



Methodological Evaluation of Off-Grid Communities Systems in South Africa: Panel Data Estimation for Risk Reduction Analysis

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Abstract

The agricultural sector in off-grid communities of South Africa faces significant challenges related to water scarcity and energy supply, necessitating robust risk reduction strategies. A comparative study using panel data estimation techniques to analyse the impact of different agricultural irrigation and power supply solutions on productivity outcomes across multiple years. The analysis revealed that a specific combination of solar-powered drip irrigation systems and modular wind turbines significantly reduced water usage by 20% compared to traditional methods, with no loss in crop yield ($n = 150 \frac{\text{farms}}{3} \text{ years}$). This study provides empirical evidence supporting the adoption of hybrid renewable energy solutions for sustainable agriculture in off-grid communities. Communities should be encouraged to adopt solar-powered drip irrigation systems and modular wind turbines as part of their agricultural infrastructure, provided with subsidies or incentives.

Keywords: *African agriculture, panel data analysis, risk assessment, renewable energy systems, off-grid communities, poverty alleviation strategies, sustainable development*

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