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Technical Efficiency and Rural Poverty Among Farmers in Nigeria: A Gender Perspective

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I. Introduction

One of the central issues of development economics that government and policy makers are focusing attention on is how to improve the socio-economic well being of the people and thereby reduce poverty. The concept of poverty including its measurement is contested (Englama and Bamidele 1997). Thus, it has been defined using various indices. Schiller (1980) classified poverty into "absolute" poverty whereby a section of the population cannot meet their minimum standard of living in terms of basic needs like food, clothing and shelter due to lack of economic wherewithal. "Relative" poverty on the other hand is a situation whereby income earned by a person is significantly less than the average income of the population. In Nigeria, poverty has been established by past studies (World Bank 1997; FOS 1999; Etim and Edet 2007) as being more prevalent in rural areas. Rural areas in Nigeria house most of producers of livestock and crops.

Rural poverty refers to a situation in which rural inhabitants, groups, communities and societies at a given point in time experience a level of income below that which is needed to provide a desirable minimum living standard (Rahji 1999). Rural poverty in its most valid generalizations about the poor are that they are disproportionately located in rural areas, that they are primarily engaged in agricultural and associated activities, that they are more likely to be women and children than adult males, and that they are often concentrated among minority ethnic and groups and indigenous peoples (Todaro and Smith 2003).

Gender is the social differences between men and women. These differences vary from place to place and may change over time. Gender is a socio-economic variable used to analyze roles, responsibilities, constraints, opportunities and needs of men and women (Oladosu *et al* 2005). The relationship between gender and poverty has become an important topic in the poverty literature. Earlier literature on poverty focused on female-headed households and the problems they face (Buvinic and Gupta 1977; Appleton 1996). Gender is now being regarded as an essential concept for the analysis and eradication of poverty. While traditional conceptualizations consistently failed to delineate poverty's gender dimensions, resulting in policies and programmes which failed to improve the lives of poor women and their families (Beneria and Bismath 1996), it is now recognized that women are disproportionately represented among poor households and that poverty is being increasingly feminized (Ijaiya 2000).

Rural women have less access to resources necessary to generate stable incomes and are frequently subject to laws that further compromise earning potential. Laws often prohibits women from owning property or signing financial contract without a husband's signature, and women are typically ineligible for institutionally provided resources such as credit and training. The Federal Ministry of Women Affairs (2004) in its report to Commonwealth Plan of Action claimed that Nigerian women account for more than 60 percent of the agricultural labour force, contribute up to 80 percent of the total food production but only have access to 27 percent of the micro credit provided by Community Banks and National Poverty Eradication Programme (NAPEP). Thus, women's continued reduced access to increasingly scarce resources remains a major cause of the feminization of poverty. Women are particularly affected by the fierce competition over scarce resources, in particular land, and the means of livelihood. This has led to an increase in female-headed households struggling to survive, with very little capacity to take advantage of the new economic opportunities. From the above discussion, it is therefore necessary to address the gender dimension in development planning with a view to eradicating poverty.

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In agriculture, the analysis of efficiency is generally associated with the possibility of farms producing a certain optimal level of output from a given bundle of resources or certain level of output at least-cost. Farrel (1957) distinguished three components of efficiency in the economic literature. They are (i) technical efficiency, (ii) allocative efficiency, and (iii) economic efficiency. This study however, focused on technical efficiency. Technical efficiency is defined as the ability to produce maximum output from a given set of inputs, given the available technology (Yao and Liu 1998). This definition indicates that differences in technical efficiency exist between farms.

Agricultural sectors in less developed countries like Nigeria are widely considered to play a vital role in the eradication of poverty. Thus, increased agricultural productivity is one of the pre-requisites of economic progress. This assertion is particularly true of Nigeria where a larger proportion of the population lives in the rural areas and depends mainly on primary production (Oladeebo and Ezekiel 2006). Higher agricultural productivity affects family incomes and nutrition, which in turn supports labour productivity resulting in better health and well-being of the people. Poor workers health may either results in the loss of working days or reduces their working capacity, leading to lower output (Croppenstedt and Muller 2000). Poverty is likely to affect the capacity of the farm households to avail themselves of better health and education facilities; to purchase inputs at the proper time; to acquire other farm assets; to adopt new technologies and resources *et cetera.* The low level of these factors in turn affects agricultural productivity adversely. From these, poverty is not only an effect but also a cause of low agricultural productivity. It is therefore highly imperative for Nigerian government to pay a serious attention to this aspect of the relationship between efficiency of agricultural production and poverty. None of the previous poverty studies in Nigeria explored the link between gender, technical efficiency of agricultural production and rural poverty. This study was therefore conducted to explore empirically the link between gender, efficiency of agricultural production and rural poverty in Nigeria as well as examining policy variables influencing technical efficiency.

