

TOWARDS MULTISERVICE IRRIGATION FOR AN AGROECOLOGICAL FUTURE VERS UNE IRRIGATION MULTISERVICE POUR UN AVENIR AGROÉCOLOGIQUE

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ABSTRACT

This perspective paper examines the persistent disconnect between agroecology and irrigation science despite their shared objective of building sustainable food systems. The authors argue that irrigation has traditionally been treated as a technical mechanism for increasing productivity and water-use efficiency, while agroecology has focused on holistic ecological and social transformation of food systems. This separation has limited opportunities to redesign irrigation systems in ways that support biodiversity, soil health, ecosystem functions and social equity. The paper proposes the concept of “multiservice irrigation,” defined as irrigation designed not only to support crop production but also to generate multiple ecosystem services essential for sustainable food production. The framework integrates agroecological principles with irrigation planning and management through attention to irrigation infrastructure, water governance, technological innovation, ecological processes and stakeholder participation. The authors emphasize that irrigation profoundly affects landscapes, ecological processes and social organization, and therefore should be evaluated beyond narrow productivity metrics. They identify six frontier research themes necessary for operationalizing multiservice irrigation: designing field-scale systems, analysing irrigated agroecological farms and transformation pathways, redesigning hydraulic infrastructure, supporting stakeholders during agroecological transitions, exploring interactions among irrigation, climate change and hydrology, and reforming public policy. The perspective ultimately calls for a paradigm shift in water management and food system planning. By reconciling irrigation science and agroecology, the multiservice irrigation framework seeks to enhance resilience, environmental sustainability, climate adaptation and equitable access to resources while maintaining agricultural productivity. The full published paper can be found with the reference Leauthaud & Leenhardt (2025).

Keywords: biodiversity; soil health; agroecological transitions; multiservice irrigation framework; agricultural productivity.

RESUME

Cet article de réflexion examine le décalage persistant entre l'agroécologie et la science de l'irrigation, malgré leur objectif commun d'établir des systèmes alimentaires durables. Les auteurs constatent que l'irrigation a traditionnellement été considérée comme un mécanisme technique visant à accroître la productivité et l'efficacité de l'utilisation de l'eau, tandis que l'agroécologie s'est concentrée sur une transformation holistique, à la fois écologique et sociale, des systèmes alimentaires. Cette division a limité les possibilités de repenser les systèmes d'irrigation de manière à favoriser la biodiversité, la santé des sols, les fonctions écosystémiques et l'équité sociale. Le document propose le concept d'« irrigation multiservices », définie comme une irrigation conçue non seulement pour soutenir la production agricole, mais aussi pour générer de services multiples écosystémiques essentiels à une production alimentaire durable. Ce cadre intègre les principes agroécologiques à la planification et à la gestion de l'irrigation

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en accordant une attention particulière aux infrastructures d'irrigation, à la gouvernance de l'eau, à l'innovation technologique, aux processus écologiques et à la participation des parties prenantes. Les auteurs mettent l'accent sur le fait que l'irrigation exerce un impact profond sur les paysages, les processus écologiques et l'organisation sociale, et qu'elle doit donc être évaluée au-delà des simples indicateurs de productivité. Ils identifient six thèmes de recherche de pointe nécessaires à la mise en œuvre opérationnelle de l'irrigation multiservice : la conception de systèmes à l'échelle de la parcelle, l'analyse des exploitations agroécologiques irriguées et des voies de transformation, la refonte des infrastructures hydrauliques, le soutien des parties prenantes aux transitions agroécologiques, l'étude des interactions entre l'irrigation, le changement climatique et l'hydrologie, ainsi que la réforme des politiques publiques. Finalement, cet article de réflexion appelle à un changement de paradigme en ce qui concerne la gestion de l'eau et la planification des systèmes alimentaires. En conciliant la science de l'irrigation et l'agroécologie, le cadre de l'irrigation multiservices vise à renforcer la résistance, la durabilité environnementale, l'adaptation au climat et l'accès équitable aux ressources, tout en maintenant la productivité agricole. L'article définitif publié se trouve sous la référence Leauthaud & Leenhardt (2025).

