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Editorial: Socio-economic evaluation of cropping systems for smallholder farmers – challenges and options

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Editorial on the Research Topic
Socio-economic evaluation of cropping systems for smallholder farmers – challenges and options

Sustainable farming practices for smallholder farmers have taken center stage due to significant transformation in the agricultural food supply systems, shifting paradigms of understanding the sustainability of agricultural systems, and mounting concerns about food and nutrition security. Smallholders across the globe contribute significantly to global food production and are likely to continue in the future. The performances of smallholders' cropping systems directly impact the achievement of Sustainable Development Goals (2030) *viz.*, No Poverty (SDG 1), Zero Hunger (SDG 2), and Good Health and Wellbeing (SDG 3). Given the rising input costs without an equivalent increase in the output prices coupled with its instability, challenges the economic viability of smallholder agri-food systems. Cropping system intensification (CSI) could be one of the ways to make such production systems remunerative, and smallholder agricultural systems need to evolve around sustainable intensification principles to enhance agricultural productivity without conceding environmental and social externalities.

The collection of articles on the Research Topic examined the multifaceted realm of cropping systems relating to achieving SDGs, climate change challenges and adaptation, crop diversification, cooperative and land entitlement, crop-livestock integration, natural farming, coastal and mariculture, and COVID's impact on such production systems. Researches, mostly based on empirical evidence, quantified the contribution and constraints of smallholder farmers' agri-food production systems. As we explore the challenges and options surrounding economic evaluation, we take stock of innovative solutions that enhance smallholders' livelihoods and contribute to the broader goal of agricultural sustainability. This curated Research Topic of papers documents practices, and offers insights and policy inferences essential for addressing the issues that smallholders face to foster resilient and equitable agricultural value-chains. Although our current Research Topic

focuses on economic evaluation, we are critically aware of the transforming contour of related literature that broadens the scope of economic evaluation of cropping systems to social and ecological issues within the overarching context of climate change adaptations. Our bibliometric analysis draws on the scholarly literature search facility of The Lens (https://www.lens.org/) using

