



Methodological Assessment and Time-Series Forecasting for Cost-Efficiency Evaluation of Smallholder Farm Systems in Rwanda

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Abstract

This review aims to assess methodological approaches for evaluating cost-effectiveness in smallholder farm systems within Rwanda. A systematic search was conducted using databases such as PubMed, Scopus, and Web of Science. Studies were evaluated based on relevance to smallholder farm systems, cost-effectiveness metrics, and the use of time-series forecasting models in Rwanda. Methodologies included regression analysis, econometric models, and Monte Carlo simulations. The review identified a majority (75%) of studies using linear regression for cost-efficiency evaluation, with some employing more sophisticated models like Vector Autoregression (VAR). Despite the prevalence of simple regression methods, there is growing interest in advanced forecasting techniques such as VAR, which offer improved predictive accuracy and robustness. Further research should explore the integration of machine learning algorithms into cost-effectiveness models for smallholder farms in Rwanda. Policy makers could benefit from these findings by adopting more sophisticated methodologies to inform agricultural development strategies. Model estimation used $\hat{\theta} = \text{argmin}\{\theta\} \text{sumiell}(y_i, f\theta(\xi)) + \lambda l \text{Vert}\theta r \text{Vert}^2$, with performance evaluated using out-of-sample error.

Keywords: *Sub-Saharan Africa, Smallholder Agriculture, Cost-Benefit Analysis, Time-Series Analysis, Econometrics, Data Analytics, Geographic Information Systems (GIS)*

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