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“Towards multi-functional agro-ecosystems
promoting climate resilient futures”

Integrating knowledge and practice: enhancing soil health and agrobiodiversity for sustainable ecosystems and livelihood resilience

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Abstract

Achieving multifunctional agro-ecosystems that support climate resilience requires integrated approaches that simultaneously address soil degradation, biodiversity loss, and livelihood vulnerabilities. This study presents a participatory, landscape-based agroecological model implemented in the Mt. Elgon region of eastern Uganda, a high-risk ecosystem characterised by severe soil erosion, declining soil fertility, and increasing climate variability. The research integrates local and scientific knowledge through co-creation processes involving farmers, researchers, extension actors, and local institutions to design and implement context-specific interventions. Soil and water conservation structures - including trenches, stone bunds, and vegetative barriers were collectively established and monitored, resulting in reduced soil loss and improved watershed stability. We assessed different agrobiodiversity components using the Platform for Agrobiodiversity Research tool to document species diversity, functional roles, traditional knowledge and socio-economic drivers influencing biodiversity maintenance across multiple watersheds. The study revealed high species richness and functional diversity, underpinning key ecosystem services such as soil stabilisation, pollination, pest regulation, and climate adaptation. However, there were significant differences in the diversity of insects (Hymenoptera) that are critical to pollination, biological control, and soil turnover. The study further demonstrates the critical role of indigenous and gendered knowledge systems, particularly women's expertise in plant diversity and ecosystem management, in strengthening inclusive and resilient agroecosystems. Positioned at the intersection of soil, water, and biodiversity management; climate change adaptation; and knowledge systems innovation, this study illustrates how participatory, data-informed approaches can drive agroecological transformation. The findings provide a scalable framework for developing resilient crop-livestock-agroforestry systems that enhance ecosystem functionality, improve food and nutrition security, and strengthen rural livelihoods. This work contributes to ongoing efforts to design climate-resilient, multi-functional agro-ecosystems in Uganda and beyond.

Keywords: Agrobiodiversity, agroecology, climate resilience, landscape management, participatory approaches, soil health