frontiers in Sustainable Food Systems

TYPE Editorial
PUBLISHED 15 April 2026
DOI 10.3389/fsufs.2026.1828193

OPEN ACCESS

EDITED AND REVIEWED BY
Liming Ye,
Ghent University, Belgium

*CORRESPONDENCE
Anas Tallou
anas.tallou@irta.cat

RECEIVED 11 March 2026
REVISED 30 March 2026
ACCEPTED 30 March 2026
PUBLISHED 15 April 2026

CITATION
Tallou A, Aziz F and Vivaldi GA (2026) Editorial: Innovative approaches in soil, water, and crop management for sustainable agricultural systems. *Front. Sustain. Food Syst.* 10:1828193. doi: 10.3389/fsufs.2026.1828193

Editorial: Innovative approaches in soil, water, and crop management for sustainable agricultural systems

Anas Tallou[1]*, Faissal Aziz[2,3] and Gaetano Alessandro Vivaldi[4]

[1]Efficient Use of Water in Agriculture Program, Institute of AgriFood, Research and Technology (IRTA), Cabrils, Spain, [2]Semlalia Faculty of Sciences, Laboratory of Water Sciences, Microbial Technologies & Natural Resources Sustainability, Cadi Ayyad University, Marrakech, Morocco, [3]National Center for Studies and Research on Water and Energy, Cadi Ayyad University, Marrakech, Morocco, [4]Department of Soil, Plant, Food Sciences, University of Bari Aldo Moro, Bari, Italy

KEYWORDS

circular economy, digital agriculture, food systems, soil health, sustainable agriculture, water management

Editorial on the Research Topic
Innovative approaches in soil, water, and crop management for sustainable agricultural systems

Agricultural systems are facing the dual challenge of increasing food production to meet the demands of a growing population while mitigating the environmental footprint of farming practices. As climate change intensifies and natural resources become increasingly scarce, the transition toward sustainable agricultural systems is mandatory. This Research Topic, "*Innovative approaches in soil, water, and crop management for sustainable agricultural systems*," brings together 13 diverse contributions that explore technological, biological, agronomic, and institutional pathways and innovative approaches toward more resilient food systems (Figure 1). The 13 articles in this Research Topic provide a comprehensive response to the urgent need for a shift from the traditional "take-make-waste" model toward a circular and regenerative agricultural framework. By integrating technological, biological, and socio-economic innovations, this Research Topic demonstrates how circular economy (CE) principles can be applied in practice to enhance ecosystem services through four primary pathways. Firstly, technological advancements are showcased through the development of real-time Internet of Things (IoT) monitoring platforms and data-driven assessments of green development efficiency, providing the digital infrastructure necessary for precise resource management, such as water and fertilizer savings. Secondly, the Research Topic strengthens soil health and nutrient recycling by exploring the conversion of municipal waste into high-value compost and identifying agroecological interventions that leverage biological synergies to reduce reliance on synthetic inputs. Thirdly, climate resilience and carbon sequestration emerge as central themes; therefore, research here highlights the potential of nature-based solutions in extreme environments—such as hypersaline coastal zones and high-altitude agroforestry systems—as critical carbon sinks. Finally, the Research Topic addresses the Water-Energy-Food-Ecosystem (WEFE) Nexus by bridging

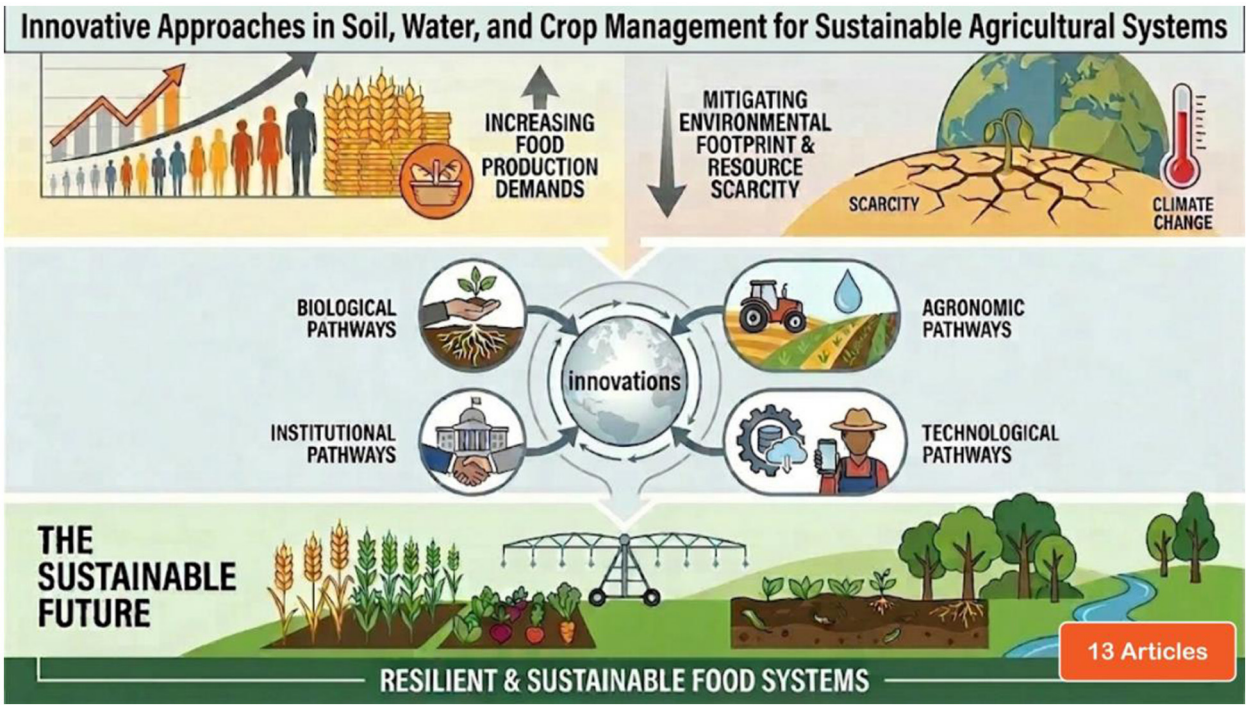

FIGURE 1
General overview of the Research Topic.

the gap between field-level practices, policies, and scientific findings through case studies on community-supported models, the impact of cash transfers on smallholder livelihoods, and policy designs that support the scaling of sustainable waste management. Together, these multi-level contributions provide a multidisciplinary roadmap for fostering a resilient agricultural framework aligned with the Sustainable Development Goals.

