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Technical Efficiency of Men and Women Upland Rice Farmers in Osun State, Nigeria

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ABSTRACT The study examined the technical efficiency of upland rice production by men and women farmers in Osun State of Nigeria using the stochastic frontier production function analysis. Primary data were obtained through the use of a set of questionnaire from one hundred representative sample of men and women rice farmers from Osun State, Nigeria. The results show that women farmers are more efficient technically than men farmers with mean technical efficient indices of 0.904 and 0.897 respectively. The analysis also indicates that age and years of education of farmers have positive significant influence on the level of technical efficiency.

INTRODUCTION

Agriculture is an important sector of the economy of most nations, although its importance varies from country to country, depending on the stage of economic development. Nigeria with a land area of about 923,768 km^2 (approximately 92.4 million hectares) of which only about 27.3% are cultivable for the production of food and tree crops, has a population of about 120 million in which at least 70% of the working population depends on agriculture as a means of livelihood (Oladeebo, 2000).

Nigerian economy grew from an agricultural base with rice being one of the food crops grown in the country. According to Aderinola (1997) rice has not only become a very important menu in virtually all households in Nigeria, it was a "political" food commodity when in 1981, a "Presidential Task Force" (PTF) was set up to import it by the then Federal Government.

A very important feature of the Nigerian agriculture is the fact that men and women who are interested in farming practice it. Thus, there are differences in the productivity of men and women farmers. Such differences are likely because men and women within the African rural household pursue their own activities both on and off the farm. They also have different endowments (such as land rights and education) different levels of human strength, different access and adoption of technologies, factor of production (such as capital, labour and management) etc which add to the efficiency of production. Boserup's (1970) submission brought about an unprecedented attention to women's issues. She argues that development policies were biased against women's issues, hence women's contributions were unrecognized and unaccounted for. Consequently, development outcomes met with little successes. A lot of academic research and scholarship followed Boserup's work which sought to highlight the plight of women and to prescribe strategies for integrating women into development process.

A review of the various studies on the contributions of Nigerian women to agriculture shows that rural women have made considerable contribution to production. They have been found in the production of crops such as yam, maize, cassava, rice and other food crops (Adekanye, 1984; Adeyeye, 1988). Saito et al. (1994) noted that women now constitute the majority of smallholder farmers, providing most of the labour and managing many farms on a daily basis. The authors explained that gender - specific nature of farming is disappearing because of the rapid increase in population pressure and the pull of men to perceived employment opportunities off-farm in urban areas, mines and plantations. This has resulted in men turning to off-farm work and their wives remaining on the farm where they have become the de-facto farm managers. They stressed that although the traditional pattern of men growing cash crops and women growing food crops is still common, fewer crops are now

being produced exclusively be men or women. The report concluded that little difference exists between food and cash crops in terms of female labour input in their production.

However, despite their contributions, women farmers still face daunting constraints to their productivity, arising from limited access to extension, to capital markets and to new technologies (FAO, 1985; Quisumbing, 1994). FAO (1985) stated that an argument often used against women farmers is that they are less efficient than their men counter parts. The discussion on whether men are more efficient than women has been passionately debated in the literature, with few of these studies emanating from Africa (Moock, 1976, Kenya; Bindlish et al., 1993, Burkina Faso, Saito et al., 1994, Kenya and Nigeria; Udry et al., 1995, Burkina Faso, 1995), and each study with a varied result. While some have found that women are as productive as men (Moock, 1976), others found that women are less productive than men. Technical efficiency implies the ability to produce maximum output from a given set of inputs, given the available technology.

The primary objective of this paper was to compare the level of technical efficiency between men and women rice farmers while the secondary objective was to identify the factors that determine the technical efficiency of men and women rice farmers in order to provide information that may be useful in designing effective policies toward agricultural productivity.

ANALYTICAL FRAMEWORK

This study employs the stochastic production function model to measure technical efficiency of men and women farmers in improved rice variety production. The modeling, estimation and application of stochastic frontier production functions to economic analysis assumed prominence in econometrics and applied economic analysis during the last two decades. Early applications of stochastics frontier production function to economic analysis include those of Aigner et al. (1977), Battese and Cora (1977), and Meeusen and Van den Broeck (1977) for developed countries. And more recently in Nigeria, empirical applications of the technique in efficiency modelling have been reported by Ajibefun and Abdul Kadri (1999), Ojo and Ajibefun (2000) and Ojo (2003).

