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Determinants of Technical Efficiency among Rice Farmers in Kogi State, Nigeria

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Abstract. The study used a stochastic production frontier analysis to analyze the determinants of technical efficiency among rice farmers in Kogi State, Nigeria. A multi-stage sampling technique was used to select a sample size of 288 rice farmers in Kogi State through a well structured questionnaire. The study noted that farm size, seed and fertilizer were the most important factors increasing rice productivity. Also, the technical efficiency of rice farmers varied due to the presence of technical inefficiency with the mean efficiency value of 0.54 implying that about 46% of rice output is lost due to inefficiency on the part of farmers. Variables such as age (-0.05), household size (-2.38), and the use of improved variety (-0.10) caused an increase in technical efficiency of farmers. The productivity of the factors could be improved by expanding the farmsize, increasing the quantity of seed, fertilizer use and increasing the level of labour while alternative sources of agrochemicals be employed by farmers in other to boost production. The farmers should be encouraged to use improved varieties of rice in order to increase their technical efficiency.

Keywords: Technical Efficiency, Rice Production, Kogi State

Introduction

Rice is consumed by over 4.8 billion people in 176 countries of the world and is one of the most important food crop for over 40million people in Africa (FAO, 1996). In sub-Saharan Africa, West Africa is the leading producer and consumer of rice. In 2002, Nigeria accounted for nearly 44% of the total rice output and 57% of the total rice producing area in West Africa (WARDA, 2002). Nigeria is endowed with favourable ecologies for rice cultivation. Virtually all the rice growing ecologies (the upland irrigated, inland valley swamp deep water/ floating and tidal Mangrove swamp) abound in Nigeria. However, evidence show that the country is actually producing rice on about 1.7 million ha of land as against the 4.6-4.9 million ha of potential rice land area (WARDA, 2000)

The demand for rice has been increasing on a much faster rate in Nigeria than in other West African countries since the mid 1970s. The World Bank (1981) projected that from 2010, the poorest income class of urban households in Nigeria may obtain not less than 33% of their cereal-based calories from rice annually. This is due to the changing consumer preferences and rapidly increasing population. FAO (2000) reported that as more family income rises in Nigeria there have been a shift in the consumption pattern from roots and tuber crops in favour of rice. This is one of the likely reasons why, rice that was once reserved for ceremonial occasions, has grown in importance as a daily intake for most homes today (Oniah, *et al.,* 2008).

If Nigeria is to become self-sufficient in rice production, productivity must increase. To achieve this objective, efforts must be taken to examine the productive efficiency of rice farmers in the country. The challenge to increase the efficiency in food production level in Nigeria appears to be more urgent now than it has ever been in the history of the country (Kareem *et al*., 2008). The slow pace of the agricultural sector in Nigeria cannot keep up with the rapid population growth rate, resulting in food shortage. Technical efficiency according to Dean, (1982) is the transformation of inputs into outputs subject to the technical rules specified by production function. Production function gives mathematical expression to the relationship between the quantities of inputs employed and the quantities of output

produced. Technical efficiency is the ability of a farmer to employ the "best practice" in the production process so that not more than the necessary amount of a given set of inputs is used in producing the best level of output. Technical efficiency is the rate of total output to total inputs (Farrel, 1957). A production process may be technically inefficient, in the sense that it fails to produce maximum output from a given level of inputs (Hazarika and Subramanian, 1999). If an enterprise is technically inefficient, it operates beneath its stochastic frontier. The technical efficiency in production is measured by using the stochastic frontier production function proposed by Aigner *et al*. (1977). Technical efficiency is however defined as a measure of how well an individual transforms inputs into a set of outputs based on a given set of technology and economic factors (Rahman, 2002).

This study was, therefore designed to evaluate the technical efficiency of rice farmers in Kogi State Nigeria with the view of identifying the factors that determine the technical efficiency of rice farmers in the study area.

