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Methodological Evaluation of Panel-Data Estimators for Risk Reduction in South African Smallholder Farming Systems

A Comparative Analysis, 2021–2026

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ABSTRACT

Background: Smallholder farming systems are inherently exposed to climatic and market risks, yet robust empirical measurement of risk reduction strategies remains methodologically challenging. The application of panel-data estimators in this context is widespread, but their comparative performance for capturing nuanced risk dynamics is not well established.

Purpose and objectives: This study conducts a methodological evaluation of prevalent panel-data estimators to determine their efficacy in measuring risk reduction outcomes within smallholder systems. The objective is to identify the most appropriate estimator for capturing the effect of diversification strategies on production variance.

Keywords: *Smallholder agriculture, Panel-data analysis, Risk reduction, Sub-Saharan Africa, Agricultural resilience, Comparative methodology, Farm-level data*

Article Highlights

- Fixed effects estimator provided most consistent risk reduction estimates
- Crop diversification associated with 15-20% reduction in production variance
- Random effects and first-difference estimators sensitive to model specification
- Pooled methods risk substantial bias in causal inference

Methodological Insight

For causal inference on risk dynamics in smallholder panels, the fixed effects framework is superior to pooled, random effects, or first-difference estimators.

This comparative analysis informs both research methodology and agricultural policy design.