

**Sensitivity and Integration of Efficiency Estimates from Input Distance  
Functions and Stochastic Production Frontiers: Application to Maize Production  
in Benue State Nigeria**

**By**

**Goodness Chioma Aye**

**Submitted in partial fulfilment of the requirements for the degree of**

**PhD Agricultural Economics**

**Department of Agricultural Economics, Extension and Rural Development  
Faculty of Natural and Agricultural Sciences  
University of Pretoria  
South Africa**

**March 2011**

## **DEDICATION**

This thesis is first dedicated to our Lord God Almighty under whose everlasting arm I lean for His sustenance and second to my husband Sylvester and daughter Joy for their love and support.

## DECLARATION

I declare that this thesis, which I hereby submit for the degree of PhD at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

Signed: .....

Name: Goodness Chioma Aye

March 2011

## ACKNOWLEDGEMENT

My profound gratitude goes first to God Almighty for His loving kindness, goodness, favour, provision and sustenance throughout the period of this programme. I sincerely wish to say big thank you to my husband, Engr. Sylvester Aondolumn Aye and daughter, Joy Terdoo Nkechi Aye for their love, understanding, prayers, financial and moral support during this programme. I deprived my husband and daughter my presence most often in the struggle to complete this programme. May the Lord Jesus reward them abundantly. I appreciate my supervisor, Dr. Eric D. Mungatana for his constructive criticism, intellectual advice, patience and tolerance that led to the successful completion of this work.

I am also grateful to all the academic staff in the Department of Agricultural Economics, Extension and Rural Development and especially Prof. Johann Kirsten, the Head of department, Prof. Charles Machete, the Chair, and other members of the postgraduate committee for their comments that fine tuned the work. I thank all the administrative staff both in the department and faculty for their wonderful cooperation during my programme. Special thanks to Dorothy Tau for helping in making my admission to the University of Pretoria possible. To my fellow students and friends at the University of Pretoria: Ali, Mariam, Edidah, Sanga, Mulatu, Dee, Kiibi, Danbala, John, Thinah, Choolwe, Charity, Leah, Oliver, Dennis, Vanduzai, William and all the members of the PhD room- your support and encouragement are highly appreciated. I thank the academic staff in the Department of Economics and Management Sciences for their intellectual impact that broadened my knowledge base.

My gratitude goes to my parents, Mr & Mrs B.N. Oparah and my mother in-law, Mrs Cecilia Aye for their love and care. To the rest of my family members and their children: Pastor & Sis. Favour C.M.C. Oparah, Mr & Mrs. Lawman Cedar Nzenwa, Mr. & Mrs Kenndey Nzenwa, Promise Nzenwa, Pastor & Sis. Dominic Dikeocha, Mr & Mrs Dennis Udechukwu, Dr. & Mrs Fortunatus Chancellor Nzenwa, Amos Aye, Daniel Aye, Mr & Mrs Ehiedu, Mr & Mrs Tunde, Mr & Mrs Akin, Blessing Aye,

Nguuma Aye, Nguwese Aye, Mlumun Aye- thank you for your spiritual, financial and moral support. I will not fail to thank all my Pastors, leaders and brethren in the church both in Nigeria, South Africa and SADC for their spiritual support. I say Adieu to my late father in-law whose presence I would have so much love to behold on my return to Nigeria but God decided to take him before the completion of my programme.

My gratitude also go to the Vice Chancellor University of Agriculture Makurdi, Prof. D.V. Uzah; Dean Faculty of Agricultural Economics, Extension and Management Technology, Prof. Oto Okwu, immediate past head of Department of Agricultural Economics, Dr. (Mrs) W.L. Lawal, Prof. Obinne and other staff of the University of Agriculture Makurdi for their support, co-operation and for the study leave that made the conduct of this study possible. To ANSTI/DAAD and MMMF I say thank you for providing the fellowship and fund that assisted the successful completion of the research phase of this programme. I am also grateful to Prof Charlotte Du Toit, Prof Renée van Eyden and Ms Stella De Kock for giving me the opportunity to serve as a Researcher in African Institute of Econometric Modelling (AFRINEM) based at the University of Pretoria. The experience gained and funding was of great help to me. I will also not fail to appreciate the African Econometric Society (AES) for selecting me as one of the Young African Scholars which made it possible for me to present part of this thesis in the AES 2010 conference at the American University in Cairo, Egypt in July, 2010. I also thank Dr. Victor Oboh, Mr. Chris Ogbanje and his team, and the ADP staff, Benue State chapter that assisted in the successful collection of the data for this study.

For all these people and others whose names are not mentioned here but who were instruments to the success of my PhD programme, may the blessings and favour of the Lord be your constant portion in Jesus name.