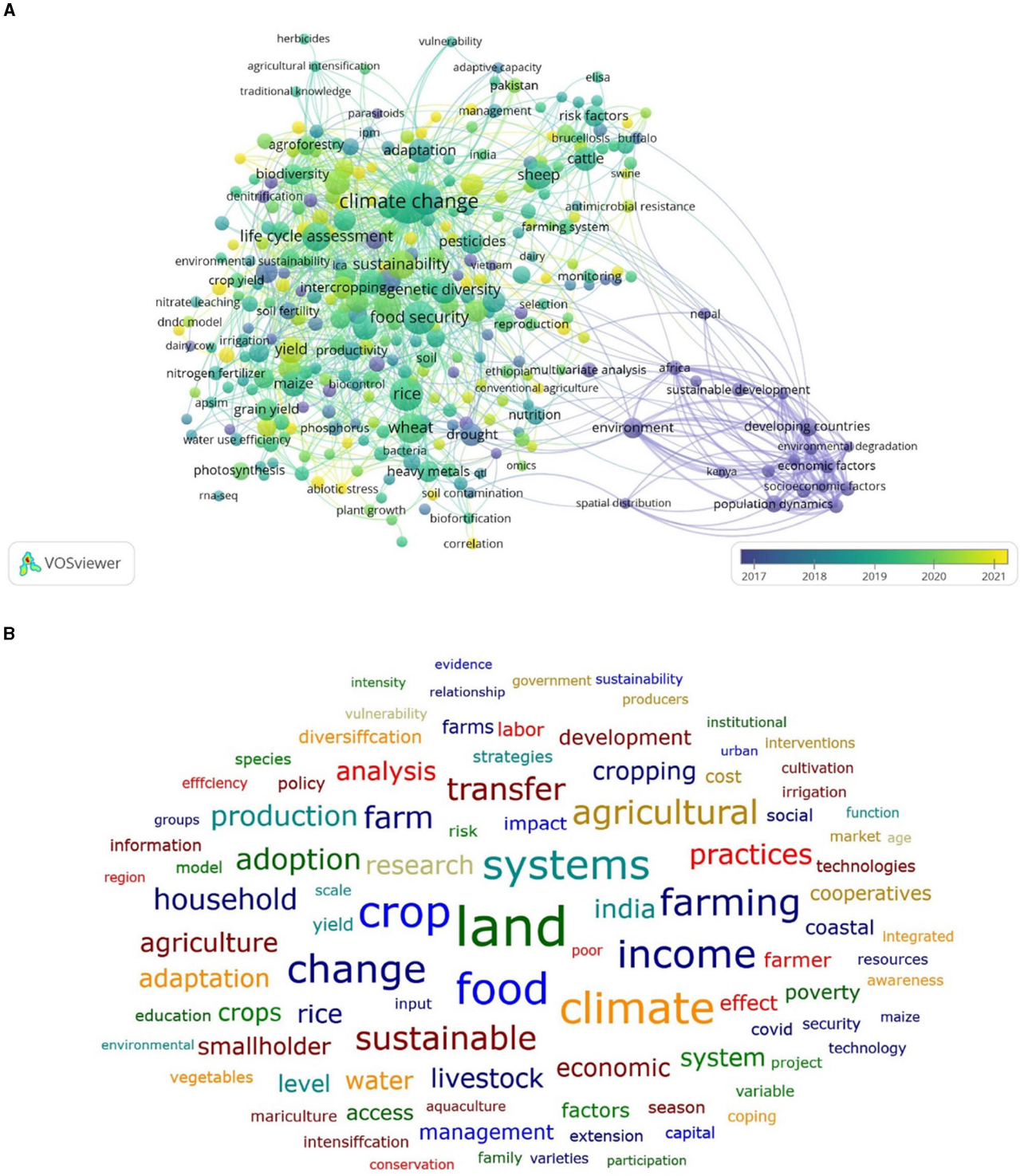

FIGURE 1
(A) Bibliometric analysis covering more than 30,000 articles shows the trend of cropping systems assessment toward multicriteria undertakings within the realm of climate change; **(B)** articles in the current Research Topic align with the existing literature with an explicit focus on systems thinking and institutional arrangements.

an iteratively formulated search string. We included journal articles from the search results and exported the bibliographic citation file to VOSviewer software to generate visualizations of bibliometric networks (Figure 1A). The co-occurrence network of keywords suggests, the evaluation of cropping systems has recently moved from economic analysis to sustainability parameters such as food security, genetic diversity, environmental externalities in the context of climate change. We analyzed the articles in the Research Topic by using ATLAS.ti software to generate a wordle featuring words that appeared more frequently in the current volume. We find the papers of this issue aligning well with this transforming scholarship (Figure 1A) and also demonstrate an explicit preoccupation with system thinking and institutional arrangements (Figure 1B).

A perspective paper by Willow and Veromann highlighted that RNAi-based technology can be a good option for managing pests in small farms if infrastructure supports are provided. RNAi technology holds a promising solution for controlling outbreaks of pests in various cropping systems. Promoting such technology may also require credible educational support from the scientific community and practitioners to overcome the "high-risk" apprehension of the smallholders.

A diversified cropping pattern with the inclusion of vegetables could be a prospective option for smallholder farmers to generate cash income and reduce the risks of crop failure due to irregular rainfall (Manickam et al.). The incorporation of vegetables in the cropping systems could also increase nutrition intake of the poverty-stricken farm-households, which might otherwise remain unaffordable to them. In a similar vein, Mandal et al. in their study on CSI in coastal agricultural systems reported a substantial increase in smallholder farmers' income achieved by reducing the yield gap. Successful CSI through active collaboration with farmers helped them acquire new knowledge of cultivation practices and expedited the adoption of remunerative cropping systems. Collaboration between researchers and farmers helped in the identification of appropriate cropping system interventions for the farmers.

