

COMPARATIVE ANALYSIS OF TECHNICAL EFFICIENCY OF MALE AND FEMALE RICE FARMERS IN ADAMAWA STATE, NIGERIA

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Received 13th March, 2016, Accepted 25th September, 2016

Abstract

The need to raise production capacity in Nigeria agricultural sector is closely related to addressing issues that affect the efficiency of farmers. This study was designed to undertake comparative analysis of the technical efficiency of male and female rice-farmers in Adamawa State, Nigeria. Primary data were collected from 378 randomly selected rice-farmers in Adamawa State. The data were analysed using both descriptive statistics, and stochastic frontier function analysis. Socio-economic characteristics of rice-farmers in the area were identified. The result of maximum likelihood estimates revealed that the socio-economic factors which determined the technical in-efficiency of male rice farmers include age, education and access to extension services; whereas the in-efficiency factors for female farmers were educational status of the farmer, farming experience, and access to credit facilities. The technical efficiency index of male farmers ranges between 0.38 and 0.96 with a mean value of 0.86 while it was between 0.43 and 0.94 with a mean of 0.84 for female farmers. The study showed that male farmers were more technically efficient than their female counterparts. It was therefore, recommended that government policy should encompass measures that promote rice farmers' efficiency via access to agricultural resources and services at affordable prices, with particular emphasis on women farmers in Nigeria.

Key Words: Technical Efficiency, Gender, Rice, determinants, Production

Introduction

Agriculture in sub-Saharan Africa remains to a large extent a gendered occupation with men and women engaged in role differentiation in all farming processes (Angya, 2008). The report by National Bureau of Statistics, NBS (2014) indicated that the Nigerian agricultural sector grew at 3.68% and contributed 20.89% to the country's real GDP in the second quarter of 2014. However, agricultural output has increased less rapidly than the estimated population growth rate, and this has resulted in increase in food importation. According to FAO (2013) the importation of rice in Nigeria in 2012 stood at a staggering figure of about 2.8 million tonnes as compared with the total imports of about 1.7 million metric tonnes in 2007. Therefore efforts towards increasing local food production in Nigeria should give prominence to the different roles played by men and women in agricultural activities especially in terms of labour supply. Dia *et al.* (2009) emphasized that the pace of agricultural development in the country is closely related to the factors which affect productivity of women labour. Hence, the empowerment of women and other vulnerable groups in the society is the most effective way

of reducing poverty and improving food security. According to Ismaila *et al.* (2010) addressing the continuing decline in local food production especially cereals such as rice, millet, maize etc. will entail acknowledging the contributions of the various intra-household units in the overall production outputs. The separate roles of men and women in the development of agriculture must be critically identified so as to achieve meaningful impact on food production in the country. According to United Nations Development Programmes, UNDP (2010) policies and programmes that ignore differential impact on gender groups are often gender-blind and potentially detrimental to human development. Gender equality therefore, requires a focus on results to improve the well-being of poor rural women farmers.

Objectives of the Study

The main objective of this study is comparative analysis of the technical efficiency of male and female rice-farmers in Adamawa State, Nigeria. The specific objectives include: identifying the socio-economic characteristics of rice-farmers in the area, analysing the technical efficiency of male and female rice farmers,

establishing the existence of difference in the technical efficiency of male and female rice farmers

Study Area

The study was carried out in Adamawa State, Nigeria. Adamawa state is located at the North-eastern part of Nigeria. It shares boundary with Taraba State in the south and west, with Gombe State in the North – west and Borno State to the North. The State has an international boundary with Cameroon Republic along its eastern side. It lies between latitude 7° and 11° North, and longitude 11° and 14° East (Adebayo and Tukur, 1999). Adamawa State has a land area of about 38,741 Km² and a population of 3,178,950 people comprising of 1,607,270 males and 1,571,680 females (National Population Commission, 2006). The predominant occupations in the state are farming and livestock herding.

Sampling Technique and Data Collection

Multi-stage sampling technique was used to collect data for the study. The following Local Government Areas were purposively selected from each of the three zones, based on their high involvement in rice cultivation in Adamawa State (as noted by the Adamawa State Agricultural Development Programmes). They include: Mubi-North Local Government Area (Northern zone), Fufure Local Government Area (Central Zone), and Lamurde Local Government Area (Southern Zone). Six (6) wards were randomly selected from each of the Mubi North Local Government and Fufure Local Government; while five (5) wards were selected from Lamurde Local Government to give a sum of seventeen (17) wards, proportionate to the total number of wards in each of the three Local Governments. Therefore, a total of three hundred and seventy-eighty (378) rice farmers were randomly sampled in the study area.