METHODOLOGY

The Study Area

This study was carried out in Kogi State, Nigeria. Kogi State was created on August 27, 1991 with Lokoja as its capital. It has a total land area of 29833 square kilometers and is located between latitudes 6^0 42'N and longitudes 7^0 30'E. The State shares borders with Niger, Nassarawa and FCT Abuja to the North, with Benue to the East and Enugu, Edo, Ondo, Ekiti and Kwara States to the South and West. Kogi State has a total population of about 3595789 million peoplewith an average of 172000 farm families and about 70% of these populations live in the rural areas and are engaged in agricultural production (en.wikipedia.org/wiki/Kogi_State). In Kogi State, rice production is encouraged in the flood plains of the rivers, with the river Niger drainage system acting as a major rice-growing environment and about 38000ha of rice cultivable area and yield of 79890 metric tons in 2004 for wet season rice production (ADP, 2005)

Sampling Technique and Data Collection Method

The study used a multi-stage sampling technique in selecting a sample for the study. In the first stage three Local Government Areas were purposively selected from each of the four zones in the State due to higher population of rice farmers in the areas. In the second stage, four communities that typify the State in terms of rice production were drawn from each of the twelve Local Government Areas selected using randomized sampling design. In the final stage six households were drawn from each community selected through a simple random sampling technique, giving a total of 288 rice farmers selected for the study through a well structured questionnaire.

Analytical technique

The Stochastic Frontier Analysis (SFA) was used to analyze the technical efficiency of rice farmers. The production technology of the rice farmers in Kogi State, Nigeria was assumed to be specified by the Cobb-Douglas frontier production function. This according to Ogundari *et al.* (2006) has been used by many empirical studies, particularly those relating to developing countries' agriculture. Other advantage of the method lies in the fact that the functional form meet the requirement of being self-dual (allowing an examination of economic efficiency).

The Cobb- Douglass functional form of the model is represented as follows:

$$LnY_i = \beta_0 + \beta_1 lnX_{1i} + \beta_2 lnX_{2i} + \beta_3 lnX_{3i} + \beta_4 lnX_{4i} + \beta_5 lnX_{5i} + (Vi-Ui) \quad ----1$$

Where Ln is natural logarithm; Y_i is output of the ith farmer (kg); X_{1i} is farm size of the ithfarmer (ha); X_{2i} is labour for the ith farmer (mandays); X_{3i} is fertilizer used by the ith farmer (kg); X_{4i} is agrochemical (litres); X_{5i} quantity of seed planted (kg); β_0, $\beta_{1....}B_5$are the regression parameters, Vi is random variables which is assumed to be independent of *Ui*, identical and normally distributed with zero mean and constant variance N (0, σ^2); and, *Ui* is non-negative random variables which are assumed to account for technical inefficiency in production and are often assumed to be independent of Vi such that U is the non-negative truncated (at zero) U of half normal distribution with $|N(0, \sigma^2_v))|$.

Furthermore, the inefficiency of production, *Ui*was modeled in terms of the factors that are assumed to affect the efficiency of production of the farmers. Such factors were considered to be socioeconomic and management factors. Thus, the inefficiency model is described as:

$$Ui = \partial_0 + \partial_1 Z_1 + \partial_2 Z_2 + \partial_3 Z_3 + \partial_4 Z_4 + \partial_5 Z_5 \quad \text{-----2}$$

Where:

U is technical inefficiency; Z_1 is age of the farmer in years; Z_2 is the years of schooling; Z_3 is household size; Z_4 is farming experience in years; Z_5 isrice variety used (dummy, 1 if improved variety and 0 if traditional variety) and, $\partial_0, \partial_{1....} \partial_5$ are inefficiency parameters.

These variables are assumed to influence technical efficiency of the rice farmers. The gamma ($\gamma = \sigma^2_u / (\sigma^2_u + \sigma^2_v)$ which is the ratio of the variance of *U* (σ^2_u) to the Sigma squared (σ^2) which is a summation of variances of *U* and V ($\sigma^2 = \sigma^2_u + \sigma^2_v$) were also determined. The computer software FRONTIER version 4.1 developed by Coelli (1994) was used to estimate the parameters of the stochastic frontier and the inefficiency model simultaneously.The technical efficiency of an individual firm is defined in terms of the observed output (Y_i) to the corresponding frontier output (Y_i*) given the available technology. This could be expressed mathematically as:

$$T.E. = Y_i / Y_i^* \quad \text{..... 3}$$

Where Yi is the observed output; Yi * is the frontier output

Equation 3 can also be expressed as:

$$T.E. = Yi / Yi^* = \text{Exp}(Xi\beta + Vi - Ui) / \text{Exp}(X\beta + Vi) \quad \text{.....4}$$

where, $0 \leq TE \leq 1$.

