the direction of transformation through their actions and decisions. Understanding the dynamics of change and proactively adapting to shifting circumstances, can help steer transformations in directions that align with desired values and interests.

Box 5. Transformation takes time. Food and bio-based system transformations have time-bound dimensions. In their typical configurations, transformations take place through longer-term and continuous—not necessarily fluent—change processes. These navigate through different phases (emergence, diffusion, and reconfiguration) and at different levels in the system: micro, meso, and macro.

Based on Leicester, 2020, and Leeuwis et al., 2021

3. What WUR social scientists do

The field of agri-food system transformations isn't unchartered territory, as it is part of a long-standing Wageningen history of understanding the societal drivers and impacts of food and agricultural systems' dynamics.

The work of WUR social scientists covers the entire domain of the transformation of food and bio-based systems, i.e. the change processes (transformation) and the envisioning, structure, and performance of new (i.e. newly transformed) systems (Figure 3).

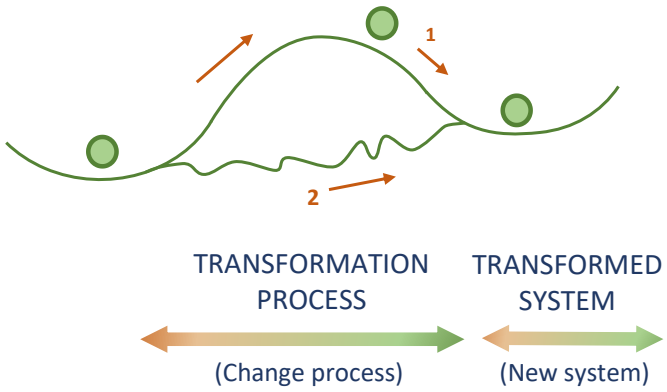

Figure 3: System transition occurs after a tipping point (1) or as a result of multiple small changes (2). WUR social scientists work along the entire domain, i.e. the change processes, and the envisioning, governance, and performance of new systems (Figure: Meuwissen et al., 2019).

Due to the specific characteristics of food and bio-based systems (Box 6), their transformation and its conceptualisation require specific frameworks and approaches. The six core areas of expertise of WUR social scientists are highlighted below. The list of example projects mentioned therein is not exhaustive.

Box 6. Food and bio-based systems are different. Most food is produced by small and medium-sized (family) businesses that are highly dependent on input and output streams from other organisations as well as on factors such as the weather. As such, farms are not powerful multinational organisations with whom governments can negotiate new 'license to produce agreements' to achieve more sustainable and resilient systems. Further, farming is not structured around 'core' technologies that can be replaced to achieve radical change. Instead, farmers often spread investments and improve their farms using piecemeal engineering, i.e. bit by bit.

Based on Hardaker et al., 2015, Hoes et al., 2019, Hebinck et al., 2021, and Mishra et al., 2024

Expertise area 1: Theories and frameworks to guide transformation. A well-established framework is the *small-wins governance framework* (Termeer and Metze, 2019; Termeer, 2024). It builds on the principle that transformative change can be facilitated through accumulating small wins. The framework is frequently used to evaluate innovation policies, for example. Another useful framework is the *multi-level perspective framework* (Leeuwis et al., 2021) which guides users in understanding the complex (multi-level) structure of food and bio-based systems. The multi-level perspective indicates that system change can be understood best if one moves beyond rational engineering approaches and looks for approaches that anticipate and accommodate inherent social tensions and struggles in processes of changing food system dynamics and outcomes. In addition, as learning is an important part of change,

the *learning in transitions framework* (Van Mierlo and Beers, 2020) has found its way to practice. In addition to learning processes, the framework also addresses superficial learning, unlearning, and learning to resist change. A fourth framework mentioned here relates to the capacity of systems to adapt and transform to changing circumstances, disruptions, and unknown risks: the *resilience framework for farming systems* (Meuwissen et al., 2019) provides a systematic framework for understanding the various aspects of resilience, such as measuring resilience performance and system attributes enhancing resilience. A useful short-list of these attributes is presented by De Steenhuijsen Piters et al. (2022).

