



# Methodological Evaluation of Smallholder Farm Systems in South Africa Using Multilevel Regression Analysis for System Reliability Assessment

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**Published:** 02 July 2004 | **Received:** 25 April 2004 | **Accepted:** 30 May 2004

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**DOI:** [10.5281/zenodo.18792106](https://doi.org/10.5281/zenodo.18792106)

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## Abstract

Smallholder farms in South Africa are crucial to agricultural productivity and rural livelihoods, yet their management remains a challenge. The review employed systematic literature search methods with inclusion criteria based on relevance to South African context and use of multilevel regression techniques. Multilevel regression models revealed significant variability in farm productivity across different geographical scales, suggesting the need for tailored interventions at both local and regional levels. This study highlighted the importance of integrating multilevel analysis into methodological frameworks to enhance reliability assessment of smallholder farming systems. Future research should focus on replicating findings in diverse regions and incorporating qualitative data to enrich understanding of system dynamics. The empirical specification follows  $Y = \beta_{0+\beta} p X + \text{varepsilon}$ , and inference is reported with uncertainty-aware statistical criteria.

**Keywords:** *African agriculture, smallholder farming systems, multilevel modelling, regression analysis, reliability assessment, farm management, rural development*

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