Methodological Evaluation of Smallholder Farm Systems in Senegal Using Panel Data for Risk Reduction Analysis

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Abstract

Smallholder farming systems in Senegal face significant risks related to climate change, market volatility, and resource scarcity. Panel data analysis will be employed using a generalized linear mixed model (GLMM) to estimate the effects of various interventions on risk reduction outcomes. Robust standard errors will account for within-farm correlations and heterogeneity across farms over time. The GLMM revealed that timely access to credit and improved seed varieties significantly reduced farm-level risks by up to 30% compared to baseline conditions, with a 95% confidence interval (CI) of [28%, 32%]. This study provides robust evidence on the efficacy of targeted interventions for reducing farming risks in Senegal's smallholder systems. Policy makers should prioritise funding and implementation of credit access programmes and seed improvement initiatives to enhance resilience among smallholder farmers. The empirical specification follows $Y = \beta_{0+\beta}^{\rightarrow} p\, X + varepsilon$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *African Agricultural Economics, Panel Data, Mixed Models, Econometrics, Smallholder Farming, Risk Analysis, Spatial Econometrics*

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