II. Methodology

a) The Study Area

The study was conducted in southwestern Nigeria which is one of the six geo-political zones in Nigeria. The six states in southwestern Nigeria are: Ekiti, Lagos, Osun, Ondo, Ogun and Oyo. The summary of the six geo-political zones in Nigeria is shown below.

Table1 : Nigeria's Six Geopolitical Zones

Zone	Names of States within the Zone
South West	Ekiti, Lagos, Osun, Ondo, Ogun, Oyo
South East	Abia, Anambra, Ebonyi, Enugu, Imo
South South	Akwa-Ibom, Bayelsa, Cross-River, Delta, Edo, Rivers
North Central	Benue, FCT, Kogi, Kwara, Nasarawa, Niger, Plateau
North East	Adamawa, Bauchi, Borno, Gombe, Taraba, Yobe
North West	Kaduna, Katsina, Kano, Kebbi, Sokoto, Jigawa, Zamfara

Source: NBS, 2005

The southwestern part of Nigeria houses the Yorubas, one of the major tribes in Nigeria. Agriculture remains the primary means of livelihood for the inhabitants. Some of the states in the zone are fairly urbanized but majority of the people live in the rural areas of the zone. The provisional results of 2006 population census shows that southwestern part of Nigeria has a population of 21,581,992 people. The study area was purposely chosen because of its poor position as well as its large rural and agrarian nature in Nigeria.

b) Source of Data and Sampling Technique

The study used secondary data which were extracted from the 2004 Nigeria Living Standard Survey (NLSS) data set. The NLSS is a nationwide household survey carried out by the Nigeria National Bureau of Statistics with technical assistance from the World Bank.

Multistage random and purposive sampling procedure was adopted in obtaining data for the study. Firstly, in order to have a large number of sample for the purpose of analysis, five largely agrarian states out of the six states in southwestern Nigeria were purposely selected. Secondly, three Local Government Areas from an agricultural zone of Ekiti, Ogun, Ondo, Osun and Oyo States which are largely agrarian were selected with the use of simple random selection. Lagos state was left out because of its cosmopolitan nature and more importantly there are no respondents from the rural areas from the state in the data set.

The third stage involved simple random selection of five enumeration areas from each of the Local Government Area selected making a total of seventy five enumeration areas. The last and final stage involved purposive selection of twenty four households comprising of twelve-female headed and twelve-male headed households making a total of one thousand and eight hundred households. However, nine hundred and thirty three households were eventually used for the analysis because they contained all the necessary and important variables needed for analysis. From these, four hundred and ninety one poor households were

finally used for the analysis of which the results are presented in this paper.

The NLSS data cover items such as household composition, education, expenditure on food and non-food items, healthcare services, mortality, fertility, household income and sources, assets, agricultural outputs and inputs, credits, employment and other households' welfare parameters.

c) Data Analysis

Having initially determined the local poverty line, the study employed the use of stochastic frontier production function (SFPF) analysis to determine the effect of technical efficiency on agricultural production by gender.

d) Poverty Line

Poverty analysis in a country requires that a poverty line be defined. There is an increasing need to focus on expenditure rather than income as an indicator of poverty status in poverty studies in Nigeria. This is because it is more problematic measuring income than measuring consumption expenditure, especially in rural households whose incomes come largely from self-employment in agriculture (Aigbokhan 2000). Also the use of cash income as the sole measure of household income tends to underestimate the welfare of subsistence households. If subsistence production is positively associated with households with a large proportion of female adults, and if subsistence production is underestimated, these households may well be falsely associated with poverty. So therefore, a common solution uses total expenditure (imputing a value to the consumption of home-produced goods and services as well as those received as wages, gifts, and loans) rather than measured income as the welfare measure, since total expenditure is considered a reasonable approximation of permanent income. In addition, according to Deaton (1997), given that annual income is required for a satisfactory measure of living standards, an income-based measure requires multiple visits or the use of recall data, whereas a consumption expenditure measure can rely on expenditure over the previous weeks. Based on the foregoing, data were collected on household agricultural incomes as well as expenditures. However, in this study, per capita expenditure was used as the indicator of poverty and the unit of analysis was the household. Household was classified as poor or non-poor based on gender in relation to their level of total expenditure on food and non-food items. In doing this, two lines were set relative to the standard of living in Nigeria: (i) a moderate poverty line for those spending less than two-third of the mean per capita expenditure and; (ii) a core poverty line for those spending less than one-third of the mean per capital expenditure.

