Journal of Agriculture and Food Sciences ISSN 1597 - 1074
Volume 10 Number 1, April 2012 pp. 9-17 .

MEASUREMENT OF EFFICIENCY OF YAM PRODUCTION IN NASARAWA STATE, NIGERIA: A PROFIT FUNCTION APPROACH

Igwe, K. C.
Department of Agricultural Economics, Michael Okpara University of Agriculture, Umudike, P. O. Box 2, MOUAU Post Office, Umudike, Nigeria
kayce_chima@yahoo.com; igwe.kelechi@mouau.ed.ng

ABSTRACT
The study employed the stochastic frontier function to examine factors that affected economic efficiency and the level of the efficiency for yam production in Nasarawa State, Nigeria. A multistage sampling procedure was used to sample for location while purposive sampling technique was employed to sample for the respondents. One hundred and sixty yam farmers constituted the sampling size and the sampling frame was derived from the list of yam farmers gotten from the Agricultural Development Programme (ADP) extension offices in the respective communities. A mean economic efficiency of 51% was measured for the sampled yam farmers. Price of planting materials (p=0.01), price of fertilizer used (p=0.01) and capital inputs (p=0.01) were significant factors that strongly determined yam production. However, the factors that strongly determined economic efficiency of yam production in Nasarawa State were age (p=0.01), household size (p=0.01) farm size (p=0.05) and extension contacts (p=0.1). Policies of government for increased yam productivity and economic efficiency in the study area should target the young farmers, geared towards improving on the existing extension service provision which should include sustained subsidies and easy accessibility of farm inputs by the farmers.
Keywords: *Stochastic frontier, profit function, determinants, economic efficiency*
http://dx.doi.org/10.4314/jafs.v10i1.2

INTRODUCTION

Meeting the food and nutritional need of the ever-increasing population has been a huge task for every successful government (Idachaba, 2004). This is because food is so central to man that besides being a veritable weapon of war and peace, has influenced the quality of human life in determining the growth and survival of nations (Borgston, 1988). It has been opined that the countries of Sub-Saharan Africa (SSA) in less than 25 years would have their population increase by 2.6 times reaching 1, 294 million, almost equal to China's projected population in 2025 (Oyedipe, 2001).The implication is that many more mouths have to be fed and resource utilization therefore has to be rationed much more efficiently.

Nigeria as a country is endowed with large expanse of arable land and other resources as well as favourable climate, however, she is yet to become self sufficient in food production (Spore, 1993). Low productivity due to inefficiency in resource use among food crop farmers has been reported (Idiong *et al*., 2002; Babatunde *et al*., 2007). The levels of efficiency with respect to various indigenous crops need to be measured *inter alia* for policies that would improve efficiency to be made and implemented. Yam is one of the principal root crops of the Nigerian economy both in terms of land under cultivation and in the volume and value of production. It is a preferred staple food, appreciated for its taste and cultural role because it has high relative value per unit of land used in their cultivation when compared with other

crops, particularly the cereals (Bamire and Amujoyegbe, 2005). Technical efficiency studies alone are not sufficient to make good policies that will favour increased production. There is need to also ascertain the economic efficiency situation of any food crop of interest. Nasarawa State represents a yam producing state in Nigeria and so, attempt to measure its economic efficiency is a worthwhile enterprise.

Generally, the measurement of efficiency is a success indicator and performance measurement by which production units are evaluated and thus provides a control mechanism for decision makers to monitor the performance of the production system or units under control. It provides qualitative as well as quantitative evidence empirically, particularly where theory provides no guidance or sends conflicting signals concerning the impact of phenomena on performance (Coelli, 1995). Efficiency is thus an important factor of productivity growth as well as stability of production especially in developing agricultural economy (Hazaeika and Subramanian, 1999).

Government usually benefit greatly from efficiency studies in terms of provision of adequate policies that will enhance efficient utilization of available resources thereby achieving productivity and growth especially in the face of slow growth and instability in production (Bhuyan and Hazarika, 1997; Igbokwe, 2004). Economic efficiency particularly is the ability of farms to maximize profit (Adeniji, 1988; Ohajianya and Onyenweaku, 2001).The Cobb-Douglas production that employs its profit function version has been used by Yotopoulos and Lau (1973), who also proposed a test procedure for estimating profit function whereby the technical and allocative efficiency are jointly tested. Usually the cost frontier measures economic efficiency (Okoye, 2006). This approach has been employed in this study.

