African Applied Botany (Agri/Plant Science)

Bayesian Hierarchical Model for Efficiency Gains in South African Smallholder Farming Systems

Ntokozo Mthembu[1,2], **Thabiso Sekoto**[3], **Mpho Tshabalala**[1,4]

[1] Department of Soil Science, South African Institute for Medical Research (SAIMR)

[2] Human Sciences Research Council (HSRC)

[3] Department of Crop Sciences, South African Institute for Medical Research (SAIMR)

[4] University of the Western Cape

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Correspondence: nmthembu@yahoo.com

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Author notes

Ntokozo Mthembu is affiliated with Department of Soil Science, South African Institute for Medical Research (SAIMR) and focuses on Agriculture research in Africa.

Thabiso Sekoto is affiliated with Department of Crop Sciences, South African Institute for Medical Research (SAIMR) and focuses on Agriculture research in Africa.

Mpho Tshabalala is affiliated with Department of Soil Science, South African Institute for Medical Research (SAIMR) and focuses on Agriculture research in Africa.

Abstract

Efficiency gains in South African smallholder farming systems are crucial for sustainable agriculture development. A Bayesian hierarchical model was developed to analyse data from multiple farms, accounting for variability between different scales of production units within the same farm. The model revealed significant gains in efficiency across various farm sizes, with a mean improvement rate of 15% in productivity metrics. The Bayesian hierarchical approach effectively captures intra-farm and inter-farm variations in smallholder farming systems, providing robust insights into efficiency dynamics. Further research should explore the model's scalability to other regions and its impact on policy interventions aiming at increasing agricultural productivity. The empirical specification follows $Y = \beta_{0+\beta}^{\rightarrow} p\, X + varepsilon$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *African agroecology, smallholder farming, Bayesian statistics, hierarchical modelling, efficiency measurement, econometrics, resource allocation*

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