



## Bayesian Hierarchical Model for Yield Improvement in Process-Control Systems: An Intervention Study in South Africa

Gqoba Khumalo<sup>1</sup>, Mahlubi Tshabalala<sup>1</sup>, Sikhululekani Mkhize<sup>2,3</sup>

<sup>1</sup> Department of Sustainable Systems, University of Zululand

<sup>2</sup> University of Limpopo

<sup>3</sup> Rhodes University

**Published:** 03 March 2010 | **Received:** 17 December 2009 | **Accepted:** 09 February 2010

**Correspondence:** [gkhumalo@yahoo.com](mailto:gkhumalo@yahoo.com)

**DOI:** [10.5281/zenodo.18906555](https://doi.org/10.5281/zenodo.18906555)

### Author notes

*Gqoba Khumalo is affiliated with Department of Sustainable Systems, University of Zululand and focuses on Engineering research in Africa.*

*Mahlubi Tshabalala is affiliated with Department of Sustainable Systems, University of Zululand and focuses on Engineering research in Africa.*

*Sikhululekani Mkhize is affiliated with University of Limpopo and focuses on Engineering research in Africa.*

### Abstract

This study evaluates the effectiveness of process-control systems in improving agricultural yields in South Africa. A Bayesian hierarchical model was employed to analyse data from field trials across multiple farms. The model accounts for spatial variability and heterogeneity in crop yields, incorporating random effects at the farm level to estimate yield improvements under different conditions. The analysis revealed a significant 15% increase in average crop yield when using the Bayesian hierarchical model compared to traditional statistical methods, with robust standard errors indicating high confidence in the results. Bayesian hierarchical models provide a statistically rigorous framework for evaluating and optimising process-control systems in agricultural settings, demonstrating substantial improvement in yield management. Implementing these models can lead to more precise predictions of crop yields, enabling farmers to make informed decisions that maximise efficiency and productivity. The maintenance outcome was modelled as  $Y = \beta_0 + \beta_1 X + u_i + \text{varepsilon}$ , with robustness checked using heteroskedasticity-consistent errors.

**Keywords:** *African agriculture, Bayesian statistics, Hierarchical modelling, Process control, Yield assessment, Field trials, Methodological evaluation*

## ABSTRACT-ONLY PUBLICATION

This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.

✉ **REQUEST FULL PAPER**

**Email:** [info@parj.africa](mailto:info@parj.africa)

Request your copy of the full paper today!

## SUBMIT YOUR RESEARCH

**Are you a researcher in Africa? We welcome your submissions!**

Join our community of African scholars and share your groundbreaking work.

**Submit at:** [app.parj.africa](http://app.parj.africa)



Scan to visit [app.parj.africa](http://app.parj.africa)

**Open Access Scholarship from PARJ**

Empowering African Research | Advancing Global Knowledge