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Editorial: Climate science, solutions and services for net zero, climate-resilient food systems

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Editorial on the Research Topic
Climate science, solutions and services for net zero, climate-resilient food systems

Food systems are both a major contributor to global greenhouse gas emissions (Costa et al., 2022) and strongly impacted by climate and weather (Falloon et al., 2022). Solutions to deliver net zero food systems therefore need to take climate impacts, adaptation, and resilience into account to ensure they are appropriate in a changing climate and do not conflict with adaptation goals. Food system adaptation options must also consider potential trade-offs, consequences, and synergies with net zero and other objectives such as the Sustainable Development Goals. Solutions for net zero, climate resilient food systems therefore require systematic, interdisciplinary approaches across academia, governments, business, NGOs, and the public. This Research Topic showcases a Research Topic of studies covering cutting edge science and thought leadership towards the goal of net zero, climate-resilient food systems.

Several papers use case study events or assess current and future practical climate adaptation and net zero practices in farming and food systems businesses. An exploration of farmers' perception of climate adaptation strategies in the rice-growing zone of Punjab, Pakistan by Khan et al. revealed significant perceived climate changes, while the extent of adaptation was strongly linked to education and access to climate information and credit services. The principal factors determining adaptation decisions included farmers' age, primary occupation, income, landholding, access to irrigation, credit, climate information, and agricultural extension services; hence improving the alterable factors amongst these should improve resilience of the rice farming system.

Sarker et al. assess the benefits of conservation tillage and residue management to soil health and crop productivity in a Bangladeshi rice-maize cropping system. Compared to conventional tillage, the overall improvement in soil conditions gradually increased crop productivity, and improved farm profitability compared

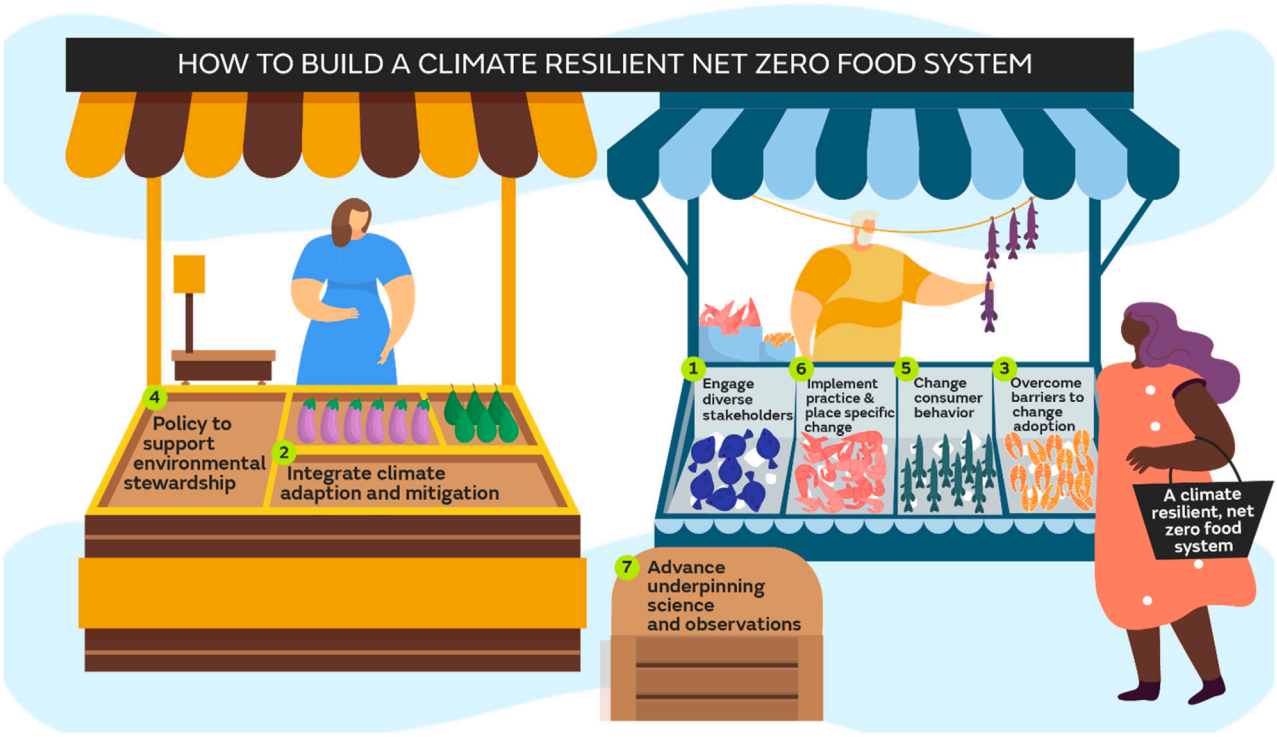

FIGURE 1
Key elements for a climate-resilient, net zero food system. (c) Crown Copyright, Met Office.

to conventionally tilled rice and maize crops. Conservation agriculture could therefore be an appropriate practice for sustaining soil fertility and crop yield under rice-maize systems in light-textured soils in Bangladesh.

