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## Integrating solar-based irrigation and vermicompost using living-lab approach: effects on yield, soil, and livelihoods, Ethiopia

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### Abstract

This study in Ethiopia's Rift Valley used field experiments and key informant interviews to evaluate (i) the combined effects of solar-based irrigation and soil fertility management on yield and soil moisture dynamics, and (ii) farmers' perceptions of solar-based irrigation's contributions to livelihoods and environmental sustainability. The participatory on-farm trial used cabbage and pepper as test crops and employed a randomised complete block design with three treatments: (i) Control/Treatment 1 - solar-based irrigation with farmers' current practices; (ii) Treatment 2-solar-based irrigation plus farmers' practices and 4 t ha<sup>-1</sup> of vermicompost; and (iii) Treatment 3-solar-based irrigation plus farmers' practices and 8 t ha<sup>-1</sup> of vermicompost. The study shows that integrating solar-based irrigation with vermicompost significantly increased crop yield and volumetric soil moisture content across sites. Financial analysis also indicates that the yield gains from this bundling technology were economically viable, with a benefit-cost ratio ranging from 0.38 to 2.46. Farmers reported that solar-based irrigation enabled livelihood diversification by expanding irrigated land, increasing harvest frequency, and supporting a shift from staple cereals to vegetables, fruits, and fodder crops. These changes strengthened household income, food security, and nutrition, while also improving dry-season feed availability. The adoption of solar-based irrigation generated environmental co-benefits, including tree planting, biodiversity-supportive practices, and improved ecosystem services. However, biodiversity efforts largely focused on economically valuable species, indicating the need for broader conservation strategies. Findings underscore that solar-based irrigation delivers the greatest benefits when integrated with soil fertility management practices, highlighting that scaling efforts should prioritise bundled interventions to maximise agronomic, economic, and livelihood impacts in Ethiopia and similar agro-ecological contexts.

**Keywords:** Crop yield, livelihood diversification, Soil moisture dynamics, soil-organic fertiliser, Solar-based irrigation

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