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Farmers perceptions and barriers to adoption of solar-powered irrigation systems in Kenya

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Abstract

Solar-powered irrigation systems offer a promising pathway to climate-resilient agriculture in Kenya's arid and semi-arid lands, where rain-fed farming is increasingly unreliable due to climate variability. Despite abundant solar resources and supportive policy frameworks, adoption rates among smallholder farmers remain persistently low. This study examines smallholder farmer perceptions on solar-powered irrigation, barriers to adoption, and establishes the current adoption gap within the Upper Ewaso Ng'iro Basin in Kenya, focusing on three Kenyan counties—Isiolo, Laikipia, and Meru. The basin is characterised by recurrent droughts, erratic rainfall, and increasing climate variability, which continue to undermine agricultural productivity and household food security among smallholder farmers. The study draws from a household survey data and qualitative insights from 180 smallholder farming households. The findings reveal overwhelmingly positive perceptions of solar irrigation technology, with 93.9 % of farmers agreeing that solar irrigation saves money and 96.1 % recognising sufficient sunlight for effective operation. However, a significant perception-adoption gap exists, as actual adoption stands at only 16.7 % overall, with the highest adoption in Isiolo (26.7 %) and lowest in Meru (6.7 %). Perceived affordability presents a major constraint, with 70.6 % of respondents agreeing that solar pumps are very expensive. Barrier analysis identifies four primary constraint categories: financial barriers including high upfront costs and limited credit access, followed by technical barriers related to inadequate knowledge and limited maintenance services, institutional barriers including weak extension support and land tenure insecurity, and awareness barriers stemming from limited exposure to demonstration. The barrier severity index shows financial barriers as most severe across all counties (0.74), followed by technical (0.47), institutional (0.42), and awareness barriers (0.41). County-level analysis reveals distinct profiles, with Isiolo farmers facing the most severe multi-dimensional barriers, Laikipia showing moderate barriers, and Meru exhibiting the lowest perceived barriers, though with the lowest SPIS adoption rate, suggesting possible unobserved constraints, or satisfaction with existing diesel-based systems. The study concludes that addressing the perception-adoption gap, equivalent to 77.2 % overall, requires integrated and county-specific interventions, including innovative financing models such as pay-as-you-grow and irrigation-as-a-service, strengthened technical support ecosystems, expanded demonstration and peer-learning opportunities, and integration of solar irrigation into agricultural extension services.

Keywords: Adoption barriers, farmer perceptions, Kenya, perception-adoption gap, solar-powered irrigation systems