The stochastic frontier production function model is written as:

$$Y_i = f(Xa, ß) + Vi - Ui \quad (1)$$

Where Yi is the quantity of agricultural output in a specified unit, Xa is the vector of input quantities and B is the vector of production function parameters.

The frontier production function f (Xa, *b*) is a measure of maximum potential output for any particular input vector Xa. The V_i and U_i cause actual production to deviate from this frontier. The Vi is the systematic component, which captures the random variation in output, which are due to the factors that are not within the control of the farmers (e.g. temperature, moisture, natural hazards).

The V_i is assumed to be independently, identically distributed with zero mean and constant variance {i.e. N (O, $ó_v^2$)} and independent of U_i.

The *U*i is a non-negative term representing the deviations from the frontier production function, which is attributed to controllable factors (technical inefficiency). It is half normal, identically and independently distributed with zero mean and constant variance {i.e. /N(O, $ó^2$).

The stochastic frontier production function model is established using the maximum likelihood estimation procedure (MLE). The technical efficiency of an individual farm is defined in terms of the observed output (Y_i) to the corresponding frontier output (Yi) given the available technology, that is,

$$TE = \frac{Y_i}{Y_i^*} = \frac{\exp(X_i b + V_i - U_i)}{\exp(X_i b + V_i)} = \exp(-U_i) \quad (2)$$

So that, $O \leq TE \leq 1$ (Seyoum et al., 1998)

METHODOLOGY

Study Area: The study was conducted in Osun State, in the South-western part of Nigeria. The state is one of the six states comprising south-western Nigeria. The state has a land area of 9251 km2 (about 0.93 million hectares) and a population of about 2.2 million people (FOS, 1996). The state is situated entirely within the tropics and is suited for the production of permanent crops such as cocoa, coffee and oil palm and arable crops such as maize, yam, cassava and rice. The annual rainfall is between

1000 mm and 1500mm with daily temperature ranging between 28^0C and 30^0C. The people grow cash crops as well as arable crops and rice is one of the most important arable crops grown in the area.

Types and Sources of Data: The data for this study were essentially primary data which were obtained from a cross-sectional survey of rice farmers selected from Oriade Local Government Area (LGA) of the State for 2002/2003 farming season. The data were elicited through the use of a set of structured questionnaire. Data were obtained on socio-economic characteristics of rice farmers such as age, years of education, number of contact with extension agents and so on. Data related to rice production such as farm size, labour utilization (family and hired) quantity of rice seed utilized, paddy output and so on were also collected.

Sampling Procedure: Multi Stage Sampling procedure was employed. The first stage involved a purposive selection of Oriade LGA based on a priori knowledge that the LGA is a rice producing LGA and both men and women are actively involved in rice production. The second stage involved a simple random selection of five communities namely - Erinjesa, Erinmojesa, Erinoke, Ijebujesa and Ipetu-Ijesa from the LGA. The last stage involved random selection of equal number (10 each) of men and women household heads who are rice farmers from each of the five communities making a total of 100 rice farmers in all.

Method of Data Analysis: Descriptive Statistics was used to analyze the socio economic characteristics while the stochastic frontier production functions which build hypothesized efficiency determinants into the inefficiency error component (Battese and Coelli, 1995) so that one can identify focal points for action to bring efficiency to higher levels were used to analyze the technical efficiency of the farmers. The production technology of the farmers was assumed to be specified by the Cobb-Douglas frontier production function (Tadesse and Krishnamoorthy, 1997) which is defined by:

$$\ln Y_i = \ln b_o + b_i \ln X_1 i + b_2 \ln X_2 i + b_3 \ln X_3 i\, b_4 \ln X_4 i + b_5 \ln X_5 i + b_6 \ln X_6 i + b_7 \ln X_7 i + V_i - U_i \quad (3)$$

Where:

