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Methodological Evaluation of Off-Grid Communities Systems in Tanzania Using Panel Data for Efficiency Gains,

Kamano Ngowi[1,2], **Kabira Tumbo**[3,4], **Mikochi Gomari**[5], **Nyawira Mwanzou**[1]

[1] Tanzania Commission for Science and Technology (COSTECH)

[2] Department of Animal Science, National Institute for Medical Research (NIMR)

[3] Department of Crop Sciences, Tanzania Commission for Science and Technology (COSTECH)

[4] Department of Soil Science, National Institute for Medical Research (NIMR)

[5] Department of Agricultural Economics, National Institute for Medical Research (NIMR)

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Correspondence: kngowi@aol.com

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Author notes

Kamano Ngowi is affiliated with Tanzania Commission for Science and Technology (COSTECH) and focuses on Agriculture research in Africa.

Kabira Tumbo is affiliated with Department of Crop Sciences, Tanzania Commission for Science and Technology (COSTECH) and focuses on Agriculture research in Africa.

Mikochi Gomari is affiliated with Department of Agricultural Economics, National Institute for Medical Research (NIMR) and focuses on Agriculture research in Africa.

Nyawira Mwanzou is affiliated with Tanzania Commission for Science and Technology (COSTECH) and focuses on Agriculture research in Africa.

Abstract

Off-grid communities in Tanzania are increasingly adopting renewable energy systems to improve agricultural productivity and reduce environmental impact. A mixed-method approach combining econometric techniques such as stochastic frontier analysis (SFA) to estimate output and technical efficiency gains from solar energy adoption in agricultural settings. Panel data revealed that the average technical efficiency of solar-powered irrigation systems was approximately 75%, with significant variability across different community setups. The study provides a robust framework for understanding the operational efficiencies within off-grid communities, highlighting areas where further investment and policy support could enhance system performance. Targeted interventions should focus on enhancing maintenance protocols and improving energy storage solutions to achieve higher efficiency levels in solar-powered agricultural systems. The empirical specification follows $Y = \beta_{0+\beta}^{\rightarrow} p\, X + varepsilon$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *Tanzania, Panel Data, Renewable Energy, Methodology, Efficiency Gains, Community Systems, Econometrics*

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