Mots-clés : Biodiversité; Santé des sols; Transitions agroécologiques; Cadre d'irrigation multiservice; Productivité agricole.

INTRODUCTION

The growing recognition of environmental degradation, climate change and biodiversity loss in the Anthropocene has intensified global efforts to redesign food production systems. Agriculture is increasingly expected not only to produce food but also to preserve ecosystems, sustain livelihoods and protect natural resources. Within this context, both agroecology and irrigation have emerged as prominent approaches for improving food security and sustainability. However, according to the perspective paper summarized here (Leauthaud & Leenhardt, 2025), these two domains have evolved largely independently, resulting in a major scientific and practical disconnect.

Agroecology is promoted internationally as a framework for transforming food systems through ecological principles, diversification, social justice and local knowledge. Irrigation, meanwhile, is commonly viewed as a technical intervention aimed at increasing productivity and stabilizing agricultural outputs. Both are often presented as solutions for climate adaptation and food security, yet they are rarely studied together measure (Siebert et al. 2014; IPCC 2023; Pörtner et al. 2022). The authors argue that this separation has hindered opportunities to design irrigation systems capable of enhancing ecological processes and contributing to sustainable food systems.

The perspective paper therefore seeks to bridge the divide between agroecology and irrigation science. It proposes a conceptual shift from conventional irrigation toward “multiservice irrigation,” a framework in which irrigation is managed not merely for biomass production but for the simultaneous generation of multiple ecosystem services. The paper also identifies key research directions needed to support this transition.

THE DISCONNECT BETWEEN AGROECOLOGY AND IRRIGATION

The authors highlight that agroecology and irrigation science have historically developed under distinct intellectual traditions, policy frameworks and management priorities (Crystele Leauthaud et al. 2025). In agroecological studies, irrigation is often mentioned only briefly as a farm characteristic rather than explored as an active ecological tool. Conversely, irrigation science has primarily emphasized technical efficiency, productivity gains and optimization of water delivery systems.

This divide is reinforced by contrasting narratives and institutional structures. Irrigation science is generally associated with mainstream agricultural modernization, emphasizing technological innovation, engineering efficiency and large-scale infrastructure. Agroecology, in contrast, is rooted in holistic and systemic approaches that prioritize biodiversity, local food systems, farmer livelihoods and social equity. Despite these differences, both domains seek to improve food systems. Agroecology aims to redesign food systems according to ecological principles, integrating research, education and social

transformation. Irrigation, meanwhile, remains essential for global food production, especially because irrigated agriculture occupies only around 20% of cultivated land while producing approximately 40% of global food output (FAO 1996).

The authors stress that irrigation has implications extending far beyond controlling crop water status. It reshapes landscapes through reservoirs, canals and terraces, influences ecological interactions within the soil–plant–atmosphere continuum and alters social organization and governance structures. Irrigation also has significant global environmental consequences, including impacts on biodiversity, groundwater depletion and sea-level rise.

However, dominant irrigation paradigms remain centered on the “more crop per drop” philosophy. Although this approach improves efficiency, it often overlooks ecological, social and cultural dimensions. The authors argue that sustainable irrigation requires broader evaluation criteria including ecosystem services, food quality, social equity and governance.

CONCEPTUAL FOUNDATIONS OF MULTISERVICE IRRIGATION

To reconcile agroecology and irrigation, Leauthaud and Leenhardt propose integrating the conceptual frameworks and principles of both fields. They note that agroecology is guided by thirteen recognized principles, including biodiversity, recycling, soil health, synergy, fairness and participation (Wezel et al., 2020). Irrigation science, while less explicitly principle-based, nevertheless incorporates concepts such as efficiency, integrated water management, governance, technological innovation and stakeholder engagement.