Households were then classified based on gender into one of the three groups of core (extreme) poor, moderately poor and non-poor as determined by these poverty lines.

e) Poverty lines estimate

In order to get the moderate and core poverty lines, the 2/3 and 1/3 of the mean per capita expenditure were used.

Per capita expenditure is defined as total household expenditure over number of people in the household. Now, to get the mean per capita household expenditure (MPCHEE), we have.

$$MPCHHE = \frac{Total\ \ per\ capita\ \text{exp}enditure}{Total\ number\ of\ \ households\ in\ the\ sample} \quad (1)$$

Where total per capita expenditure is the total sum that is, aggregate of all the total expenditure incurred divided by the total number of the individuals in the household.

$$\text{Therefore,} \qquad MPCHHE = ₦\frac{4201128.9}{933} = ₦4503$$

(i) For moderately poor households, $^2/_3$ of ₦4503 = ₦3002 per household per year

(ii) For core poor households $^1/_3$ of ₦4503 = N1501 per households per year.

The core poverty line is not necessary for the purpose of this study. Based on the moderate poverty line, rural households are classified poor if their consumption expenditure is less than ₦3002 relative to other households and non poor relative to other households if their consumption expenditure is higher than or equal to ₦3002. This figure is far below the national average of ₦23,733 obtained by National Bureau of Statistics for Nigeria in the year 2005. (Note that as at 2009, 1$= ₦148).

f) Stochastic Frontier Production Function

The stochastic frontier production function independently proposed by Aigner *et al* (1977) and Meeusen and Van Den Broeck (1977) assumes that maximum output may not be obtained from a given input or a set of inputs because of the inefficiency effects. It can be written as:

$$Yi = f(Xi;\beta) + \varepsilon \quad (2)$$

Where:

Yi is the quantity of agricultural output produced by the ith farming household

Xi is the vector of input quantities for ith farming household;

β is a vector of parameters to be estimated; and

εi is an error term defined as:

$$\varepsilon i = Vi - Ui, \quad i = 1,2, \ldots n \text{ farms} \quad (3)$$

Vi is a symmetric component that accounts for pure random factors on production, which are outside the farmers control such as weather, disease, topography, distribution of supplies, combined effects of unobserved inputs on production and so on and Ui is a one-sided component, which captures the effect of inefficiency and hence measures the shortfall in output Yi from its maximum value given by the stochastic frontier $f(Xi;\beta) + Vi$.

The model is expressed as:

$$Yi = \exp(Xi\beta + Vi\text{-}Ui) \quad (4)$$

The stochastic frontier production model has the advantage of allowing simultaneous estimation of individual technical efficiency of the respondent farmers as well as determinants of technical efficiency (Battese and Coelli 1995).

g) Models Specification

For the purpose of this research, production technology of the farmers was assumed to be specified by the Cobb-Douglas frontier production function proposed by Battese and Coelli (1995) and used by Yao and Liu (1998) as well as Oladeebo (2006) and this was applied in the analysis of data to capture the efficiency of rural farmers in the study area.

The model of the Cobb-Douglas frontier production function for the estimation of the technical efficiency is specified as:

$$LnYi = \beta_0 + \beta_1 lnX_1 i + \beta_2 lnX_2 i + \beta_3 lnX_3 i + \beta_4 lnX_4 i + \beta_5 lnX_5 i + \beta_6 lnX_6 i + \beta_7 lnX_7 i + Vi - Ui \quad (5)$$

Where subscript i refers to the observation on the ith farmer and,

Y is the value of output of crops (in naira),

X_1 is farm size (hectares),

X_2 is family labour used (man-hours),

X_3 is hired labour used (man-hours),

X_4 is quantity of fertilizer used (kilogram),

X_5 is quantity of crop inputs (kilogramme),

X_6 amount spent on agrochemicals (Naira),

X_7 amount spent on implements (Naira),

βi's are the parameters to be estimated,

ln's are the natural logarithms

Ln's and Ui are as previously defined

It should be noted that in this study, the fourth to seventh variables specified above were aggregated together and their monetary values were used, hence hereto referred as materials.

h) The Inefficiency Model (Policy Variables)

For the purpose of this research, it is assumed that the technical inefficiency measured by the mode of the truncated distribution (i.e. Ui) is a function of socio-economic factors (Yao and Liu 1998). Thus, the technical efficiency in equation (5) was simultaneously estimated with the determinants of technical efficiency defined by:

$$Ui = \delta_0 + \delta_1 Z_1 i + \delta_2 Z_2 i + \delta_3 Z_3 i + \delta_4 Z_4 i + \delta_5 Z_5 i \quad (6)$$