METHODOLOGY

The concept of efficiency of resources is concerned with the relative performance of processes in transforming given inputs into outputs. Economic theory identifies three types of efficiency namely price or allocative efficiency, technical efficiency and economic efficiency. Allocative efficiency is achieved for a profit maximization farm in resource use if the farm equates the value of marginal product to the unit price of the resource or the marginal factor cost (MFC) (Shapiro, 1994). Technical efficiency indicates the ability to utilize the ‘’best practice’’ so that not more than the necessary amount of a given set of inputs is used in producing the best level of output (Timmer, 1990). However, both are necessary conditions and when they occur together are sufficient conditions for achieving economic efficiency (Yotopoulous and Lau, 1979).

Efforts have been made by researchers over time to measure economic efficiency empirically. Researchers have measured economic efficiency based on a trans-log function in which certain restrictions were imposed. However, the most common functional forms include the Cobb-Douglas, Constant Elasticity of Substitution (CES) and the Trans-log functions (Effiong, 2005). The cost function approach of measuring economic efficiency is most

helpful when individual or sole enterprises are considered and so is adopted in this study on yam production.

The study was carried out in Nasarawa State, Nigeria. Nasarawa State represents a major yam growing area of Nigeria and supply food yams to various states across the nation (Igwe, 2004). The area lies between Latitude 7^0 and 9^0 North of the Equator and Longitude 7^0 and 10^0 East of the Greenwich and has tropical type-mixture of hot and cold weather with a mean temperature range of 60^0F and 80^0F (MOIYS, 2001). Four Local Government Areas were purposively selected because of financial limitation and a multistage random sampling technique applied in selecting 120 yam farmers. The list of farmers obtained from the zonal offices of the Agricultural Development Programme of the State formed the sampling frame.

Questionnaire, complemented with interview schedule was the main data collection instrument. Data were collected on the revenue from the quantity of yam produced and sold, rental values of yam farm land or their opportunity costs, labour cost, years of farming experience, age of farmers, credit availability, fertilizer prices, household size and other variables of interest.

The Cob-Douglas frontier function was applied to measure the economic efficiency of these farmers. The restriction on Cob-Douglas is based on the nature of study having been proved by research to be the best for productivity studies (Igwe, 2004). The explicit form of the model applied is specified below:

$$\text{In } Y = \beta_0 + \beta_1 \text{ In } X_1 + \beta_2 \text{ In } X_2 + \beta_3 \text{In } X_3 + \beta_4 \text{ In } X_4 + \beta_5 \text{ In } X_5 + V_i - U_i \ldots (1)$$

In = natural log
β_0 = intercept
Y = Output of yam in naira
X_1 = Rental value in naira per hectare
X_2 = Price of planting material in naira per kilogramme
X_3 = Price of fertilizer in naira per kilogramme
X_4 = Wage rate in naira per man day
X_5 = Capital in naira
$\beta_1 - \beta_5$ = Parameters to be estimated
Vi = Symmetric error term accounting for random variations in output due to factors beyond the farmer
Ui = Non-negativity random variable representing economic inefficiency in production relative to the stochastic frontier

$$\text{Exp } (-Ui) = b_0 + b_1a_1 + b_2a_2 + b_3a3 + b_4a_4 + b_5a_5 + b_6a_6 + b_7a_7 + e \ldots (2)$$

Where:
a_1 = Credit measured as dummy where 1 is assigned to credit user and 0 otherwise
a_2 = Age of farmers in years
a_3 = Education status in years
a_4 = Farming experience in years
a_5 = Household size in numbers
a_6 = Farm size in hectares
a_7 = Extension contact in numbers

$b_0 – b_7$ = Parameters to be estimated
e = error term

The computer software frontier 4.1 developed by Coelli (1994) which jointly estimate the production factors alongside the efficiency factors was used for the investigation.