The authors identify several shared principles between the two domains. Building on these overlaps, the authors introduce the concept of “multiservice irrigation” (Figure 1 & Figure 2). This framework conceives irrigation not simply as a means of maximizing yields but as a mechanism for enabling ecological functions and generating ecosystem services. These ecological processes can in turn generate ecosystem services including improved soil fertility, enhanced biodiversity, biomass production, carbon storage and pest control.

The framework requires irrigation systems to be redesigned at multiple levels, including infrastructure, governance, technological management and evaluation criteria. Importantly, the authors caution that multiservice irrigation should not become a justification for expanding irrigation indiscriminately. Rather, irrigation should be assessed carefully across scales to ensure that benefits outweigh environmental and social costs.

The proposed framework aligns closely with the One Health perspective, which recognizes the interconnectedness of environmental, human and animal health. Through integration of agroecological principles, multiservice irrigation seeks to contribute simultaneously to environmental sustainability, equitable water access, nutritious diets and resilient local economies.

RESEARCH THEMES HIGHLIGHTED BY THE AUTHORS

The final section of the paper identifies six major research themes that should guide future work on multiservice irrigation and agroecological transformation. The first theme concerns the design of field-scale irrigation systems adapted to agroecological practices. Since agroecological systems modify soil structure, nutrient cycling and biological interactions, irrigation scheduling, water quantities and irrigation technologies must be redesigned to support ecological processes rather than simply maximize yields.

The second theme focuses on understanding irrigated agroecological farms and the pathways required to transition from conventional irrigated agriculture toward agroecological systems. Research is needed to evaluate not only technical performance and water-use efficiency but also labor organization, financial risks and broader food-system implications.

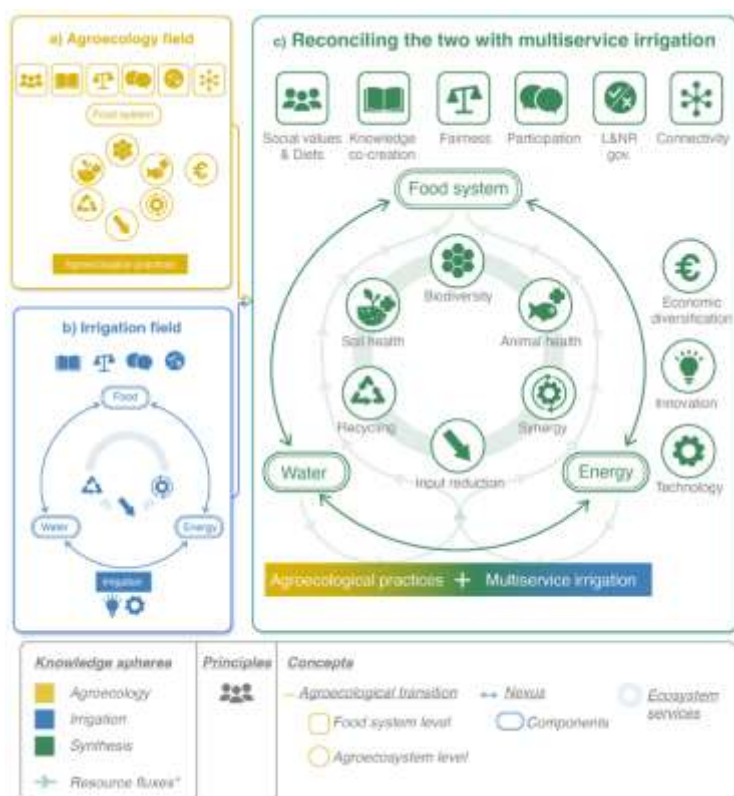


Figure 1. Reconciling conceptual frameworks and principles used in the fields of: a) agroecology and b) irrigation, within a c) consolidated framework that highlights the multiservice scope of irrigation. L&NR gov.: land and natural resource governance. *Indicative pathway of resource fluxes to achieve sustainable food systems. Figure from Leauthaud & Leenhardt (2025).

