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Multifunctional landscapes drive biodiversity and ecosystem services in small-holder farms

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Abstract

Agricultural intensification has led to significant biodiversity loss, undermining ecosystem services essential for sustainable food production. The decline of insect communities threatens pollination and biological pest control, which are critical for maintaining crop yield, quality, and resilience. Approximately 35 % of global crops depend to some extent on animal pollination, highlighting the importance of conserving agricultural biodiversity. Nature-based solutions that enhance habitat diversity within agricultural landscapes preserves biodiversity and optimises ecosystem services.

Deforestation and landscape simplification further reduce habitat availability for beneficial insects. Although pesticide use mitigates pest damage, it can negatively affect pollinators and natural enemies, disrupting ecological balance. Sustainable farmland management must therefore integrate biodiversity conservation with production goals through landscape-level approaches that strengthen ecological interactions.

This study examines how local and landscape-scale factors influence insect biodiversity and ecosystem services in smallholder agroecosystems, using homestead gardens in Mandla district, Madhya Pradesh, India, as a model system. In landscapes undergoing community-led reforestation, we test the hypothesis that forest cover and on-farm diversity jointly enhance insect-mediated ecosystem services in winter croplands. Pollinator and natural enemy diversity, along with indicators of pollination and biocontrol, were assessed across gradients of forest cover and farm diversification.

Results reveal strong complementarity between forests and farms. Proximity to forests increased insect diversity and abundance, while diversified farms provided essential foraging and nesting resources. Together, these factors enhanced pollination and biological pest control, supporting more resilient agroecosystems.

Our findings highlight the role of habitat heterogeneity as a nature-based solution for strengthening agricultural biodiversity and ecosystem services. Integrating forest conservation with diversified farming can enhance ecological resilience and contribute to sustainable intensification in smallholder landscapes.

Keywords: Biocontrol, ecosystem services, forest, habitat heterogeneity, landscape, nature-based solution, pollination

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