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Editorial: On-farm implementation of transformative technologies and practices for sustainability transitions in agriculture

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Editorial on the Research Topic

On-farm implementation of transformative technologies and practices for sustainability transitions in agriculture

There is increased pressure on agri-food sectors globally to transition to more sustainable food systems (Klerkx and Begemann, 2020). Transformative technology and practices advocated by scholars and policy makers include digitalization and automation (Ingram et al., 2022; Kukk et al., 2022), agroecological systems (Wezel et al., 2020), diversification (Roesch-McNally et al., 2018), de-intensification, local food systems, circularity (Velasco-Muñoz et al., 2022; Bracke et al., 2023), transformative value chains (Mechri et al., 2023), and land-use change for net zero. These practice changes ultimately need to be implemented at a farm scale, but the implications will impact regional and global food systems.

Theories of transformative agricultural technologies and practices are widely researched and modeled. However, greater scholarly focus is required on the farm system level implications, including the positive and negative effects on the livelihoods of those being urged to change (Vermeulen et al., 2018). Transformation can be a complex process that intersects land, livelihoods, and security of the wider food supply system. Moving from theoretical concepts to reality in farming systems can be difficult to implement for farmers due to unforeseen implications (Romera et al., 2020). Better understanding of farmer experiences is needed for effective and viable transformation.

This Research Topic includes nine articles related to innovation processes, land use transitions, roles of advisors, application of agroecological practices, and farmer perspectives in change processes. The research represents regional contexts including Kenya, Australia, the UK, the Netherlands, Ghana, and the Philippines.

Farmers or land managers are at the front line of both sustainability challenges and societal pressure to change approaches to agricultural production. The process of change

can involve significant uncertainty and risk, therefore empirical studies of novel practices are vital to provide farmers with evidence and knowledge of what change processes actually involve including associated challenges and benefits. Juventia and van Apeldoorn note that there are limited empirical studies related to diversification using intercropping. Their study evaluated the edge effects of strip cropping in the Netherlands and highlights the importance of practical management considerations when designing crop systems. More broadly, in their research of agroecological design in Kenya, Kuria et al. show that it is vital to understand constraints to agroecological transition that are context-specific, from soil and water constraints to implications of household dynamics. While including farmers in co-design and experimentation is critical to achieving positive change, Stone et al. highlight that this approach will only lead to sustainable transition if integrated in governance frameworks and value chains that support the farm systems. They also note that care is needed to ensure collaboration does not only involve more privileged farmers while excluding those who have the biggest impediments to change.

Dumas et al., in their study of Ghanaian agroforestry transitions, highlight the role of blocking mechanisms, such as institutional frameworks with land tenure security, uncertainty related to long-term investments, and lack of financial resources or access to finance of upfront investments. Farmer knowledge, confidence in managing new systems, and negative past experiences are important in such changes. Through a study of an innovative tiller device for Laboy fields in the Philippines, Manalo et al. examined scaling ingredients and highlight that while popular, some components of land practice change may not thrive if specific conditions are not met. They also propose the role of altruism in successful scaling, an important insight deserving further research attention. Acceleration and sustainable scaling of agroecological integration for greening in Kenya 'requires tools and processes that foster responsive external support for community empowerment, agency, and action' according to Fuchs et al. Transformation agendas need to be driven by local communities to ensure sustainable change.

Critical to scaling are farm advisors and extension networks. Jakku et al. highlight the role of advisors in longer term decision making for farmers, in a context of regional uncertainties in a changing climate. The authors show how advisors can be important trusted intermediaries for information and change practices, especially in contested spaces such as climate change, as they can make personal connections, and help understand regionally specific and long-term climate trends. Nettle et al. examine how smart farming technologies (SFTs) are changing the nature of work for advisors in the UK and Australia and present new insights on the bifurcation and specialization of roles, leading to increased importance of intermediaries, and those advisors engaging in "digiwork."

Digital transformation was investigated by Jakku et al. and Yeo and Keske. The latter used technology acceptance theory to show that "trust operates as a moderating factor to the desire for economic returns" in farmer decisions on technology investments. Increasing adoption of digital tools is therefore not just about theoretical financial benefits. However, without digital technologies

presenting value to smaller scale farm businesses, these farms may be further marginalized.

Stone et al. examined the process of fostering agricultural transition and emphasize that farmers make decisions related to their specific context and should not be considered a homogenous group. Kuria et al., Manalo et al., and Stone et al. highlight that change is a nuanced process which can be incremental and/or transformative and there needs to be consideration of where the burden of change falls, as it is often placed upon the farmer. They call for rebalancing the burden across governance, food and farm systems. Nettle et al. also question where the responsibility lies for building advisory capacity to support transitions with smart farming technologies.

From this Research Topic we propose the following research agenda:

- What are benefits or costs and operational implications experienced by farmers when implementing transformative technologies and practices?
- What are the linkages between transformational practices and positive sustainability outcomes?
- How is transformation addressed in a context of deep uncertainty?
- How is responsible innovation enacted in farm-level transformations?
- What is the role of advisory networks that farmers require during transformative change?
- What are implications for advisors with respect to their work, roles, capacities and businesses?
- How can we improve our methodologies for assessing socioeconomic and sustainability impacts of farm system transformation and on-farm digitalization?

Author contributions

CE: Project administration, Conceptualization, Writing – original draft, Writing – review & editing, Investigation. JE: Investigation, Writing – review & editing, Project administration. JI: Investigation, Writing – review & editing, Conceptualization, Project administration. MA: Writing – review & editing, Project administration, Investigation. SF: Project administration, Writing – review & editing, Investigation. AR: Project administration, Investigation, Writing – review & editing.

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Conflict of interest

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