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Implicit principles, explicit gaps: Systemic design for multifunctional agroecosystems

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Abstract

Agricultural systems are increasingly required to deliver multiple functions simultaneously, a challenge especially relevant for tropical agriculture, where climate risks, biodiversity loss, land-use change, and livelihood vulnerability interact within farming systems and exceed single-solution adaptation approaches. Although systemic and participatory approaches are promoted, it remains unclear whether systemic design principles are being considered, by whom, and through which methods in agriculture.

This study presents a systematic review assessing the extent to which systemic design principles are present in agricultural systems research. Following a PRISMA process, literature was retrieved and screened against predefined criteria. From 4605 identified records, 121 studies were selected and analysed through descriptive synthesis and inductive coding. Publication trends, geographical distribution, farming-system types, systemic design principles, methodologies, design objectives, and practitioner involvement were investigated.

The literature has expanded since the mid-2010s, but remains concentrated in Europe, with limited representation of tropical regions, and focused mainly on arable and horticultural systems. Systemic design principles were identified implicitly in the selected papers, but no paper explicitly referred to systemic design. This indicates limited formalisation and systematic application of these principles in agricultural systems design. The most frequent associated principles were appreciating complexity, idealisation, purpose finding, and boundary framing, while principles related to generative emergence, system ordering, and self-organisation were less addressed. Methodologically, the field combines participatory workshops, co-design protocols, simulation modelling, scenario planning, conceptual frameworks, and evaluative approaches. Practitioner involvement was dominated by researchers, farmers, extension agents, and policy-makers.

A central finding is that systemic design is not used as a framework for the (re)design of agricultural systems. Instead, the investigation identified partial and fragmented engagement with related principles, such as complexity framing, co-design, and system redesign,

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with weaker evidence of long-term transformation, emergence, and self-organisation. The strong European concentration of evidence reveals an important gap for tropical agriculture, where multifunctionality and climate resilience are pursued under constrained institutional, ecological, and livelihood conditions. This work supports strengthening systemic design research in tropical agriculture by moving from short-term problem framing toward implementation, evaluation, and transformative adaptation in multifunctional agroecosystems.

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