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Agroforestry as a nature-based solution for water-scarce drylands: Ecological and economic outcomes from a *Melia Dubia*-based system in Karnataka, India

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Abstract

Water scarcity and land degradation pose mounting threats to smallholder farming in dryland regions of South Asia, where conventional irrigation-dependent agriculture is increasingly unviable under climate stress. However, agroforestry can act as a multi-thronged approach to improve soil organic matter, regulate microclimate and on-farm biodiversity along with increasing farm income. The paper supports this through a case study-based approach where a *Melia Dubia* (Hebbevu)-based agroforestry system established on one hectare [2.5 acres] of dryland in Davanagere district of the state of Karnataka, India, delivered integrated ecological and economic outcomes over a nine-year period. In addition to field-based observations, the study incorporates geospatial satellite-based monitoring to assess changes in tree cover and plantation development over the period 2016–2026, enabling spatially explicit evaluation of vegetation growth, canopy expansion, and landscape-level ecological transformation. The study also includes greenhouse gas estimation to examine the climate mitigation potential of the agroforestry system through above-ground biomass accumulation, carbon sequestration, and avoided land degradation pathways.

After nine years, the plantation yielded approximately 300 tonnes of timber, generating gross returns of 20–25 lakh (approx. €18,000–23,000), translating to an estimated net income of 50,000–60,000 per acre annually, substantially outperforming conventional dryland cropping systems in the region.

Beyond economic outcomes, the system demonstrates the multi-functional character of tree-based agricultural systems. The case also highlights how strategic species selection, intercropping sequencing, and institutional support can enable resource-poor dryland farmers to adopt nature-based solutions that simultaneously enhance soil health, water-use efficiency, and ecosystem services.

This case study contributes evidence for the scalability of agroforestry as a policy-relevant, low-external-input land-use strategy in water-stressed tropical and subtropical dryland contexts, with implications for livelihood resilience and climate adaptation across similar agro-ecological zones in peninsular India and the broader Global South.

Keywords: Agroforestry, Carbon sequestration, Climate resilience, Ecology, Economic cost, Geospatial monitoring, GHG estimation, Nature-based solutions, Smallholder livelihoods, Soil organic carbon, Water scarcity

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