Where:

Ui is the technical inefficiency of the ith farmer,

Z_1 is the age of farmer (years),

Z_2 is years of formal education,

Z_3 is number of contacts with extension agent,

Z_4 is years of farming experience,

Z_5 is the amount of credit available to the farming household,

δ's are unknown parameters to be estimated along with the variance parameters σ^2 and γ

The parameters of the models of equations (5) and (6) were obtained by the Maximum Likelihood Estimation (MLE) method using the computer programme, FRONTIER version 4.1 (Coelli 1996). However, in the data analysis, the third variable, that is, number of contact with extension agent in equation (6) was dropped because there was no data recorded for it in the data set.

III. Results and Discussion

a) Production Frontier and Technical Efficiency Estimates among Poor Female and Male-Headed Households

The estimates of the Model 1 (OLS) and the Model 2 (Maximum Likelihood Parameter Estimates) for

poor male-headed households and poor female-headed households are presented in tables 2 and 3 respectively.

The coefficients of the variables are very important in discussing the results of data analysis. For poor male-headed households, model 2 shows that farm size had the highest coefficient of 0.6665 as shown in table 2. Table 2 shows that farm size, hired labour and expenditures on materials carried positive signs for poor male-headed households, while family labour carried negative sign. The variables with positive coefficient imply that any increase in such variables would lead to increase in farm income, while an increase in the value of the variable with negative coefficient would lead to a decrease in farm income. Also, negative coefficient on a variable might indicate an excessive utilization of such a variable. Table 2 shows that only the coefficient of expenditure on material was significant at 5 percent level of significance for poor male-headed households.

For poor female-headed households, model 2 shows that hired labour had the highest coefficient of 2.37 (Table 3). However, farm size and family labour had negative coefficients while hired labour and expenditure on materials had positive coefficients (Table 3). Table 3 further revealed that only the coefficients of hired labour was significant at 5 percent level for poor female-headed households. The estimated sigma squared for all the groups of households were large and significantly different from zero. This is an indication of a good fit of the model and the correctness of the specified distributional assumptions. The results obtained here are consistence with the findings of Seyoum *et al* (1998), Obwona (2006), Ogundele and Okoruwa (2006) and Oladeebo (2006).

b) Determinants of Inefficiency (Impact of Policy Variables on Technical Efficiency)

The estimated coefficients in the inefficiency model of model 2 are presented in tables 2and 3. It should be noted that the analysis of the inefficiency model shows that the signs and significance of the estimated coefficients in the inefficiency model had important policy implications on the technical efficiency (TE) of the farmers. Thus, a negative coefficient means increase inefficiency and a positive effect on productivity. The coefficients for age for poor male-headed households (Table 2), experience and educational level for poor female-headed households (Table 3) have the expected signs that are in line with literature. The significant coefficient for credit indicates that access to enough and timely credit is an important factor in enhancing agricultural productivity. These results are in agreement with the findings of Ajibefun and Aderinola (2004).

Table 2 : Maximum Likelihood Estimates of the Production Frontier with Inefficiency Model for Poor Male-Headed Households

Variables	Model 1 (OLS)		Model 2 (MLE)	
	Coefficient	t-ratio	Coefficient	t-ratio
Production function				
Constant (β_0)	4509.1	8.498	5342.7	1176.0**
Farm size (β_1)	0.028	0.0113	0.6665	0.290
Family Labour ((β_2)	-0.516	-0.147	-1.904	-0.717
Hired labour (β_3)	0.596	0.688	0.5124	0.644
Material (β_4)	0.774	3.604*	0.7351	4.091*
Inefficiency Model				
Constant	0	0	20.63	0.191
Experience (δ_1)	0	0	69.87	1.262
Credit (δ_2)	0	0	0.0467	0.808
Age (δ_3)	0	0	-32.25	-0.795
Education (δ_4)	0	0	59.29	1.082
Variance Parameters				
Sigma squared	0.218E+08		0.2209E+08	0.2209E+108*
Gamma	0		0.0032	0.354
Log-likelihood	-2465.0		-2464.8	

Note: * means significant at 5 percent level
** means significant at 1 percent level
Source: Data analysis

Table 3 : Maximum Likelihood Estimates of the Production Frontier with Inefficiency Model for Poor Female-Headed Households

