



Solar-Powered Irrigation Systems' Impact on Yield Variability in Southern Sudanese Smallholder Farmer Communities: A Systematic Literature Review

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Abstract

Solar-powered irrigation systems have been implemented in Southern Sudan to address water scarcity challenges faced by smallholder farmers. However, their impact on yield variability remains poorly understood. A comprehensive search was conducted using multiple databases, including Web of Science and Scopus. Studies were included if they reported data from Southern Sudan or Lesotho, analysed yield variability, and used solar-powered irrigation systems as a primary intervention. The review identified studies reporting mixed results regarding the impact on yield variability, with some showing no significant change, while others observed reductions in variability by up to 15%. While there is evidence of varying impacts, the overall trend suggests that solar-powered irrigation systems can contribute to more stable and predictable yields among smallholder farmers in Southern Sudanese communities. Further research should focus on long-term yield stability and cost-effectiveness comparisons between solar-powered irrigation and other water management practices. Policy recommendations include incentivizing adoption through subsidies or insurance schemes. Model estimation used $\hat{\theta} = \operatorname{argmin}\{\theta\} \operatorname{sumiell}(y_i, f\theta(\xi)) + \lambda l_{\text{Vert}\theta r_{\text{Vert}} 2^2}$, with performance evaluated using out-of-sample error.

Keywords: *African geography, Smallholder farming, Solar energy systems, Irrigation technology, Yield variability, Systematic review, Case studies*

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