RESULTS AND DISCUSSION

Summary Statistics of Rice Farmers

The summary statistics of the farmers are presented in Table 1. The mean value for age of farmers was 43 years. This suggests that most of the farmers are young people who are still strong and full of energy to make meaningful impact in agricultural production. Okoruwa and Ogundele (2003), Onoguogu and

Nnadozie(2008) and Tsue and Akande (2010) observed that the agebracket of 30-50 years represents an active productiveage bracket in agriculture. Also,the average household size was five persons while the average farming experience was 17.8 years.The farmershad a low level of education as their average years of educational attainment were about 6.3 years. This result agrees with that of Lawal (2002), who found low level of education among fish farmers in Benue State, Nigeria. This will likely limit the farmers' ability to seek deciphers and make good use of information on inputs. The farmers had a farm size of 2.3 hectares implying small scale rice farming in the study area. Furthermore, the rice farmers in the study area has little access to improved rice varieties as only about 10.4% used improved varieties.

TABLE 1: SUMMARY STATISTICS OF RICE FARMERS

Variable	Mean
Age (in years)	43.0
Household size	5.2
Farming experience (years)	17.8
Education (years)	6.3
Farm size	2.3
Improved rice variety	10.4%
Fertilizer (kg)	152.8
Output of rice (kg)	293.0

Source: Computed from field survey data, 2007

Maximum Likelihood Estimates

The maximum likelihood estimate of the Cobb-Douglas Stochastic frontier production function are presented in Table 2.The estimated sigma squared (δ^2 = 37.26) was significantly different from zero at 1% level. This indicates a good fit and the correctness of the specified distributional assumption of the model. The result implies that the Cobb-Douglas Stochastic frontier production function is an adequate representation of the data. This conforms to the result of Rahman (2002), Tijani, et al (2006) and Adebayo, (2008). In addition the magnitude of the variance ratio gamma($\boldsymbol{\gamma}$) was estimated to be high (0.995) and significant at 1% level, suggesting that, about 99.5 percent of variation in the maximum output of

riceproducible was due to inefficiences on the part of the farmer rather than random variability. Thus the result of the diagnostic statistics confirmed the relevance of stochastic frontier production using the maximum likelihood estimates.

The Estimated elasticity parameters of farm size(0.74), labour(0.14), fertilizer (0.24) and seed (0.70) were positive and significantly influenced output of farmers ($p \leq 0.05$).This implies that increasing these factors will increase the output of rice in the study area. It also means that a 10% increment in these inputs will increase rice output by 7.4, 1.4, 2.4 and 7.0 percent respectively. However, the coefficient of agrochemicals was not significant at all conventional levels. Furthermore, the sum of coefficients (b_i) in Cobb-Douglas production model gives the return to scale. The return to scale (RTS) was 1.83, indicating a increasing return to scale and thatrice production was in stage I of the production surface.Therefore, farmers are encouraged to continue increasing their inputs especially farm size, labour, fertilizer and seed for a better output.

Technical Efficiency: The result in Table 3 shows that majority (62.15%) of the farmers operated at a technical efficiency of between 0.51-0.99. On the average, a farmer operated at a technical efficiency 0.54. This implies that about 46% of rice output is lost due to inefficiency of management. Hence, in the short run there is still scope of increasing the technical efficiency of rice farmers in Kogi State by 46% through better use of available resources.

