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A global systematic review of the water–energy–food (WEF) nexus in advancing sustainable and resilient agrifood systems

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Abstract

Transforming agrifood systems to achieve sustainability and resilience under conditions of climate change and resource scarcity remains a critical global challenge. Sustainability and resilience are increasingly recognised as essential for ensuring long-term food security, system stability, and the capacity to absorb and adapt to shocks such as climate change-induced extremes (e.g., droughts and floods), geopolitical disruptions, energy crises, and global pandemics such as COVID-19. A sustainable and resilient agrifood system maintains food production and access while balancing environmental integrity, economic viability, social equity, and governance dimensions.

This study presents a systematic literature review conducted using the PRISMA protocol of 62 peer-reviewed studies assessing the application of the Water–Energy–Food (WEF) nexus in agrifood systems, compared to the thousands of existing WEF nexus publications globally. The findings reveal that while sustainability is assessed in all studies, only 6.5 % explicitly incorporate resilience, indicating a major gap in addressing system adaptability. Key determinants of sustainability and resilience are consistently underrepresented. Food productivity dominates (82.3 %), while food access (8.1 %) and food losses (4.8 %) are minimally considered. Similarly, water availability is assessed in 71 % of studies compared to only 21 % for water quality and 17.7 % for water access. In the energy sector, demand dominates (56.5 %), whereas energy access is included in just 14.5 % of cases.

These patterns reveal a strong bias toward biophysical and efficiency-oriented metrics, with limited integration of social equity, governance, and access dimensions that are critical for system sustainability and resilience. Methodologically, System Dynamics Modelling (SDM) is applied in only 23 % of studies despite its capacity to capture feedbacks and adaptive behaviour. Spatially, research is concentrated at provincial and basin scales (63 %), while local-scale studies account for only 14.5 %, creating a critical scale mismatch. Furthermore, only 30 % of studies include stakeholder participation, limiting inclusive governance.

This study highlights critical gaps in WEF nexus applications and exposes methodological, spatial, and conceptual biases that must be addressed to enable the transition toward sustainable and resilient agrifood systems.

Keywords: Agrifood systems, PRISMA protocol, resilience, SARAs, sustainability, water-energy-food nexus