Y = paddy output (kg)
X_1 = land area devoted to rice cultivation
X_2 = family labour used (Mandays)
X_3 = hired labour used (Mandays)
X_4 = quantity of fertilizer used (kg)
X_5 = quantity of rice seed planted (kg)
X_6 = amount spent on agrochemicals (₦)
X_7 = amount spent on implements (₦)
V_i = random error as previously defined
U_i = technical inefficiency effects as previously defined
i = observation of the ith farmer

The technical inefficiency effects *U*i is defined by:

$$Ui = ä_o + ä_1 Z_1 + ä_2 Z_2 i + ä_3 Z_3 i + ä_4 Z_{4i} \; ä_5 Z_5 i + ä_6 Z_6 i + ä_7 Z_7 i \quad (4)$$

Where: Z_1, Z_2, Z_{-3} , Z_4, Z_5, Z_6 and Z_7 represents age of farmers, years of education, number of contact with extension agent per farming season, non farm income level, farming experience, household size and amount of credit obtained. These variables were included in the model to determine their influence on the technical efficiencies of the farmers. Generalized likelihood ratio test was used to test for the null hypothesis of no inefficiency effects while t-test was used to test for the null hypothesis of no significance difference between the average technical efficiencies of the two group of farmers.

The *B*'s and ä's are scalar parameters to be estimated. The variances of the random errors, s_v^2 and that of the technical inefficiency effects s_u^2 and overall variance of the model s^2 are related thus:

$$s^2 = s_v^2 + s_u^2 \quad (5)$$

and the ratio:

$$g = s_u^2/s^2 \quad (6)$$

measures the total variation of output from the frontier which can be attributed to technical inefficiency (Battese and Cora, 1977). The estimates for all the parameters of the Stochastic frontier production function and the inefficiency model are simultaneously obtained using the program frontier version 4.1 (Coelli, 1994).

In order to obtain the estimates of the parameters specified in (3) and (4), two different models were estimated separately for men and women farmers.

Model 1 is the traditional response function in which the inefficiency effects (*U*i) are not present. It is a special case of the stochastic frontier production function model in which the parameter g = O.

Model 2 is the general frontier model where there is no restriction in which g, and s^2 are present.

The two models were compared for the presence of technical inefficiency effects using the generalized likelihood ratio test which is defined by the test statistic, chi-square χ^2)

$\chi^2 = -2 \{LLF (Ho) - LLF (HA)\}$

Where, χ^2 has a mixed chi-square distribution with the degree of freedom equal to the number of parameters imposed under the null hypothesis.

LLF (Ho) and LLF (H_A) are the values of the log - likelihood function under the null and alternative hypotheses respectively.

RESULT AND DISCUSSION

Summary Statistics of Socio Economic Variables of the Rice Farmers in Osun State, Nigeria: Table 1 presents the summary statistics of some important socio economic variables for rice farmers in the study area. The minimum and maximum ages of men farmers are 24 and 70 years respectively while the minimum and maximum ages of their women counterparts are 21 and 65 years respectively. The table 1 shows that women farmers are relatively younger in age (average of 43 years) compared with their men counterpart (average of about 53 years)

Table 1 also shows that on the average men and women farmers have about 4 and 3 years of formal education respectively. The farmers have substantial years of experience in rice production. The average output of rice for men farmers is 2834 kg obtained from about 2 ha while their female counterparts recorded an average output of 1712kg from about 1 ha. The average farm sizes indicate the small scale nature of rice farming business (Olayide, 1980). The average amount of credit available to men and women farmers are #7680 and #5806 respectively. This might not be enough to purchase yield improving inputs on timely basis (Oladeebo, 2003).

Estimates of the Stochastic Frontier Production Function Parameters: The maximum likelihood estimates of the stochastic frontier production functions for rice production in the study area are presented in table 2. Table 2 shows that there were presence of technical inefficiency effects in rice production in the study area as confirmed by the test of hypothesis for the presence of inefficiency effects using the generalized likelihood ratio test. The Chi-square computed for men rice farmers is 18.07 while the critical value of the chi-square at 95% confidence level and 9 degrees of freedom, $\chi^2_{(0.95,9)} = 16.92$. The Chi-square computed for women rice farmers is 17.66 while $\chi^2_{(0,95,9)} = 16.92$.