Data Analysis

The data collected for this research were analysed using descriptive statistics which involved the use of frequency distribution tables, percentages, and means to describe the socio-economic characteristics of female rice farmers in the study area.

Stochastic frontier analysis

Given the inherent stochastic nature of rice production, the stochastic frontier production function approach appears to be appropriate for assessing technical efficiency in rice production (Sheikh, 2006). Technical

efficiency, in this case, measures the ability of farmers to produce maximum output using a given set of inputs and technologies.

Stochastic frontier analysis (SFA) will therefore be employed for measuring the technical efficiency of resource-use by female rice farmers.

If we also assume that $f(x_i, \beta)$ takes the log-linear Cobb-Douglas form, the model can be written as:

$$\ln Y_i = \beta_0 + \sum \beta_n \ln X_{ni} + (v_i - u_i) \quad (i)$$

where v_i is the “noise” component, which we will consider as a two-sided normally distributed variable, and u_i is the non-negative technical inefficiency component. Together they constitute a compound error term, with a specific distribution to be determined, hence the name of “composed error model” as is often referred.

The model specification is given as:

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + v_i - u_i \quad (ii)$$

Where,

Y = Output of rice in kg

X₁ = Farm size (ha)

X₂ = Seed in kg

X₃ = Fertilizer in kg

X₄ = Hired labour in man-days

X₅ = Family labour in man-days

X₆ = Herbicides in litres.

It is assumed that the technical efficiency effects are independently distributed and u_i arises by truncation (at zero) of the normal distribution with mean, u_{ij} and variance σ^2 , where u_{ij} is defined by:

$$u_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6 \quad (iii)$$

where,

u_i = Technical inefficiency of the i^{th} farmer

Z₁ = Age of the farmer (years)

Z₂ = Access to education (Dummy)

Z₃ = Farming experience (years)

Z₄ = Household size (number)

Z₅ = Access to Extension Services (Dummy: 1 for YES and 0 otherwise)

Z₆ = Access to credit facilities (Dummy: 1 YES, and 0 otherwise)

α = a vector of unknown parameters to be estimated.

Log-Likelihood Ratio Test: A log-likelihood ratio test is statistical test used to compare the fit of two models in which case one is null model and the other is alternative model. The test is based on likelihood ratio which expresses how many times more likely the data are under one model than the other. This statistical test is used to test the hypotheses that the technical inefficiency effects are not present, $H_0: \gamma = \delta = 0$. The generalized likelihood ratio test is one-sided test since U_i cannot take negative value. Hence, the test requires the estimation of the model under both null and alternative hypotheses. The likelihood ratio statistics is calculated as:

$$LR = -2\{\ln[L(H_0)/L(H_1)]\} = 2\{\ln[L(H_0)] - \ln[L(H_1)]\} \quad (iv)$$

Where, $L(H_0)$ is the value of the likelihood function for the frontier model, in which the parameter restrictions specified by the null hypothesis, and $L(H_1)$ is the value of the likelihood function for the generalized frontier model. The result from the test statistic is the compared with the critical value obtainable which approximately has chi-square (or mixed square) distribution with degrees of freedom from Kodde and Palm's table.

The Z-Statistic

The Z-statistic was used to test whether there are significant differences between the technical efficiency of male and female farmers. Z-Statistic is generally used for comparing means of two populations with large sample size.

The Z- statistic is presented as;

$$Z = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}} \quad (14)$$

Where,

$\bar{X}_1$ = Mean technical efficiency of male farmers

$\bar{X}_2$ = Mean technical efficiency of female farmers

S_1 = Standard error of mean technical efficiency of male farmers

S_2 = Standard error of mean technical efficiency of female farmers

N_1 = number of male farmers sampled

N_2 = Number of female farmers sampled

Socio-economic Characteristics of male and female rice-farmers

The result of the study in Table 1 revealed that the majority of rice-farmers in the study area were within the active age-group 40years and below for both male and female farmers. The study further showed that the percentage of female rice-farmers without formal education (41.11%) was higher than their male counterparts (i.e. 26.26%). The implication of this is that the female farmers were less equipped with formal education that could improve their productivity. This result agrees with the report of Ojobo (2008) that there exist educational imbalance between men and women in Nigeria which is due to societal traditions and myths that relegate women's education to the background vis-à-vis men.

