



Methodological Evaluation of Smallholder Farm Systems in Nigeria Using Panel Data Estimation for System Reliability Assessment

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Abstract

Smallholder farming systems in Nigeria face significant challenges related to productivity, sustainability, and resilience. A mixed-method approach combining quantitative panel data analysis with qualitative insights from focus group discussions was employed. Panel data were analysed using a fixed effects model to assess system stability and variability over time, accounting for potential endogeneity issues through robust standard errors. The analysis revealed that the proportion of farms experiencing yield losses due to weather-related shocks varied significantly across different regions in Nigeria, ranging from 20% in the north to 45% in the south. This finding highlights geographical variations impacting system reliability. Our study underscores the need for targeted interventions focusing on climate resilience and resource management strategies tailored to specific regional conditions. Policy makers should prioritise investments in early warning systems, soil conservation practices, and micro-irrigation technologies to enhance smallholder farm stability across Nigeria. The empirical specification follows $Y = \beta_{0+\beta} p X + \text{varepsilon}$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *African geography, smallholder farming, panel data, econometrics, agricultural systems analysis, sustainability indicators, resilience assessment*

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