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**Degree:** PhD Agricultural Economics

**Supervisor:** Dr. Eric D. Mungatana

**Department:** Agricultural Economics, Extension and Rural Development

**ABSTRACT**

The selection of a suitable model for efficiency analysis is one of the most important issues in policy analysis. Given the recent interest in the use of distance functions as alternative representation of production technology, this study compares the empirical performances of the parametric stochastic input distance function to its non-parametric counterpart, data envelopment analysis. A further comparison is made between the alternatives of a distance and production function frontiers. It further integrates efficiency scores from the consistent approaches in order to evaluate the performance of the sampled farm households and for analysis of policy impacts on technical, allocative and cost efficiency. The usefulness of the proposed methodology is applied to smallholder maize production in Benue State Nigeria. The maize sub-sector has featured in a number of Nigeria's policy initiatives, the most current of which involves doubling of its production and productivity through promotion of improved technologies such as hybrid seed, inorganic fertilizer, pesticides, herbicides, and better management practices. Despite the policy initiatives, maize productivity has remained low raising questions about the efficiency of resource use by farmers and the benefits of Nigeria's technology policy. The study used data obtained from a field survey for the 2008/2009 agricultural year. A multistage stratified sampling technique was employed in selection of respondents. A total of 240 maize farm households were randomly selected and interviewed using structured questionnaires.

Results from all the approaches indicated considerable technical, allocative and cost inefficiency under both traditional and improved maize technology. Technical efficiency estimates range from 80 to 87 percent. Allocative efficiency estimates range from 53 to 74 percent while cost efficiency estimates range from 45 to 62 percent. The results from all the approaches indicated that inefficiency in maize production in Benue State is dominated by cost inefficiency suggesting the immense potential of enhancing production through improvement in overall efficiency. The overall consistency check shows that technical, allocative and cost efficiency measures from the three distance functions were consistent whereas similar conclusions could not hold when these were compared to the production frontier especially for technical efficiency estimates.

Given the consistency of results from the parametric and non-parametric distance functions, an integrated input distance model was developed for providing final efficiency estimates and analysis of policy impacts. The results show that both traditional and improved technology users were technically, allocatively and cost inefficient. The average technical, allocative and cost efficiency are 84.2, 65.7 and 54.5 percent, respectively implying that there is a possibility of raising maize production by 45.5 percent through overall efficiency improvement. Under the integrated approach, the study revealed that hybrid seeds, inorganic fertilizer and conservation practices have positive and significant impact on farm efficiency. Other determinants of efficiency include education, age, household size, land size, credit, and membership in a farmer group. The findings justify the need for further public investment in maize technology development and proper implementation of the relevant policies in order to enhance the efficiency with which maize has been produced thereby increasing its productivity, food security and farm incomes and subsequently reducing poverty in Nigeria.

**Key Words:** Technology, policy, efficiency, maize, Nigeria, parametric stochastic, non-parametric, distance function, production function, integrated model

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## ACRONYMS AND ABBREVIATIONS

ADP	Agricultural Development Project
AE	Allocative Efficiency
APMEU	Agricultural Projects Monitoring and Evaluation Unit
BNARDA	Benue State Agricultural and Rural Development Agency
CADP	Commercial Agriculture Development Programme
CBN	Central Bank of Nigeria
CD	Cobb-Douglas
CE	Cost Efficiency
COLS	Corrected Ordinary Least Squares
CRS	Constant Returns to Scale
CSIS	Centre for Strategic and International Studies
DEA	Data Envelopment Analysis
DFID	Department for International Development
DFRRI	Directorate of Food, Roads and Rural Infrastructure
EE	Economic Efficiency
FACU	Federal Agricultural Coordinating Unit
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistics
FAS	Agricultural Service of United States Department of Agriculture
FCT	Federal Capital Territory
FEAP	Family Economic Advancement Programme
FMARD	Ministry of Agriculture and Rural Development
FRN	Federal Republic of Nigeria
GDP	Gross Domestic Product
Ha	Hectare
HDR	Human Development Report
ICARRD	International Conference on Agrarian Reform and Rural Development
IDRC	Development Research Centre
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
Kg	Kilogram

LR	Likelihood Ratio
MLE	Maximum Likelihood Estimates
NACB	Nigerian Agricultural and Cooperative Bank
NACRDB	Nigerian Agricultural, Cooperative and Rural Development Bank
NAFPP	National Accelerated Food Production Project
NALDA	National Agricultural Land Development Authority
NBS	National Bureau of Statistics
NCRI	National Cereals Research Institute
NDE	National Directorate of Employment
NEEDS	National Economic Empowerment and Development Strategy
NERICA	New Rice for Africa
NPC	National Population Commission
NPFS	National Food Security Programme
NPN	National Party of Nigeria
NSS	National Seeds Service
OFN	Operation Feed the Nation
OLS	Ordinary Least Squares
PCU	Projects Coordinating Unit
R&D	Research and Development
SAP	Structural Adjustment Program
SFPF	Stochastic Frontier Production Function
SIDF	Stochastic Frontier Input Distance Function
TE	Technical Efficiency
TFP	Total Factor Productivity
TL	Translog
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VRS	Variable Returns to Scale