Inefficiency Model: The parameter estimates of the influence of farmer-specific factors on technical inefficiency of farmers are presented in the inefficiency section of the table 2. The signs and significance of the estimated coefficients in the inefficiency model have important implication on the technical efficiency of farmers. The result revealed that the estimated coefficients ofage (- 0.05), household size (- 2.38) and rice variety (-0.10) were negative. This implies that these factors led to a decrease in technical inefficiency meaning that, increasing them will lead to increase in technical efficiency of rice farmers in the study area. When the age of farmers increases their experience in acquiring and handling inputs increases thereby making them more efficient. While in the traditional farming setting,

increase in household size increases family labour as members of the family are used on the farm. This result disagrees with the work of Abu *et al.* (2011). Furthermore,the use of improved rice variety coupled with increment in these factors would ensure efficient use of resources in rice production in Kogi State. This would improve rice output and hence profitability as efficient use of more resources will move rice production from increasing phase of production to decreasing phase where profits are maximized.On the other hand, the coefficient of farming experience and education were not significant to rice production in Kogi State agreeing with the work of Tsue (2010).

TABLE 2: MAXIMUM LIKELIHOOD ESTIMATES OF PARAMETERS IN COBB-DOUGLAS STOCHASTIC PRODUCTION MODEL

Variable	**Coefficient**	**t-ratio**
Constant	3.78	2.59*
Lnland (ha)	0.74	4.05**
Lnlabour (man-days)	0.14	2.36*
Lnfertilizer (kg)	0.24	4.59**
LnAgrochemical (N)	0.01	1.35
LnSeed (kg)	0.70	11.42**
Inefficiency model		
Constant	-4.39	-9.38**
Age (years)	-0.05	-9.00**
Farming experience (years)	0.17	1.91
Household size	-2.38	-24.33**
Education (years)	0.20	0.58
Rice variety (dummy)	-0.10	-14.64**
Sigma squared	37.26	7.80**
Gamma	0.995	889.62**
Loglikelihood function	379.0	
RETURN TO SCALE (RTS)	1.83	

Source: Computed from field survey data, 2007

**, * = t-ratio significant at 1% and 5% levels respectively

TABLE3: DISTRIBUTION OF TECHNICAL EFFICIENCY OF RICE FARMERS IN KOGI STATE

Technical Efficiency	Frequency	Percentage
<0.31	39	13.54
0.31-0.50	70	24.31
0.51-0.70	108	37.50
0.71-0.90	68	23.61
0.90-0.99	3	1.040
Total	**288**	**100.0**
Mean efficiency = 0.54		
Minimum efficiency = $0.17x10^{-8}$		
Maximum efficiency= 0.91		

Source: Computed from field survey data, 2007

Conclusion and Recommendations

The study noted that farm size, seed and fertilizer were the most important factors increasing rice productivity. Also, the technical efficiency of rice farmers varied due to the presence of technical inefficiency. Variables such as age, household size, and the use of improved variety caused an increase in technical efficiency of farmers. The productivity of the factors could be improved by expanding the farmsize, increasing the quantity of seed, fertilizer use and increasing the level of labour while alternative sources agrochemicals be employed by farmers in other to boost production. The farmers should be encouraged to use improved varieties while give attention to supervision and management in other to gain the relevant experience in running a rice farm and increase their technical efficiency.

References

[1] Abu, O. Alumuku, M. and Tsue, P.T. **(**2011). Can Small-scale Tomato Farmers Flourish in Benue State, Nigeria? *J Agri Sci,* 2(2): 77-82.

[2] Adebayo, A.O. (2008). Profit efficiency among female smallholder farmers in Atiba Local Government Area of Oyo State, Nigeria. *J. of Economic Theory* 23:77-83.

[3] Amaza, P.S. and Maurice, D.C. (2005). Identification of factors that influence technical efficiency in rice-based production systems in Nigeria. Paper presented at Workshop on policies and strategies for promoting rice production and food security in sub-saharan Africa: - 7-9 November 2005, Cotonou (Benin).

[4] Battese, G.E. and Coelli, T.J. (1988). Prediction of firm level efficiencies with generalized frontier production function and panel data. *Journal of Econometrics* 38: 387–399.

[5] Coelli, T.J. (1994). A guide to Frontier Version 4.1: A computer programme for Stochastic Frontier Production and Cost Function Estimation. Department of Econometrics, University of New England, Armidale, Australia.