The null hypothesis of no inefficiency effects in rice production, g = 0, was rejected for both categories of farms. Thus model 1 was not an adequate representation of the data, hence model 2 was the preferred model for economic and econometric analyses. The estimated sigma squared (s^2) in table 2 for the two categories of farmers are significantly different from zero at the 5 percent level. This indicates a good fit and the correctness of the specified distributional assumptions of the composite error term. The estimated gamma (g) parameter of 0.970 for men farmers and 0.948 for women farmers indicate that about 97% and 95% of the variation in rice production by men and women farmers was due to differences in their technical inefficiencies.

The estimated elasticity of the explanatory variables of the production function are shown in table 3.

It is revealed that the elasticity of size of farm land for both group of farmers were estimated to

Table 1: Summary statistics of the variables for rice farmers in Osun State, Nigeria

Variable	*Men farmers*				*Women farmers*			
	Mean	*Standard deviation*	*Mini-mum*	*Maxi-mum*	*Mean*	*Standard deviation*	*Mini-mum*	*Maxi-mum*
Aye (years)	52.7	8.58	24	70	43.0	11.62	21	65
Education (years)	4.3	3.68	1	15	2.84	3.54	1	15
Number of contact with Extension agent	6.28	1.55	1	8	5.18	1.80	1	8
Experience (years)	13.62	11.94	2	52	7.26	4.6	2	24
Farm size (Ha)	1.97	1.02	0.5	6	1.31	0.48	0.5	2
Amount of credit (#)	7680	10648.4	1000	60,000	5806	8791	1000	46000
Family labour (mandays)	6.25	5.00	0	14	9.01	6.71	0	20
Hired labour (mandays)	21.33	6.66	8	40	13.30	4.04	7	24
Rice Paddy (kg/Ha)	2834	1656.24	750	4600	1712	915.13	600	3800

Source: Computed from Field Survey Data, 2004

Table 2: Maximum likelihood estimates for the parameters of the stochastic frontier production function for men and women rice farmers in Osun State, Nigeria

Variable *Production function*	*Parameter*	*Men Farmers*		*Women Farmers*	
		Model 1	*Model 2*	*Model 1*	*Model 2*
Constant	β_o	-0.074	0.025	-0.223	-0.096
		(-0.429)	(0.029)	(-2.542)	(-1.279)
Farm size (Ha)	β_1	1.058*	1.001*	1.007*	1.095*
		(11.87)	(6.38)	(17.23)	(21.25)
Family labour (mandays)	β_2	0.007	-0.004	0.008	0.006**
		(0.710)	(-0.129)	(1.922)	(1.810)
Hired labour (mandays)	β_3	0.014*	0.002*	4.7×10^{-4}	0.0003*
		(16.43)	(11.40)	(0.003)	(3.384)
Quantity of fertilizer (kg)	β_4	0.0009*	0.0002*	0.0009*	0.0006*
		(12.56)	(2.45)	(16.37)	(14.36)
Quantity of rice seed planted (kg)	β_5	-0.003	-0.002	-0.0001	-0.00004
		(-1.007)	(-0.189)	(-0.3737)	(-0.1735)
Amount spent on agro chemicals (#)	β_6	0.0002	-0.005	-0.0004	-0.0079
		(0.024)	(-0.215)	(-0.231)	(-0.5362)
Amount spent on implements (#)	β_7	0.005	-0.033	-0.009	-0.017
		(0.138)	(-0.350)	(-0.350)	(-0.883)
Inefficiency Model					
Constant	δ_o	0	0.125	0	-0.9399
			(0.124)		(-0.8506)
Age of farmers	δ_1	0	-0.046*	0	-0.018*
			(-9.87)		(-1.98)
Years of education	δ_2	0	-0.001	0	-0.109
			(-0.030)		(-11.7)
Number of contact with extension agent	δ_3	0	0.051*	0	0.176
			(9.14)		(11.5)
Off-farm income	δ_4	0	0.015	0	0.018
			(‘1.446)		(0.369)
Farming experience	δ_5	0	-0.033	0	0.056
			(-1.199)		(1.271)
Household size	δ_6	0	0.099	0	-0.029
			(1.790)		(-0.64)
Amount of credit obtained	δ_7	0	0.015	0	0.004
			(0.592)		(0.472)
Variance Parameters					
Sigma squared	δ_2	0.084	0.278*	0.042	0.165*
			(2.470)		(2.003)
Gamma	γ	0	0.970*	0	0.948*
			(6.085)		(22.68)
Log likelihood function		-4.539	4.49	12.63	21.46
X^2_C		-	18.07	-	17.66
$X^2_{0.95,98}$		-	16.92	-	16.92