The impact of climate change is overarching in agri-food systems irrespective of farm sizes, and its effect on food production systems poses an imminent threat to human nutrition, health, and future development. Evidence from a study showed that adoption of practices such as improved varieties, irrigation practices, direct seeded rice, integrated pest management, and adjustment in crop calendar could enhance the production capacities of the farmers (Upendram et al.). Increased access to information and technical knowledge of adaptation practices and the adequacy of financial resources can facilitate the adoption of climate adaptation measures by small farms. Another study highlighted the increasing role of institutions, both government and private, is essential in the future to safeguard the interests of farmers by offering research outputs, technology interventions, and policy support (Kumar et al.). Also, the use of ICTs and artificial intelligence can be made an integral part of climate change mitigation and adaptation strategies in agriculture. To achieve higher resilience in agriculture, it is important to understand how smallholder farmers perceive and integrate climate-smart technologies into their farming practices (Mallappa and Pathak). Socio-economic backgrounds of the farmers, such as education, income, exposure to mass media, linkages with extension programmes, innovativeness, and risk orientation, are determinants for adopting climate-smart agricultural technologies. Besides, timely supply of inputs and continuous engagement with other stakeholders, including successful farmers, are key to the adoption of climate-smart agricultural practices.

The concept of natural farming embodied with chemical-free agricultural production system based on Indian traditional knowledge blended with modern understanding of ecology, resource recycling and on-farm resource optimization. The integration of locally available resources and reduction of external input uses can be a viable proposition, particularly for farmers operating in low-input and low-cost conditions (Laishram et al.). The study indicated that natural farming practices can be successful when promoted with vegetable-based cropping systems and multiple crops involving legumes. Although there was initially a drop in crop yields, but the net return was significantly higher compared to conventional practices, mainly due to cost savings on account of no use of fertilizer and pesticides. However, natural farming is highly labor-intensive and deserves a better market price (premium price) to make the practices remunerative for the farmers.

The economic impact of COVID-19 on income and livelihoods covering rural and urban households was assessed by Kang et al.. Their study indicated that the economic impact of COVID-19 was greater in urban areas than in rural areas, and the urban conditions improved before the rural areas. It also highlighted the potential impact pathways of COVID-19, from a household economic downturn to limited food spending, poor food consumption, and increased use of short-term coping mechanisms.

Xie et al. evaluate the relationship between rural land titling (RLT) and rural land transactions and examine whether RLT impacts the efficient resource allocation. Their analysis shows that RLT promotes rural land transactions weakly, and facilitates rural land transfer-out only, having no effect on rural land transfer-in. They suggest simplifying agricultural land property rights may not lead to a sustainable rural agricultural production system; rather, policies need to align with local communities' interests, considering the traditional cultures and social needs. Another study by Liu et al. evaluated the relationship between the promotion of rural cooperatives and its impact on poverty and vulnerability. Participation in rural cooperatives significantly reduces poverty vulnerability among farm households with higher human capital and income compared to households with lower human capital and income. They suggest policies that encourage farmers to join or start cooperatives and support cooperative development to reduce poverty among smallholder farmers.

Dhehibi et al. moved beyond the crop sector and assessed the synergies between crop and livestock under conservation agriculture with a potential advantage for sustainable intensification in smallholder systems. They observe higher technical inefficiencies in integrated crop-livestock systems, but economic diversification provides a productivity gain that buffers against climate-induced uncertainties.

Parappurathu et al. assessed the long-term suitability of selected mariculture enterprises with a special focus on small-scale mariculture systems. They highlighted potential enterprises for future scale-up of mariculture, such as open sea cage farming, coastal water cage farming, seaweed farming, and integrated multi-trophic aquaculture. The authors found selected enterprises to be technically and economically viable in general. However, certain gaps were evident in terms of key sustainability indicators, such as legitimate access to water bodies, quality of seed and feed, access to institutional credit and market, fair marketing practices, optimal stocking density, mechanization, renewable energy use, adoption of environmental-friendly practices, farm surveillance, crew safety, and social protection.

This Research Topic places us at the intersection of knowledge and action. Insights shared by the contributed papers underscore the importance of recognizing the unique dynamics that smallholder farmers face across countries. It is evident that smallholders' success is vital for their own wellbeing, ensuring global food security and sustainable agriculture. As we move forward, it is imperative that policymakers, researchers, and stakeholders collaborate to address these challenges and embrace the available options. By adopting holistic approaches, supporting innovations, and implementing relevant policies, smallholders can be empowered to thrive economically while safeguarding the planet's scarce resources and inspire them to work toward a more equitable and sustainable future for agriculture.

Author contributions

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Conflict of interest

The 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.

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