



Methodological Diagnostics and Multilevel Regression Analysis of Regional Agricultural Monitoring Networks in Nigeria

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ABSTRACT

Agricultural monitoring networks are critical for informing food security policy, yet their methodological rigour in developing regions is often unexamined. In Nigeria, regional networks generate yield data, but the statistical validity of their designs and their capacity to detect genuine improvement remains unclear. This study conducts a comprehensive methodological diagnostic of existing regional monitoring systems. Its primary objective is to quantify their efficacy in measuring yield improvements using a multilevel modelling framework. We performed a diagnostic audit of network design across three agro-ecological zones. A three-level hierarchical model was fitted to panel data: $y_{ijt} = \beta_0 + \beta_1 X_{ijt} + u_j + v_k + \epsilon_{ijt}$, where i, j , and k index plots, districts, and zones, respectively. Inference was based on robust standard errors clustered at the district level. The diagnostic revealed that 40% of networks used inconsistent plot sampling protocols. The multilevel analysis showed a significant positive association between improved seed variety adoption and yield ($\beta = 0.23$, 95% CI [0.11, 0.35]), but district-level random effects accounted for over 60% of the unexplained variance, indicating substantial design-induced noise. Current monitoring network methodologies are statistically heterogeneous and introduce significant spatial confounding, undermining the reliable detection of yield gains attributable to interventions. Implement standardised, statistically powered sampling protocols nationally. Monitoring frameworks must integrate explicit multilevel structures to partition variance correctly and attribute change accurately. agricultural monitoring, multilevel modelling, sampling design, yield measurement, spatial variance, Nigeria This paper provides the first integrated methodological audit and variance component analysis of agricultural monitoring networks in the region, introducing a diagnostic-modelling framework for evaluating network efficacy.

Keywords: *Agricultural monitoring, multilevel modelling, yield variability, Sub-Saharan Africa, methodological evaluation, precision agriculture, food security policy*

Article Highlights

- 40% of networks used inconsistent plot sampling protocols
- Improved seed adoption showed significant yield association ($\beta=0.23$)
- Multilevel analysis revealed substantial spatial confounding
- Standardised sampling protocols needed for reliable detection

Key Finding

Current monitoring methodologies introduce significant spatial confounding, undermining reliable detection of yield gains from interventions.

This study provides the first integrated methodological audit of agricultural monitoring networks in the region.

ABSTRACT-ONLY PUBLICATION

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