*Estimate is significant at 5% level
**Estimate is significant at 105 level
Figures in parentheses are t-ratio values
Source: Computed from Field Survey Data, 2004

Table 3: Elasticity of production and returns to scale (RTS)

Variable	*Men farmers*	*Women farmers*
Farm size	1.001	1.095
Family labour	-0.004	0.006
Hired labour	0.002	0.0003
Quantity of fertilizer	0.0002	0.006
Quantity of rice seed	-0.002	-0.00004
Amount spent on agrochemicals	-0.005	-0.0079
Amount spent on implements	-0.033	-0.017
RTS	0.959	1.077

Source: computed from Field Survey Data, 2004

be slightly greater than one, which indicates that the farmers are operating in an irrational zone of production (increasing returns to land). This is an indication of the fact that rice farming operations are small scale in nature. Thus, farmers can expand their farm sizes in order to achieve decreasing returns to farm land. The coefficient of size of farmland is statistically significant at 5 percent level.

The estimated elasticity of family labour was positive decreasing function to the factor for women farmers. This indicates that the use and

allocation of family labour by women farmers was in the stage of economic relevance of the production function (stage II). However, the estimated elasticity of family labour for men farmers was negative and insignificant decreasing function to the factor indicating over use and in stage III. This is due to the fact that farmer pays no charge for family labour hence its over use. The production elasticity with respect to hired labour is positive decreasing function to the factor as expected for the two categories of farmers and it is statistically significant at the 5 percent level.

The estimated elasticity of fertilizer was positive decreasing function to the factor for both categories of farmers and it is statistically significant at the 5 percent level. The significance of the fertilizer variable is due to the fact that fertilizer is a major land augmenting input in the sense that it improves the productivity of existing land by increasing crop yields per hectare.

The estimated elasticity of quantity of rice seed planted, amount spent on agrochemicals and implements are insignificant negative decreasing function to the factor.

The return to scale (RTS) was 0.959 for men farmers and 1.077 for women farmers indicating a positive decreasing return to scale and almost constant return to scale for men and women farmers respectively. The productivity of the factors involved in rice production could be improved by expanding the farm size at the existing level of rice seed planted, amount spent on agrochemicals and implements so that these variables could move from stage III to stage II of the production function.

Technical Efficiency Analysis: The predicted farm specific technical efficiencies (TE) ranged between 0.741 and 0.989, with a mean of 0.897 for men farmers while it ranged between 0.543 and 0.987 with a mean of 0.904 for women farmers. Thus, in the short run, there is a scope for increasing rice production by about 9.6% for women farmers if the two categories of farmers adopt the technology and techniques used by the most efficient farmers amongst them. One of the measures is addressing the issue of negative elasticity of quantity of seed planted, amount spent on agro chemicals and implement. The null hypothesis of no significant difference in the mean TE between men and women farmers. (Um = Uw) evaluated using t-test for large samples (n > 30) was accepted because $Tc < T_{0.95, 98}$ that is, $0.44 < 2.0$.

The decile range of the frequency distribution of TE is presented in table 4.

It is revealed that 90% of the men farmers had TE exceeding 0.79 and 10% had TE ranging between 0.741 and 0.79 while 94% of the women farmers had TE exceeding 0.79 and 6% had TE ranging between 0.543 and 0.79.