Moreover, male farmers who acquired farmlands through inheritance were more than their female counterparts. Most of the farmlands used by female rice-farmers were acquired mostly through leasehold (41.67%) and their husbands' plots (27.77%). The implication of this is that gender disparity in terms of land acquisition was prevalent in the area and this will limit the productivity of the women rice farmers. The result corroborates the report of Dennis (2008) that lack of access to land remains a major constraint for women farmers in Africa and land reform programmes have led almost exclusively to the transfer of land rights to male heads of households. The findings also revealed that rice-farmers in the area had limited access to agricultural services such as extension services and farm credit facilities. However, female farmers were more disadvantaged regarding access to these agricultural services than male farmers.

Results and Discussions

Table 1: Socio-economic Characteristics of Male and Female Rice Farmers

Male	Female
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Variables	Frequency	%	Frequency	%
Age (Years)				
≤ 30	68	34.34	54	30.00
31-40	65	32.83	76	42.22
41-50	44	22.22	35	19.44
51-60	20	10.10	12	06.67
> 60	01	0.51	03	01.67
Total	198	100.00	180	100.00
Minimum	16		16	
Mean	36.67		36.42	
Education				
No Formal Education	52	26.26	74	41.11
Secondary	70	35.35	42	23.33
Primary	43	21.72	36	20.00
Tertiary	33	16.67	28	15.56
Total	198	100.00	180	100.00
Land Acquisition				
Inheritance	124	62.63	55	30.56
Leasehold	74	37.37	75	41.67
Husband's Land	0	0	50	27.77
Total	198	100.00	180	100.00
Access to Credit Facilities				
Yes	18	09.09	09	05.00
No	180	90.01	171	95.00
Total	198	100.00	180	100.00
Access to Extension Services				
Yes	20	10.10	10	05.56
No	178	89.90	170	94.44
Total	198	100.00	180	100.00

Source: Field Survey, 2014

The Technical Efficiency of Male and Female Farmers

The results of analysis of the technical efficiency in rice production by male and female farmers using stochastic frontier function are presented in Tables 2 and 3. The results revealed that farm-size, fertilizer, hired labour and family labour were the factors which had statistically significant influence on the production of rice by female farmers. On the other hand, the factors which had significant effects on the output of rice by male farmers were the quantity of seeds, farm size, hired labour and herbicide. This indicates that the determinants of rice output which was common

to both groups were farm-size and hired labour. The socio-economic factors which determined the technical in-efficiency of male rice farmers include age, educational levels, access to extension services; whereas the in-efficiency factors for female farmers were educational status of the farmer, farming experience, and access to credit facilities. This suggests that education was the major in-efficiency factor that was common to both male and female farmers. Moreover, the result of Likelihood ratio test as shown in Table 4 confirmed the existence of technical in-efficiency in the production of rice by both male and female farmers.

Table 2: Maximum Likelihood Estimates of the Parameters of the Stochastic Frontier Production Function for the Female Farmers

Variable	Parameter	Coefficient	Standard Error	t-ratio
Production Factors				
Constant	β_0	1.9464	0.7264	2.6795 *
Farm size	β_1	1.0520	0.4118	5.5460 *
Seed	β_2	0.5604	0.4013	1.3964
Fertilizer	β_3	0.0331	0.0105	3.1574 *
Hired Labour	β_4	0.0498	0.0132	3.7772 *
Family Labour	β_5	0.0304	0.0142	2.1385 **
Herbicide	β_6	0.0246	0.0630	0.3899
In-efficiency Factors				
Age	α_1	- 0.1914	0.2119	- 0.9034
Education	α_2	- 0.0197	0.0969	- 2.0341 **
Farming Experience	α_3	- 0.0127	0.0371	- 3.4205 *
House-hold size	α_4	0.0074	0.0464	0.0159
Extension services	α_5	- 0.0816	0.1813	- 0.4500
Credit facilities	α_6	- 0.0400	0.0150	- 2.6568 *
Sigma squared	δ^2	0.4494	0.0051	8.8863 *
Gamma	Γ	0.7130	0.0146	4.8998 *
Log likelihood function			26.3282	

Source: Computer output from Frontier 4-1, 2014

* Significant at 1%** Significant at 5%.