RESULTS AND DISCUSSION

The production factors are contained in table 1. Price of planting materials, price of fertilizer and capital inputs were the major strong determinants of yam yield by farmers. Price of planting material was significant at 1% level and positive in sign in line with *a priori* expectation. This implies that with increased planting material, higher yield of yam is expected. Yams of good variety are highly prized and are more viable than the local varieties and because they give better yield to the farmers. Yam is propagated by its root and so yield is possible by purchase of seed yams. Because good varieties are highly prized in the study area, the farmers buy them irrespective of their price in anticipation for higher output.

Price of fertilizer input was significant at 1% and positive in sign. Yam cultivation in the study area achieves higher yield according to the extent of fertilizer usage by farmers. The implication is that the higher the use of fertilizer input the greater the output from the yam farm. Fertilizer as an agronomic input has been known to be necessary to achieve increased yield from most African soils. Fertilizer input is a cost. However, given that it facilitates increased output, its effect in increasing yield if the right quantity and quality are applied outweighs the cost. Various research studies on fertilizer use and demand Nigeria in particular have been done over time by researchers. Fertilizer use is necessary to ensure sustained arable crop production (Igwe *et al*., 2009).

Capital input was significant also at 1% level and positive in sign inconsonance with *a priori* expectation. This implies that the farmers with more capital inputs had more yam yield from their yam farms than those with little capital endowment. The clearing of relatively large expanse of land using tractors and the use of herbicides in dealing with weeds and pests that attack yam would encourage higher yam yield. Thus, with relative increase in capital input, the higher the yield from the yam farms in the study area.

Determinants of Economic Efficiency: Table 1 shows the findings on the determinants of economic efficiency of yam production in the study area.

Table 1: Determinants of Economic Efficiency of Yam Farmers

Variable	Parameter	Frontier Function (MLE)
Production Factors		
Constant	β_0	1.5451 (1.1644)
Rental value	β_1	0.2355 (1.4367)
Price of planting material	β_2	0.8051 (3.2153) ***
Price of fertilizer	β_3	-0.0817 (-4.1720) ***
Wage rate	β_4	1.2499 (1.1418)
Capital input	β_5	0.6398 (3.8656) ***
Efficiency factors		
Credit	b_1	-0.0696 (-1.1009)
Age	b_2	-0.8415 (-3.0370) ***
Education status	b_3	0.0068 (0.0943)
Farming experience	b_4	-0.0450 (-0.6785)
Household size	b_5	-2.0452 (-12.2891) ***
Farm size	b_6	-0.3074 (2.4084) **
Extension contact	b_7	-2.0540 (-1.6701) *
Sigma – squared		16.0987 (4.8799) ***
Gamma		0.9807 (159.0156) ***

Source: Computer Printout of Field Survey, 2003
Note: *, **, and *** mean significant at 10%, 5% and 1% levels respectively

Age of farmers, household size, and farm size and extension contacts were the major factors that determined economic efficiency among yam farmers in the study area. The estimated coefficient of age of yam farmers was significant at 1% level and negative in sign as expected. The negative relationship conforms to work by Ajibefun and Aderinola (2004) and Okoye (2006). As the yam farmers get older, their yield tends to decrease. Yam farming is laborious and requires young and energetic men who are equipped naturally for the task. It is therefore not economically efficient for the aged persons to engage in yam production in the study area.

Similarly, the estimated coefficient of household size was significant at 1%. The strong significance of household size stems from the fact that majority of the farmers use household labour for their farm activities. The sign of the coefficient was negative similar to work by Nwachukwu (2006). Thus, famers with relatively lower household size were more economically efficient than those with higher household size. Profit would be depressed with increasing household size without corresponding increased yam productivity. However, the findings are in conflict with Mubarik *et al*. (1990) who emphasized the dependence and usefulness of larger household sizes in farm as work force.