1 Technological and digital innovations

The integration of "Agriculture 4.0" into agricultural systems is a cornerstone of this Research Topic. Baraka et al. demonstrated this using the AgriLink platform, an innovative real-time data-monitoring system in Moroccan orange orchards. By linking field-deployed sensors to data loggers and a centralized platform, the end users can leverage precise data to optimize water use and preserve soil. In parallel with technological hardware, Wang et al. examined the efficiency of science- and technology-driven green development in Chinese agriculture. Their study highlighted significant regional differences in policy and investment, advocating for an integrated approach to solve these disparities. Furthermore, Lin provided a comprehensive review of ecological co-culture hotspots, mapping the evolution of these systems and identifying shifts in digital and conceptual frontiers toward more symbiotic production models. They constructed an analytical framework for the ecological co-culture model of rice-fish, livestock, and fruit mixture. They sought to showcase the synergies and evolutionary pathways in low-carbon agriculture using bibliometric methods.

2 Soil health and nutrient management

Optimizing the rhizosphere and closing nutrient loops are vital for long-term sustainability. Belkacemi et al. applied circular economy principles by using compost derived from municipal solid waste and enriched with sheep manure to enhance red beetroot cultivation in Morocco significantly. Meanwhile, Ritcey-Thorpe et al. examined how multiple agroecological interventions—such as cover cropping and diverse rotations—influence crop nutrient acquisition, emphasizing biological synergy over synthetic inputs. In the Indian subcontinent, Ramesh et al. evaluated the sustainability of rice–sesame cropping systems, focusing on the critical interactions between tillage practices and nutrient management to maintain soil integrity.

3 Climate resilience and biodiversity

As the impact of climate change and water scarcity increases, understanding plant resilience in marginal environments becomes crucial. Dhawi reviewed the survival mechanisms of Avicennia marina (Gray Mangrove) in hypersaline, arid zones, offering insights into how extreme stress tolerance can be harnessed through nature-based solutions for carbon sequestration, soil stabilization,

and coastal resilience. It highlights that while the species is naturally resilient, its establishment in extreme "sabkha" (salt flat) conditions requires active management. Rangappa et al. investigated the productivity and physiological efficiency of understorey crops within Himalayan agroforestry systems (Alnus nepalensis and Gmelina arborea), proving that tree-crop interactions can bolster yields in challenging terrains. Additionally, Krach et al. provide a blueprint for climate-smart horticulture by demonstrating how specific management practices add tangible value to organic almond production systems, even under climatic pressure.

4 Socio-economic and institutional frameworks

Innovation extends beyond the field into the institutions that govern agricultural life. Qin and Su discussed the necessity of designing institutional mechanisms to support the circular bioeconomy, with a specific focus on the sustainable development of bio-breeding. The synergy between policy and practice is further explored by Liao et al., who analyze the government-market relationship in China's transition to low-carbon agriculture, emphasizing the need for regional policy adaptation. In addition, Menzel et al. compared the energy efficiency between Community Supported Agriculture (CSA) and conventional vegetable production, highlighting how localized social models can drastically reduce the energy footprint of the food systems. Ghosh et al. demonstrated that these financial interventions can significantly improve beneficiaries' livelihoods and enable investments in high-yield seeds and modern technology. However, the findings also suggested that such schemes are most effective when integrated into a broader rural development strategy that includes agricultural extension services and improved market linkages. By easing credit constraints and fostering productive investments, these policy-oriented approaches play a crucial role in supporting the transition toward more resilient and sustainable food systems.

5 Conclusion and future directions

A common thread throughout these 13 publications is the shift from "resource-intensive" to "knowledge-intensive" agriculture. The data suggest that while individual innovations in soil or water management are valuable, their impact is maximized when integrated into holistic, site-specific systems that involve multiple stakeholders, thereby reducing the gap between research findings and field application. The "Innovative Approaches" highlighted in this Research Topic demonstrate that sustainable agriculture is a multifaceted endeavor. By bridging the gap between traditional ecological knowledge and cutting-edge digital tools, the contributors to this Research Topic have provided a robust foundation for future research. We hope this Research Topic serves as a catalyst for researchers and policymakers to continue pursuing evidence-based solutions for the global agricultural landscape. The published works highlighted the importance of adopting new technologies and digital tools to achieve a sustainable agricultural system and to provide farmers with accurate data they can use to act precisely. Another important aspect for future directions is the involvement of all stakeholders through inter- and intradisciplinary efforts to address challenges related to sustainable food systems, preserve soils, reduce pressure on freshwater resources, and maintain high agricultural productivity within the Water-Energy-Food-Ecosystem Nexus.

Author contributions

AT: Writing – original draft, Writing – review & editing. FA: Writing – review & editing. GV: Writing – review & editing.

Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was used in the creation of this manuscript. An AI tool was used to improve the language and fluency of the manuscript, also to organize the Editorial.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note