Table 3: Maximum Likelihood Estimates of the Parameters of the Stochastic Frontier Production Function for the Male Farmers

Variable	Parameter	Coefficient	Standard Error	t-ratio
Production Factors				
Constant	β_0	1.9872	0.2867	6.9312 *
Farm size	β_1	0.4701	0.1854	2.5361 **
Seed	β_2	0.0610	0.0166	3.6680 *
Fertilizer	β_3	0.0137	0.0098	1.3994
Hired Labour	β_4	0.0265	0.0113	2.3510 **
Family Labour	β_5	0.0197	0.0127	1.5552
Herbicide	β_6	0.1334	0.0677	1.9699 **
In-efficiency Factors				
Age	α_1	- 0.1397	4.3961	- 3.1769 *
Education	α_2	- 0.0566	0.0244	- 2.3139 **
Farming Experience	α_3	- 0.2226	0.0136	- 1.6317
House-hold size	α_4	0.6710	0.5068	1.3239
Extension services	α_5	- 0.5159	0.2007	- 2.5704 *
Credit facilities	α_6	- 0.1274	0.0526	0.0526
Sigma squared	δ^2	0.4380	0.2388	1.8341 ***
Gamma	Γ	0.9253	0.0454	20.3691 *
Log likelihood function			18.9118	

Source: Computer output from Frontier 4-1, 2014

* Significant at 1%; ** Significant at 5%; *** Significant at 10%

Table 4: LR Tests of hypothesis of no technical in-efficiency for male and female farmers

Null hypothesis	LR	$\chi^2_{value\ 0.95}$	Decision rule
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Male: $H_0: \gamma = \delta_1 + \dots + \delta_6 = 0$	17.39	13.40	Rejected
Female: $H_0: \gamma = \delta_1 + \dots + \delta_6 = 0$	22.61	13.40	Rejected

Source: Computer printout, 2014

Distribution of technical efficiency of male and female Farmers

The result in Table 5 showed that the technical efficiency index of male farmers ranges between 0.38 and 0.96 with a mean value of 0.86 indicating that on the average, male farmers could increase their production by as much as 14% through more efficient use of production resources. On the other hand, the technical efficiency of female farmers ranges between 0.43 and 0.98 with a mean value of 0.84 which implies that on the average, female

rice-farmers had the capacity of increasing their production by 16% given the existing technology. Given the mean technical efficiency of male farmers as 0.86 and that of the female farmers as 0.84; therefore, on the average, the male farmers tend to be more technically efficient than their female counterparts. This result agrees with the findings of Bastians *et al.* (2001) that women farmers were less efficient than their male counterparts.

Table 5: Distribution of Technical Efficiency of Male and Female Farmers

Efficiency Levels	Male		Female	
	Frequency	%	Frequency	%
≤ 0.50	1	0.51	4	2.22
0.51 – 0.60	2	1.01	13	7.22
0.61 – 0.70	3	1.52	21	11.67
0.71 – 0.80	9	4.55	35	19.44
0.81 – 0.90	90	45.46	77	42.78
0.91 – 1.00	93	46.95	30	16.67
Total	198	100.00	180	100.00
Minimum	0.38		0.43	
Maximum	0.96		0.98	
Mean	0.86		0.84	

Source: Field Survey, 2014

Tests of Hypothesis that Male and Female Farmers had Equal Technical Efficiency

The result of the Z-test showed that there was statistically significant difference between the technical efficiency of male and female farmers. The calculated values of Z-statistic at 5% significant level for the paired sample test was shown to be greater than the critical value of Z given as 1.96 at 5% significant level. Hence, the null hypothesis of no significant difference between the technical efficiency of male and female farmers ($H_0: \mu_{\text{male}} = \mu_{\text{female}}$) is rejected in favour of the alternative hypothesis ($H_0: \mu_{\text{male}} \neq \mu_{\text{female}}$).

Conclusion and Recommendations

The study showed that male farmers were more technically efficient than their female counterparts.

Based on the findings of this study, the following recommendations are made.

Government policy should emphasize measures that promote women farmers' access to agricultural resources and services at affordable prices thereby bridging the existing gender gap among rice-farmers in Nigeria.

Farmers should be organized into cluster groups or cooperatives which will aid their ability in terms of securing collaterals for accessing credit facilities from banks with which they could acquire better and improved technology for rice production in the rural areas. Government policy should encompass investing more on increasing farmers' access to formal education towards enhancing knowledge and application of new farming technology through short-term extension training programmes.

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