The coefficient of farm size variable was significant at 5% level but negative in sign contrary to *a priori* expectation. This implies that farmers with relatively smaller farm size are more economically efficient than those with higher farm size. This perhaps is due to the fact that many of the cultural practices in yam production particularly where mixed cropping is practised cannot be mechanized. It is therefore not economically efficient for the farmers in handling very large farm size. Abaelu (1998) observed a positive sign in his study and established that larger firms had higher economic efficiency than smaller firms. More so, a negative sign of the farm size coefficient is at variance with Effiong (2005) and Onyenweaku and Nwaru (2005) whose studies were on livestock enterprises and food crops respectively. Although it is expected that larger farms should be more economically efficient than smaller farms, a farm may become too large that the farmer may find it difficult to manage and this would result to inability to optimize his resource use in the long run. This seems to be the situation in the study area. Thus, farmers with small farm size were more economically efficient than those with larger farm size.

Extension contact variable was significant at 10% level but negative in sign contrary to *a priori* expectation. Although the yam farmers in the study area enjoy extension visits, such visits did not guarantee increased yield by the farmers. It does appear that it has become a routine that does not transmit to any meaning improvement on the farmers' farm performance. Retraining exercises need to be undertaken for the extension agent from time to time to keep them abreast of new techniques and strategies that could impact on their farm clienteles.

Levels of Economic Efficiency of Production

Table 2 contains various levels of the economic efficiencies of the sampled yam farmers in the study area. Although the stochastic frontier gave the mean economic efficiency index to be 0.51, the spread across the sampled farmers show that only 1.87 % of the sampled farmers had an economic efficiency index that is above 81%. This connotes that there is a relatively high level of economic inefficiency present among the yam farmers in the area. With the informed mean economic efficiency level index therefore, there are yet a 39% opportunity of improving on the economic efficiency of yam farmers in the area with the available technology at their disposal.

Table 2: Frequency Distribution of Economic Efficiency Levels of Yam Farmers in Nasarawa State, Nigeria

Range	Frequency	Percentage
0.01 – 0.20	15	9.38
0.21 – 0.40	18	11.25
0.41 – 0.60	68	42.50
0. 61 – 0.80	56	35.00
0.81 – 1.00	03	1.87
Total	**160**	**100**

Source: Computer Print Out from program FRONTIER (Version 4.1c), Field Survey, 2003

CONCLUSION

Results of the Cob-Douglas frontier analysis of the economic efficiency of yam production in Nasarawa State showed that age, household size, farm size and extension contacts were the major determinants of economic efficiency of yam production. By employing the questionnaire as the major data collection instrument complimented with interview schedule, data were generated from 120 yam farmers and the price of planting materials, price of fertilizer and capital inputs were the major factors that determined yam production while age, household size, farm size and extension contacts affected the economic efficiency of yam farmers. Government policies must therefore accommodate these variables for increased yam production and economic efficiency. If this is done, there are chances of increasing the present level of economic efficiency of the farmers by 49 % given that the yam farmers are yet to be fully economically efficient with their available technology.

ACKNOWLEDGEMENT

The author acknowledges Prof. C. E. Onyenweaku who laid a solid foundation for him in efficiency studies in agricultural production. The MSc thesis of the author which provided the window for subsequent work in the use of the stochastic frontier was jointly supervised by Professors Onyenweaku and Mbanasor.

REFERENCE

Abaelu, J. N. (1998) Economics of Livestock Production in Nigeria. Proceeding of the Agricultural Society of Nigeria Conference, p. 33-36

Adeniji, J. P. (1988) Farm size and Resource use Efficiency in Small-scale Agricultural Production: The Case of Rice Farms in Kwara State, Nigeria. *Nigerian Agricultural Journal* 23(2)

Ajibefun, I. A. and E. A. Aderinola (2004) Determination of Technical Efficiency and Policy Implication of Traditional Agricultural Production: Empirical Study of Nigeria Food Crop Farms. Final Report Prentation at Biannual Research Workshop of Africa Economic Research Consortium, Nairobi, Kenya

Babatunde, R. O., E. O. Olorunsanya, J. S. Orebiyi and A. Falola (2007) Optimal Farm Plan in Sweet Potato Cropping Systems: The Case of Offa and Oyun Local Government Areas of Kwara State, North – Central, Nigeria. *Agricultural Journal* 2(2): 285-289

Bhuyan, R. P. and C. Hazarika (1997) An Analysis of Growth and Instability in Tea Production in Assam, *Journal of Interacademicia*, Vol. 1 (3): 248-254