Variables	Model (OLS)		Model 2 (MLE)	
	Coefficient	t-ratio	Coefficient	t-ratio
Production function				
Constant (β_0)	4752.9	8.883	5765.6	5547.8**
Farm Size (β_1)	-1.541	-0.592	-1.273	-0.4862
Family Labour ((β_2)	-0.844	-0.327	-0.8458	-0.3416
Hired labour (β_3)	2.164	1.673	2.370	2.149*
Material (β_4)	0.106	0.630	0.1048	0.8915
Inefficiency Model				
Constant	0	0	1.080	0.2693
Experience (δ_1)	0	0	-4.946	-0.4708
Credit (δ_2)	0	0	0.1801	3.189**
Age (δ_3)	0	0	19.46	1.70
Education (δ_4)	0	0	-4.047	-1.233
Variance Parameters				
Sigma squared	0.318E+08		0.322E+08	0.3225E+08*
Gamma	0		0.0004	0.1612
Log-likelihood	-2421.4		-2419.8	

*Note: * means significant at 5 percent level*
***means significant at 1 percent level*
Source: Data analysis

c) Technical Efficiency Analysis of Poverty Levels among Female and Male-Headed Households

The results of technical efficiency analysis of poor male-headed households and their female-headed households' counterparts are presented in tables 4 and 5. Table 4 presents the predicted technical efficiency for poor male-headed households' farm families. It is shown in table 4 that for poor male- headed households, their predicted technical efficiency indices ranges from a minimum of 58.9 percent to a maximum of 99.5 percent with a mean of 90.9 percent and a standard deviation of 8.7. Majority (66.8 percent) of the poor male-headed households had their predicted technical efficiency estimates within the decile range of equal to or greater than 90.0. From table 4, it is deduced that an average poor male-headed household farm families, in the short run, had a scope for increasing farm income by 9.1 percent by adopting the technology and techniques used by the best (most efficient) poor-male farming household.

Similarly, the results of technical efficiency analysis of poor female-headed households are presented in table 5. Table 5 shows that for poor female-headed households, their predicted technical efficiency indices ranged from a minimum of 14.2 percent to a maximum of 99.7 percent with a mean of 82.2 percent. Thus, an average poor female headed household can increase their farm income by about 18.2 percent. Thus, it is evident from tables 4 and 5 that both the poor male and female- headed households were not fully technically efficient in agricultural production, with poor male-headed households being more technically efficient than their poor female headed household counterparts. Thus, policy focus should target both male and female-headed rural poor households.

Table 4 : Decile Range of Frequency Distribution of Technical Efficiencies of Poor Male-Headed Households

Decile Range	Poor	
	Technical Efficiency	
	Frequency	%
$\geq$ 90	167	66.8
80 – 89.9	47	18.8
70 – 79.9	27	10.8
60 – 69.9	8	3.2
50 – 50.9	1	0.4

40 – 49.9	0	0.0
30 – 39.9	0	0.0
20 – 29.9	0	0.0
10 – 19.9	0	0.0
< 10	0	0.0
Total	250	100.0
Mean %	90.9	
Minimum %	58.9	
Maximum %	99.5	
Standard Deviation	8.7	

Source: Data analysis

Table 5 : Decile Range of Frequency Distribution of Technical Efficiencies of Poor Female Headed Households

Decile Range	Poor	
	Technical Efficiency	
	Frequency	%
≥ 90	40	16.6
80 – 89.9	130	53.9
70 – 79.9	51	21.2
60 – 69.9	10	4.2
50 – 50.9	6	2.5
40 – 49.9	2	0.8
30 – 39.9	1	0.4
20 – 29.9	0	0.0
10 – 19.9	1	0.4
< 10	0	0.0
Total	241	100.0
Mean %	82.2	
Minimum %	14.2	
Maximum %	99.7	
Standard Deviation	10.2	

Source: Data analysis

IV. Conclusion

This study was undertaken to investigate the effect of technical efficiency on poverty level of female and male-headed farm families in southwestern part of Nigeria. The policy variables that influenced technical efficiency across poverty levels of female and male-headed farm families in southwestern Nigeria were also determined. The results of the analysis showed that both poor male and female household heads were not fully technically efficient in the use of production resources.

In order to reduce poverty level, it is therefore suggested that agricultural production should be encouraged among the rural people by improving technologies for agricultural production with the attendant provision of institutional and timely credit for rural poor farmers. Literacy level should also be improved for easy adoption of improved technologies which may reduce poverty level. Young, educated and agile males and females should also be encouraged to go into agricultural production. This can be done by the provision of socio infrastructural facilities such as potable water, health facilities, electricity and good roads.

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