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Bayesian Hierarchical Model for Assessing System Reliability in Smallholder Farms Systems in South Africa: A Systematic Literature Review

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Abstract

Smallholder farms in South Africa face challenges in maintaining reliable systems due to varying environmental conditions and resource availability. A comprehensive search strategy was employed using databases such as PubMed, Web of Science, and Google Scholar. Studies published between and the present were included if they used Bayesian hierarchical models to evaluate system reliability in smallholder farms in South Africa. Data extraction focused on model formulation, parameter estimates, and model performance metrics. The review identified a trend towards using more complex hierarchical Bayesian models with multiple levels of variability to account for farm-specific factors affecting system reliability. Bayesian hierarchical models provided robust frameworks for understanding the reliability of agricultural systems in smallholder contexts but highlighted challenges related to data quality and model specification across different farms. Future research should prioritise validation studies to ensure the applicability of these models in diverse farm settings, particularly those with limited resources and varying conditions. The empirical specification follows $Y = \beta_{0+\beta}^{\rightarrow} p\, X + varepsilon$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *Sub-Saharan, Bayesian, Hierarchical, Model, Reliability, Methodology, Smallholder*

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