Kumar Jha et al. report results from experimental studies in the rice-wheat system of Bihar, India that evaluate the feasibility of early rice transplanting combined with a community irrigation approach. These practices increased rice yield and water productivity, compared to late-sown crops, while timely wheat harvesting allowed cultivation of an additional summer crop. Overall, this approach to managing climatic risks and variability increased the productivity of the rice–wheat cropping system.

Sakrabani analyses the opportunities and challenges for organo-mineral fertilisers (OMFs) in enabling food security and meeting net zero goals, identifying policy interventions that balance environmental protection and meeting food security. Short-term priorities include development of guidelines, energy incentives for drying feedstocks and renewable energy; in the medium-term, evidence gathering from long-term field trials, funding to support innovation, and regional policy harmonisation; and in the long-term feedstock certification and joined-up waste-fertilizer policy.

Davie et al. use the record-breaking United Kingdom heatwave of 2022 as a case study to explore the impacts on the poultry and wheat sectors, and to identify potential adaptation options for a climate-resilient, net-zero food system. Both negative and positive heatwave impacts were felt across the food system, from greater energy costs for cold storage, retail refrigeration failure, and livestock heat stress but also increased wheat yields. A range of adaptation measures are proposed for both poultry and wheat.

Asif et al. present a novel methodology for developing a sustainable business model (SBM) in the food, beverage, and tobacco sector, using data from 252 businesses that reported to the Carbon Disclosure Project (CDP). Their analysis identified, prioritized and mapped a range of environmental sustainability themes and 150 green practices that could contribute to emission reduction targets, resulting in a net-zero value proposition to customers.

The remaining papers tackle key challenges at the broader policy level. Gelardi et al. review the evidence for agricultural soils to contribute to net zero goals, examine existing support strategies and emerging markets, and recommend ways to synthesize approaches into a cohesive policy portfolio for the US to deliver effective and equitable outcomes.

Moghayer et al. apply a multi-level participatory scenario approach combined with modelling and decision support tools to develop scenarios in support of future food security policy in Bangladesh. Their future scenarios show that diverse pathways are possible, but with very different food security and low-carbon development outcomes.

Andrews et al. draw on agroecological principles to propose a framework for aligning food-systems policy to provide multiple benefits. Their six-part framework can underpin public health, environmental sustainability, economic stability, social cohesion, and national security and sovereignty. The seven tactical implementation principles they propose can help integrate

community-scale efforts to establish food systems and ensure food systems policy effectiveness.

To advance solutions and services that support the goal of climate-resilient, net-zero food systems and better food security outcomes, several key themes emerge from the papers presented here, noting that the challenges highlighted below should not dissuade action Gelardi et al.:

1. Broad and diverse stakeholder engagement across the agri-food supply-chain and beyond in solution co-design and development (Asif et al.; Gelardi et al.), including youth and poor rural communities (Moghayer et al.).
2. Effective integration and joint prioritization of climate adaptation and mitigation options, alongside consideration of their trade-offs, consequences, co-benefits and interactions. This should include social, economic and environmental dimensions and pressures for land (Davie et al.; Gelardi et al.; Kumar Jha et al.), and balancing short and long-term priorities (Moghayer et al.).
3. Addressing barriers to adoption and structural issues (Davie et al.; Gelardi et al.; Khan et al.) in climate adaptation and net-zero.
4. Integrated policy that supports effective environmental stewardship and is underpinned by well-functioning governance systems and political will (Andrews et al.; Moghayer et al.; Sakrabani).
5. Enabling shifts in consumer behaviour (Moghayer et al.).
6. Implementation of practice- and place-specific programs of change (Gelardi et al.).
7. Advancing underpinning science, modelling, tools, methods, frameworks and observational data to be fit for purpose in decision-making and policy support (Gelardi et al.; Sarker et al.).

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PF: Conceptualization, Investigation, Writing–original draft, Writing–review and editing. AJ: Writing–original draft, Writing–review and editing. SB: Writing–original draft, Writing–review and editing. SK: Writing–original draft, Writing–review and editing. MR: Writing–original draft, Writing–review and editing.

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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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