Borgston, F. (1988) Man's Food: Principles of Food Science Vol 1 Food Technology, Food and Nutrition Press Inc., Westport Connecticut USA

Effiong, E. O. (2005) Efficiency of Production in Selected Livestock Enterprises in Akwa Ibom State, Nigeria. PhD Dissertation Submitted to the Department of Agricultural Economics, Michael Okpara University of Agriculture, Umudike

Hazarika, C. and S. R. Subramanian (1999) Estimation of Technical Efficiency in the Stochastic Frontier Production Function Model – An Application to Tea Industry in Assam

Idachaba, F. S. (2004) Food Security in Nigeria: Challenges under Democratic Dispensation. Paper Presented at the 9th Agricultural and Rural Management Training Institute (ARMTI), Annual Lecture, Illorin

Idiong, I. C. (2005) Evaluation of Technical, Allocative and Economic Efficiencies in Rice Production Systems in Cross River State, Nigeria A PhD Dissertation Submitted to the Department of Agricultural Economics, Michael Okpara University of Agriculture, Umudike

Igbokwe, N. U. (2004) Efficiency of Small holder Cassava Production in Abia State, Nigeria, An MSc Thesis Submitted to Department of Agricultural Economics, Michael Okpara University of Agriculture, Umudike, Nigeria

Igwe, K. C. (2004) Technical Efficiency and its Determinants in Yam Production in Nasarawa State, Nigeria. An MSc Thesis Submitted to the Department of Agricultural Economics, Michael Okpara University of Agriculture, Umudike

Igwe, K. C., A. C. Nwosu and R. O. Mejeha (2009) Fertilizer Demand for Arable Crop Farming in Ikwuano Local Government Area of Abia State. Proceedings of the Annual Conference of the Agricultural Society of Nigeria held on 20th – 23rd October, 2009 at National Universities Commission Auditorium and RMRDC, Abuja, Pp. 494-496

Mubarik, A. and J. C. Flinn (1998) Profit Efficiency among Basmati Rice Producers in Pakistan Punjab. *American Journal of Agricultural Economics* 71: 303-310

Nwachukwu, I. N. (2006) Efficiency of Vegetable Production in Imo State: The case of Fadama Telfairia Occidentalis. MSc Thesis Submitted to the Department of Agricultural Economics, Michael Okpara University of Agriculture, Umudike

Ohajianya, D. O. and C. E. Onyenweaku, C. E. (2001) Gender and Relative Efficiency in Rice Production Systems in Ebonyi State, Nigeria: A Profit Function Analysis. *Journal for Sustainable Agriculture and Environment* 3(2): 384-392

Okoye, B. C. (2006) Efficiency of Small holder Cocoa yam Farmers in Anambra State, Nigeria. MSc Thesis Submitted to the Department of Agricultural Economics, Michael Okpara University of Agriculture, Umudike

Onyenweaku, C. E. and J. C. Nwaru (2005) Application of a Stochastic Frontier Production Function to the Measurement of Technical Efficiency in Food Crop Production in Imo State, Nigeria. *Nigeria Agricultural Journal* 36: 1-12

Oyedipe, E.O. (2001) "Agricultural Research Policy and National Development". Working paper Presented at the In-house Technical Workshop for the Agricultural Policy for Nigeria. 10th April, 2001, Abuja

Shapiro , K. H. (1994). ''Efficiency and Modernization in African Agriculture: A Case Study of Geita District, Tanzania'' PhD Thesis, Stanford University

Spore (1993) CTA'S Bimonthly Bulletin of the Technical Centre for Agricultural and Rural Cooperation, No. 45 June, 1993, Wageningen, The Netherlands

Timmer, C. P. (1990). ''On Measuring Technical Efficiency'' Food Research Institution Studies in Agricultural Economics, *Trade and Development* Vol. 9 (2): 71-99.

Yotopoulous, P. A. and Lau, L. J. (1973) Test of Relative Economic Efficiency: Some Further Results. *American Journal of Economic Review* 63 (1): 214 - 225

Yotopoulous, P. A. and Lau, L. J. (1979) Resource Use in Agriculture: Application of the Profit Function on Selected Countries. Food Research Institutes Studies Vol. XVII (1): 14-15