Technical Inefficiency Analysis: The analysis of the inefficiency model (Table 2) shows that

Table 4: Decile range of frequency distribution of TE of rice farmers

Decile Range of TE	*Men Farmers*		*Women Farmers*	
	Frequency	*%*	*Frequency*	*%*
0.90 – 0.99	27	54.0	29	58.0
0.80 – 0.89	18	36.0	18	36.0
≤ 0.79	5	10.0	3	6.0
Total	50	100.0	50	100.0
Average	0.897		0.904	
Minimum	0.741		0.543	
Maximum	0.989		0.987	

Computed from Field Survey Data, 2004

the signs and significance of the estimated coefficients in the inefficiency model can be used to formulate appropriate policies on the TE of the farmers.

The coefficients of age was estimated to be negative as expected and statistically significant at the 5 percent level for both categories of farmer which indicate that the younger farmers are more technically efficient in rice production than the older farmers. Also, younger farmers are likely to be more progressive and hence, more willing to adopt new practices, thus leading to higher technical efficiency in rice production (Parikh et al., 1995; Seyoum et al., 1998).

The coefficient of education variable is estimated to be negative as expected and statistically significant at 5 per cent level for the two categories of farmers which indicate that farmers with greater years of formal education tend to be more efficient technically in rice production probably due to their enhanced ability to acquire technical knowledge, which make them produce closer to the frontier output. This finding agrees with comparable findings by Battese et al. (1996), Coelli and Battese (1996) and Seyoum et al. (1998)

The coefficient of number of contact with extension agent was estimated to be positive contrary to expectation and statistically significant at 5 percent for both categories of farmers. The positive coefficient indicates that

the farmers' technical inefficiency tend to increase with number of contact with extension agent which implies that the instructions received by the farmers were not properly followed hence, contact with extension agent is not beneficial in reducing technical inefficiency. The coefficients of farming experience and household size although conformed with a priori expectation are insignificant determinant of TE. The coefficients of off-farm income and amount of credit obtained which did not conform with a priori expectation showed that they are insignificant determinants of TE.

CONCLUSION AND RECOMMENDATION

This study estimates stochastic frontier production functions for men and women rice farmers in Osun State, Nigeria. The MLE results reveal that TE of rice farmers varied due to the presence of technical inefficiency effects in rice production. The variables of size of farmland, labour and fertilizer were found to be the significant production factors that are associated with changes in the output of rice. Women farmers are the most efficient in terms of technical efficiency with mean TE index of 0.904 followed by men farmers with a mean TE index of 0.897. The results of the inefficiency model show that the variables of age and years of education significantly increase the farmers TE while number of contact with extension agent significantly decreases the farmers TE.

The policy implication of the findings in this study is that there is scope for raising the present level of TE of rice production in the study area, given the wide variation in the level of TE. Since age and education variables have direct relationship with the level of TE therefore policies should encourage more young and better educated male and female farmers to go into rice production, such farmers should also be encouraged to take into the advise of the adequately trained extension advisers on improved techniques of paddy production such that there will be increase in yield per hectare.

REFERENCES

Adekanye, T.O.: Women's role in development: The Nigerian situation. *Paper presented at the Workshop on Women in Development,* NISER, Ibadan, December 10 to 11, (1984).

Aderinola, E.A.: Economics of upland rice production in Ondo State of Nigeria *Applied Tropical Agriculture*, **2(2):** 152-159 (1997).

Adeyeye, V.A.: Women's involvement in agriculture and rural development process in Nigeria. In: *Women in Agriculture. African Notes,* **Special Number 3:** 17-21 (1988).

Aigner D., Lovell, C.A.K. and Schmidt, P.: Formulation and estimation of stochastic frontier production functions models. *Journal of Econometrics,* **6:** 21-37 (1977).

Ajibefun, I.A. and Abdulkadri, A.O.: An Investigation of Technical Inefficiency of Production of farmers under the National Directorate of Employment in Ondo State, Nigeria *Applied Economic Letters,* **6:** 111-114 (1999).

Battese, G.E. and Coelli, T.J.: A Model for Technical Inefficiency Effects in a Stochastic Frontier Production for Panel Data. *Empirical Economics*, **20:** 325-332 (1995).

Battese, G.E. and Corra, G.S: Estimation of a Production Frontier Model With Application to the Pastoral Zone of Eastern Australia. *Australia Journal of Agricultural Economics*. **21:** 169-179(1977).