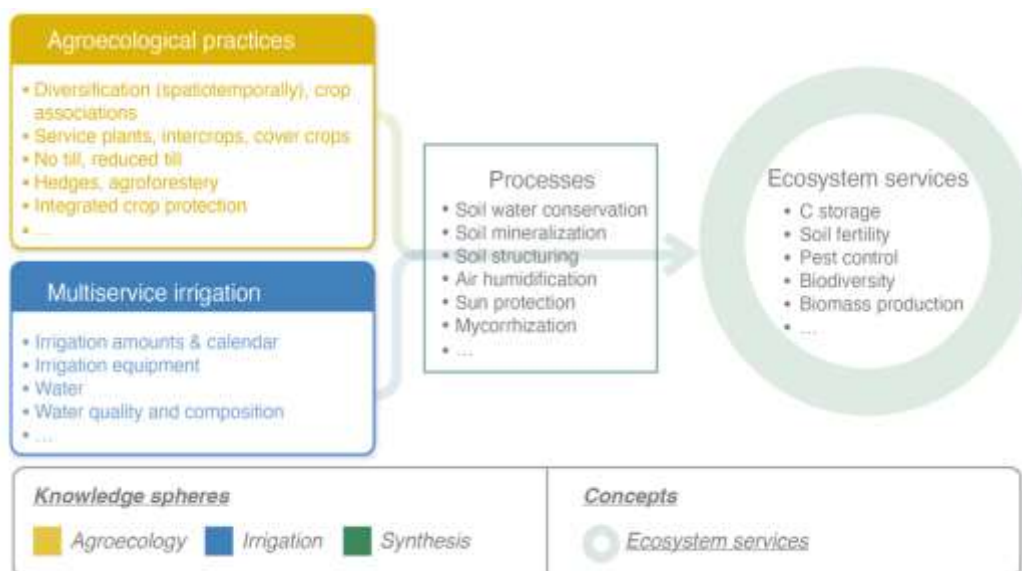


Figure 2. Multiservice irrigation: the interaction between agroecological and irrigation practices can generate or enhance specific ecological processes and functions, thereby giving rise to a range of different ecosystem services. Figure from Leauthaud & Leenhardt (2025).

The third theme addresses hydraulic infrastructure and irrigation equipment. Existing dams, canals, reservoirs and distribution systems may either support or constrain agroecological transitions depending on their design and governance. The authors call for analysis of how infrastructure and water management institutions can be adapted to agroecological objectives.

The fourth theme emphasizes the importance of supporting stakeholders during the agroecological transition. Farmers, local authorities, consumers and civil society organizations all influence irrigation practices. Participatory approaches, governance tools and supportive policy environments are therefore necessary to encourage adoption of agroecological irrigation systems.

The fifth theme examines the relationships among multiservice irrigation, climate change and the hydrological cycle. The authors argue that agroecological irrigation systems may contribute to climate adaptation and mitigation through improved soil management, carbon sequestration and enhanced resilience to drought. However, further research is needed to determine how these systems affect regional water balances and irrigation demand.

The sixth and final theme concerns public policy and governance. Current agricultural policies often separate irrigation from agroecology and may continue to favor conventional high-input agriculture. The authors therefore call for policy reforms capable of integrating sustainable water management, ecosystem services and agroecological transformation.

Together, these six themes provide a research agenda for integrating irrigation science and agroecology. They demonstrate that achieving sustainable food systems will require interdisciplinary collaboration, participatory governance and a broader understanding of irrigation as a socioecological process rather than merely a technical input.

ACKNOWLEDGEMENTS

The authors thank the G-EAU community of practice on agroecology for their thoughtful insights.

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