Methodological Evaluation of Smallholder Farms Systems in Kenya Using Multilevel Regression Analysis for Risk Reduction Assessment

Kerensah Gitonga Nganga[1], **Oscar Kibet Mutua**[2]

[1] Kenya Medical Research Institute (KEMRI)

[2] Department of Software Engineering, Kenya Medical Research Institute (KEMRI)

Author notes

Kerensah Gitonga Nganga is affiliated with Kenya Medical Research Institute (KEMRI) and focuses on Computer Science research in Africa.

Oscar Kibet Mutua is affiliated with Department of Software Engineering, Kenya Medical Research Institute (KEMRI) and focuses on Computer Science research in Africa.

Abstract

Smallholder farms in Kenya face significant challenges related to risk reduction due to environmental factors, market fluctuations, and limited access to resources. A comparative study using multilevel logistic regression models was conducted to analyse data from 100 randomly selected farms across three counties. Data included environmental conditions, market access, and farmer training programmes. The analysis revealed a significant reduction in risk factors ($p < 0.05$) for farms implementing integrated pest management practices compared to those without such interventions. Multilevel regression models effectively quantify the impact of system-level interventions on risk reduction among smallholder farmers, providing actionable insights for policy development. Policy makers should prioritise funding for climate-smart agricultural practices and farmer training programmes that integrate local knowledge with modern technology solutions. Model estimation used $\hat{\{\theta\}} = argmin\{\theta\} sumiell(yi, f\theta(\xi)) + \lambda lVert\theta rVert 2^2$, with performance evaluated using out-of-sample error.

Keywords: *African geography, multilevel modelling, resource constraints, smallholder agriculture, statistical methods, econometrics, geographic information systems*

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