



Methodological Evaluation of Smallholder Farms Systems in South Africa Using Multilevel Regression Analysis for Efficiency Measurement

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Abstract

Smallholder farms in South Africa face challenges related to resource management and profitability. A multilevel regression model was applied, incorporating both fixed effects (farm-level) and random effects (region-level). The model revealed significant differences in farm efficiency across regions, with some farms achieving efficiency gains of up to 25%. Multilevel regression analysis provided insights into the factors affecting smallholder farm efficiency, offering a robust method for future studies. Future research should consider longitudinal data and incorporate additional variables such as climate variability. Smallholder farms, South Africa, Multilevel Regression Analysis, Efficiency Measurement Model estimation used $\hat{\theta} = \operatorname{argmin} \{ \theta \} \operatorname{sumiell} (y_i, f\theta (\xi)) + \lambda \operatorname{Vert} \theta \operatorname{Vert}^2$, with performance evaluated using out-of-sample error.

Keywords: *Sub-Saharan, Multilevel, Regression, Efficiency, Smallholder, Contextual, Hierarchical*

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