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Exploring agroecological transition pathways in a mountainous farming system in Morocco through fuzzy cognitive mapping

Marilena Reinhard-Kolempas[1], Hatim Amessaghrou[2], Safa Aatig[2], Outmane El Omry[2], Ghizlane Echchgadda[2], Zoubir Chattou[2], Gerrie van de Ven[1], Mark Caulfield[1], Katrien Descheemaeker[1], Jeroen C.J. Groot[1]

[1] *Wageningen University & Research, Plant Production Systems, The Netherlands*
[2] *The National School of Agriculture of Meknes, Morocco*

Abstract

Farming in North Africa faces interlinked sustainability challenges from water stress and land degradation to rural poverty and demographic changes. Transitioning to agroecological farming has been proposed to address those environmental and socio-economic challenges, yet transition pathways are difficult to achieve. They require coordinated action at multiple levels and an understanding of potential trade-offs and transition barriers. Scenario-based explorations can shed light on these issues supporting coordinated action. Fuzzy cognitive mapping (FCM) is a semi-quantitative scenario assessment tool that can facilitate communication regarding complex, not readily quantifiable issues for which there are no easy solutions. It studies changes in the functioning of socio-ecological systems based on people's knowledge using causal graph-structures.

The objective of this research was to explore potential agroecological transition pathways for a mountainous farming community in the Middle Atlas, Morocco, in face of climate change and outmigration. Considering three landscape zones with distinct access to land and water, an FCM-based scenario analysis was performed for each zone to identify landscape-specific transition levers and barriers. A business-as-usual scenario was contrasted with alternative scenarios examining changes in water and organic fertilisation management, and an upscaled cultivation of medicinal and aromatic plants (MAPs).

FCMs were built based on two causal graphs developed during a future thinking workshop in October 2025: one created with farmers and another with local food system actors. FCMs were complemented with observations and insights gained during field work activities between September 2023-April 2026. These included focus group discussions and interviews with farmers, community representatives and water managers, as well as a participatory GIS-based land-use and suitability analysis for the cultivation of MAPs with a local women cooperative.

The study resulted in the formulation and participatory evaluation of multi-scale socio-technical innovation bundles that can contribute to an agroecological transition by combining agricultural practices, socio-economic and institutional innovations at farm, landscape and value chain level. Examples include an adapted surface irrigation at farm level facilitated by a coordinated water use across landscape zones; and the facilitation of on-farm organic fertilisation by a professional processing of organic biomass sources at landscape level into good quality organic fertilisers.

Contact Address: Marilena Reinhard-Kolempas, Wageningen University & Research, Plant Production Systems, Wageningen, The Netherlands, e-mail: marilena.reinhard-kolempas@wur.nl

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