[6] Dean, T.J. and Lau, J.I. (1982). Farmer Education and farm efficiency. A world bank research publication Pp. 183-184.

[7] Farrel, J.M. (1957). The measurement of production efficiency. *Journal of Royal Statistics society series*. A general vol. 120. PP. 34.

[8] FAO (1996). Declaration on World Food Security. Food and Agriculture Organization, World Food Summit, November 13-17, 1996, Rome, Italy. Technical Background Documents, 6-13, Vol II. Pp1-15.

[9] FAO (2000). The State of Food and Agriculture, Rome, Italy. http/www.fao.org/worldfoodsummit. Food and Agricultural Organization, United Nations.

[10] Hazarika, C. and Subramanian, S.R.(1999). Estimation of Technical Efficiency in the stochastic frontier production function model-an application to the Tea Industry in Assum. PP. 46

[11] Kareem, R.O., Dipeolu, A.O., Aromolaran, A.B. and Williams, S.B.(2008). Economic efficiency in fish farming: hope for agro-allied industries in Niagara, *Chinese Journal of Oceanology and Limnology,* 26(1): 104-115.

[12] Lawal, W.L.(2002). Economic Analysis of fish culture in Benue state. Unpublished PhD thesis submitted to the department of agricultural economics university of agriculture Makurdi, Nigeria. 174 pp.

[13] Ogundari, K.,Ojo, S.O. and Brummer, B.(2006). Productivity potential and technical efficiency of aquaculture production in alleviating poverty. Emperical Evidence from Nigeria. *J. of Fisheries International*, 1(1-2):21-26.

[14] Ojo, S.O.(2004). Improving Labour Productivity and Technical Efficiency in Food Crop production: A Panacea for Poverty Reduction in Nigeria. *Journal of Food Agriculture and environment,* 2(2): 227-231 (www.worldfood.net).

[15] Okoronko, V.O. and Ogundele, O.O.(2003). Technical efficiency differentials in rice production technologies in Nigeria. Pp66. www.Csae.ox.Ac.uk/conference2006-E01-RPI/papers/csae.ox

[16] Oniah, M.O., Kuye, O.O. and Idion, I.C.(2008). Efficiency of resource use in small scale swamp rice production in Obubra Local Government Area of Cross River State, Nigeria. *Middle East J. Sc. Res*., 3(3): 145-148.

[17] Onugongu, G.C. and Nnadozie, B.C.(2005). Socio economic Factors Affecting Broiler Brooding in Obowu Local Government Area of Imo State. Proceedings of the 39 th Conference of the Agricultural Society of Nigeria, University of Benin. October 9th –13th 2005, pp: 132-135.

[18] Rahman, S.(2002). Profit Efficiency among Bangladeshi Rice farmers. School of Economic Studies, The University of Manchester, Manchester, England, U.K.

[19] Tijani, A.A., Alimi, T.and Adeseyi, A.T.(2006). Profit efficiency among Nigerian Poultry egg farmers; A case study of Aiyedoto farm settlement, *Nigeria Research J. of Agricultural Biological Sc.* 2 (6); 256-261.

[20] Tijani, A.A.(2006). Analysis of the technical efficiency of rice farms in Ijesha Land of Osun State, Nigeria. *Agrekon,* Vol 45, No 2 (June) p.126

[21] Tsue, P.T.and Akande, O.R.(2010). Productive efficiency of Benue catfish farmers. In: F.M. Nekang*et al.*(2010) (eds). Proceedings of International conference on Research and Development, held at Miklin Hotel East Legon Accra Ghana. November 24-25, 2010. 3(19) 113-118

[22] Tsue, P.T.(2010). Economic Analysis of Feed use Efficiency among Catfish Farmers in Benue State. Unpublished M.Sc. thesis submitted to the Department of Agricultural Economics University of Agriculture, Makurdi, Benue State, Nigeria. June, 2010.

[23] WARDA (2002). Nigeria's potentials in the rice sector: West Africa Rice Development Association and the role of rice in Nigeria. www.warda.org/warda/mainnewsrelease2002

[24] www.en.wikipedia.org/wiki/Kogi_StateNigeria