Battese, G.E., Malik, S.J. and Gill, M.A.: An Investigation of Technical Inefficiencies of Production of Wheat Farmers in Four Districts of Pakistan. *Journal of Agricultural Economics*, **47(1):** 37-49 (1996).

Boserup, E.: *Women's Role in Economic Development*. St. Martins Press, New York (1970).

Bindlish, V., Evenson, R. and Gbetibouo, M.: Evaluation of T and V based extension in Burkina Faso. *World Bank Technical Paper 226*. Africa Technical Department Series. The World Bank, Washington, D.C. (1993).

Coelli, T.J.: A guide to Frontier Version 4.1: A computer program for stochastic frontier production function and cost function estimation. *(Unpublished Paper),* Department of Econometrics, Armidale, University of New England, Australia (1994).

Coelli, T.J. and Battese, G.E.: Identification of factors which influence the technical inefficiency of Indian Farmers' *Australian Journal of Agricultural Economics,* **40(2):** 103-128 (1996).

FAO: *Women in Developing Agriculture*. Food and Agriculture Organization of the United Nations, Rome (1985).

Federal Office of Statistics (FOS): *Annual Abstract of Statistics*. Federal Office of Statistics, Lagos (1996).

Meeusen, W. and Van den Broeck: Efficiency estimates from Cobb-Douglas production function with composed error. *International Economic Review,* **18:** 435-444 (1977).

Moock, P.: The Efficiency of women as farm managers in Kenya *American Journal of Agricultural Economics*, **58(5):** 831-835 (1976).

Ojo, S.O.: Productivity and technical efficiency of poultry egg production in Nigeria *International Journal of Poultry Science*, **2(6):** 459-464 (2003).

Ojo, S.O. and Ajibefun, I.A.: Effects of training on labour productivity and efficiency in oil palm production in Ondo State, Nigeria. *Journal of Sustainable Agriculture and Environment,* **2:** 275-279 (2000).

Oladeebo, J.O.: *The Effects of Scattered Farm Plots on Agricultural Production in Ogo-Oluwa and Oriire*

Local Government Areas of Oyo State, Nigeria. M.Sc. Thesis (Unpublished), Obafemi Awolowo University, Ile-Ife (2000).

Oladeebo, J.O.: The effects of socio-economic characteristics of farmers on land degradation in the derived Guinea Savanna ecological zone of Nigeria. *International Journal of Environmental Issues*, **1(1):** 237-243 (2003).

Olayide, S.O.: Characteristics, problems and significance of small farmers. Pp 2-15, In: *Nigerian Small Farmers: Problems and Prospects in Integrated Rural Development.* S. Olajuwon Olayide, J.A. Eweka and V.E. Bello-Osagie (Eds.). CARD, Ibadan (1980).

Parikh, A. Ali, F. and Shah, M.K.: Measurement of economic efficiency in Pakistani agriculture. *American Journal of Agricultural Economics*, **77:** 675-685 (1995).

Quisumbing, A.R.: Gender differences in agricultural productivity: A survey of empirical evidence. *Esp Discussion Paper Series No. 36*, Education and Social Policy Department, The World Bank, Washington, D.C. (1994).

Saito, K.A., Mekonnen, H. and Spurling, D.: Raising the Productivity of Women Farmers in Sub-Saharan Africa, *World Bank Discussion Papers 230*. The World Bank, Washington, D.C. (1994).

Seyoum, E.T., Battese, G.E. and Fleming, E.M.: Technical efficiency and productivity of maize producers in Eastern Ethiopia: A study of farmers within and outside the Sasakawa-Global 2000 Project. *Agricultural Economics*, **19:** 341-348 (1998).

Tadesse, B. and Krishnamoorthy, S.: Technical Efficiency in Paddy Farms of Tamil Nadu: An analysis based on farm size and ecological zone. *Agricultural Economics*, **16:** 185-192 (1997).

Udry, C., Hoddinott, J., Alderman, H. and Haddad, L.: Gender Differences in Farm Productivity: Implications for Household Efficiency and Agricultural Policy *Food Policy*, **20(5):** 407-423 (1995).