Expertise area 2: Envisioning of future systems and design of pathways. Developing transition pathways is a suitable way to explore routes towards more sustainable and resilient food and bio-based systems by involving a range of actual and potential stakeholders (e.g. Dijkshoorn-Dekker et al., 2021; Reidsma et al., 2023). The main benefits lie in the collective envisioning of alternative futures for a certain food system, and in enabling the development of an action perspective to attain these visions, even if they seem unrealistic at present. WUR social scientists lead foresight and pathway projects and initiatives at various levels, from farming systems (Hoes et al., 2023), to consumers, producers and organisations (see e.g. Transpath – led by F. Alpízar and J. Nel), and low- and middle income countries (see e.g. FoSTr – led by H. Brouwer and J. Dengerink). Klerkx and Begemann (2020) elaborate on the role of mission-oriented agricultural innovation systems to enable transformations.

Expertise area 3: Understanding societal and actors' needs and behaviour as the basis for technological solutions (not the other way around). Understanding societal needs is indispensable for enabling differentiated and thus more contextually fitting approaches to transformation (Wertheim-Heck and Raneri, 2020; Van der Gaast et al., 2023). Farmers' behaviour is found to be a crucial component within transformation processes, see e.g. Sok et al. (2021) and De Lauwere et al. (2022). The latter conclude that step-by-step processes are better suited to the nature of agriculture.

Box 7. Unique position of WUR social scientists to work on food and bio-based systems' transformations. WUR social scientists are well positioned to study transformation of food and bio-based systems. First because the Social Science Group hosts social scientists from multiple disciplines, i.e. from law to sociology and from anthropology to economics. Therefore, research outcomes, such as transformation pathways, are more complete and go well beyond disciplinary thinking. Second, WUR social scientists are close to their natural science colleagues as everyone functions under the OneWageningen umbrella of WUR. This proximity facilitates a good understanding of new technologies, for example, enabling a better understanding of the feasibility of envisioned systems. Third, profound sector knowledge and close contacts with business and governments enable WUR social scientists to easily connect with practitioners to discuss ideas. Such 'reality checks' increase the impact of our academic work. Fourth, the WUR global network and globally distributed partnerships facilitate a better understanding of the food and bio-based system transformations – as drivers and solutions often play globally.

Expertise area 4: The consumer perspective. Developing social-differentiated pathways means taking a community-based perspective on transformations. Ultimately the transition takes place via the daily food consumption of people across the globe. WUR social scientists apply consumer theory to better understand consumer behaviour in relation to new food technologies and systems. Examples include the transition to plant-based proteins (A. Fisher) and the use of reusable packaging (E. van Herpen).

Expertise area 5: New modes of governance including business models, finance, and risk management. As part of the transformation to new food and bio-based systems, governance is also changing. Explicit inclusion of environmental and social issues plays a central part. For instance, how can environmental and social costs be priced in final products (true cost pricing – K. Boone) and how does it influence corporate firms' decision-making structures (M. Annosi – among others) and farm-level business models (H. Kortstee – among others)? How can new collective organisations reward improvements in the delivery of ecosystem services related to environmental and social performance (e.g. SoilValues – H. Saatkamp and B. Smit, and InbestSoil – V. Materia)? The influence of environmental, social, and governance (ESG) performance on decision making around finance, insurance and other forms of risk-sharing is discussed in Autumn 2024 at a seminar entitled "Financing sustainable and resilient transitions" – a joint WUR Social Science initiative under the banner of the European Association of Agricultural Economists (contact: M. Meuwissen).

Expertise area 6: Modelling economic, environmental, and social implications of transition. At macro-level, existing economic models mostly ignore material cycles and recycling, as well as co- and by-production of products and materials (Pyka et al., 2022). WUR social scientists work on improving macro-economic models to enable a better understanding of implications for trade flows, prices, global food security, and environmental performance – and their distribution across territories (contact: H. van Meijl). At the so-called 'micro-level', economic, environmental, and social implications of transformations are modelled at multiple scales, e.g. for farms switching to strip agriculture (J. Sok), for regions switching to mixed farming (F. Ang), and for entire food systems switching to locally-embedded high-tech and data-driven systems (M. Koppenberg). Implications at household level are also considered (T. Achterbosch).

Box 8. From research to education. The thinking about transformations in food and bio-based systems is progressing. Concepts, frameworks, and applications are continuously integrated in education. It is good to see the enthusiasm of WUR students from all science domains to discuss and think through new food system structures, governance modes, paradigms, and values – and ways to get there.

All these expertise areas illustrate the contributions of social scientists in the pursuit of more sustainable and resilient food and bio-based systems. Our WUR colleagues mentioned, and their respective team members, help illuminate the path towards change processes, and new food and bio-based systems in which environmental and social costs are included, and which connect better to local context and culture.

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