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Profitability and Productivity of Growers of New rice for Africa (NERICA) in the Southern Guinea Savanna of Niger State, Nigeria

Lawal, A.F[1]; Agboluaje, A. A[2] and Liman, A[3]

[1]Department of Agricultural Economics and Extension Services, Ibrahim Badamasi Babangida University, Lapai Niger State, Nigeria
[2]Department of Mathematics and Computer Science, Ibrahim Badamasi Babangida University Lapai Niger State, Nigeria
[3]Department of Agricultural Extension and Management, College of Agriculture, Mokwa Niger State, Nigeria.

Abstract
This study examined the profitability and productivity of growers of new rice for Africa in the upland of southern guinea savanna of Niger State, Nigeria. Data for the study were obtained from sample survey of 150 NERICA rice farmers using multistage sampling technique. The farm budgetary technique and ordinary least square (OLS) regression model were used to analyse the data. Results shows that a typical NERICA variety farmers is male, married, about 43years cultivating about 2.22 hectares of land in 1-3 locations. Labour cost accounted for 68% of production cost and there was low level of use of fertilizer, herbicides and mechanization of land preparation. Farm budgetary analysis shows that NERICA variety production is profitable with a gross margin (Gm) and net farm profit (NFI) of ₦92,948.00 and ₦90, 302.66 per hectare respectively. The GM, NFI and return on Naira investment of 2.02 is competitive in the upland crop production system in Nigeria. Farm size (X_1), labour input (X_2), cost of purchased input in Naira (X_3) and household size of grower (X_5) were positively related and significantly ($p < 0.05$) affect the level of income realised; all the productive resources were underutilized. The study supports increased use tractor for farm mechanization and herbicides to reduce labour use and production cost to support the farm size expansion policy. Assess to purchase input such as seeds and fertilizer as well as credit should be made available at subsidize rate to encourage use.

Key word: *NERICA, upland rice, net farm income and resource productivity.*

Introduction

Rice (*Oryza sativa)* is an important food crop in Nigeria; it is one of the major staples and a strategic commodity to Nigeria economy. Demand for rice has been increasing at a faster rate in Nigeria than in most part of Africa with about 24.5 kg per capital consumption per year (Daramola, 2005). Since 2002 Nigeria has been importing an average of about 2 million metric tonnes of rice per annum and spending between $500 million and $1 Billion on rice importation (Akande, 2002; Daramola, 2005; Rahji and Omotesho, 2006; RMM, 2011). Rice self- sufficiency is a major food policy focus of Nigeria. To achieve these would require a significant change in the level of production and processing of rice in the country. The ecologies being exploited to increase rice production in Nigeria were lowland, upland and irrigated land. The most common and accessible among these is the upland rice production system although it is characterised by low productivity (Daramola, 2005).

To improve the productivity of upland system, the New Rice for Africa (NERICA) was bred by scientist of Africa Rice Center (WARDA). NERICA was introduces to Nigeria rice farming system through multinational NERICA rice dissemination project which was launched in 2002. In addition to the launch of the NERICA variety, complementary technology to improve management practices has been developed. These practices have been disseminated to farmers in Nigeria for adoption. Different studies have shown levels of adoption of NERICA variety and complementary technology (Spencer *et al,*. 2006; Tiamiyu *et al.*, 2010; Lawal and Alabi, 2011). However, these studies have not accessed the profitability of this upland variety nor determine the efficiency of the rice farmers. The questions that this study answered include:-

- Can the present NERICA rice production practices enhance economic benefits?
- Are NERICA rice farmers efficient in the use of inputs?
- What are the factors that determine the level of inefficiency of the farmers?

The study provides empirical information on the profitability and productivity of NERICA variety in the southern guinea savanna of Nigeria. The specific objectives were to:- (i) determine the costs and return to NERICA variety (ii) determine the technical allocative and economic efficiency of NERICA farmers (iii) Identify the determinants of technical inefficiency of the NERICA farmers.

The study aimed at providing more information about NERICA variety and increases our understanding of the economics of its production towards better policy and decisions making for improve rice production system in Nigeria.

Methodology

Area of study

The study was carried out in Niger State, Nigeria. Niger State is in the southern guinea savanna of Nigeria, it is located between 8^o 11’ to 11^o 20’ N of the equator and between 4^o 39’ and 7^o 15’E. It covers an estimated land area of 4240km sq. The mean annual rainfall ranges between 800mm – 1100mm in the north and 1600mm in the south of the state. The average number of raining days ranges between 187 – 220 days. The rain starts in late April and ends in October with the peak in July. The average temperature ranges between 26^o C – 38^oC. The mean humidity ranges between 60% (January - February) and 80% (June - September) (NCRI, 1997). Niger State is the second largest producer of rice in Nigeria (Daramola, 2005).

Data and Sampling Procedure

Data used for this study were from primary source. The relevant primary data were obtained through a farm management survey of NERICA variety farming households in Niger state conducted between October and December, 2010. A Multistage sampling technique was used to collect data from 150 NERICA variety farming households used for the study.

Data were analysed with descriptive statistics, budgetary technique and stochastic frontier production function. Descriptive statistics were used to capture the socio-economic characteristics of sampled NERICA variety farming households. The Budgetary Analysis involves the estimation of net farm income and return on Naira (ROI) invested which was used to determine the profitability of NERICA variety production in the study area.

Following Olukosi and Erhabor (1988), the net farm income was estimated on per hectare basis as

NFI = GM – TFC (1)

GM = TR – TVC (2)

Where

NFI= Net Farm Income

GM = Gross margin (₦)

TR = Total revenue (₦)

TVC = Total variable cost (₦)

TFC = Total Fixed cost per hectare (₦) (Average annual depreciation cost for all input will be used)

TR = Py . Y (3)

Where

Py = Price per unit output (₦)

Y = Total quantity of output (Kg)/unit/Ha

Following Lawal (2008) return on Naira invested (ROI) was obtained as follows:

$$ROI = \frac{\text{Total revenue}}{\text{Total production cost}}$$

Multiple Regression Analysis was employed to determine factors influencing NERICA variety production and the resource use efficiency of the households in the study area. The implicit model for NERICA variety households in the study area is stated thus:-

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8\ e_t)$$

4

Where, Y = Output (Kg)

f = functional form

X_1 = Farm size in Hectares

X_2 = Nerica seed in Kg

X_3 = Labour in Man-days

X_4 = Fertilizer used in Kg
X_5 = Rice farming experience in years
X_6 = Age in years
X_7 = Access to credit expressed as dummy, 1 for access and 0 for no access
X_8 = Number of extension contact in years
e = error term.

Three (4) functional forms namely linear, semi-log and double-log were fitted to data generated using ordinary least square (OLS) technique under the assumption that data fulfilled the assumption of the multiple regression models.

The explicit forms of this model are as follows:-

$Y = b_o + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_{7\,+}\, e_t$ (Linear). 5

$LogY = bo + b_1LogX_1 + b_2Log\ X_2 + b_3LogX_3 + b_4LogX_4 + b_5LogX_5 + b_6LogX_6 + b_7LogX_7e_t$ (Double-Log). 6

$Y = b_o + b_1LogX_1 + b_2LogX_2 + b_3LogX_3 + b_4LogX_4 + b_5LogX_5 + b_6LogX_6 + b_7LogX_7 + e_t$ (Semi-Log) 7.

$LogY = b_o + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_{7\,+}\, e_t$ (Exponential). 8

On a priori basis it is expected that each of the independent variable (Xi) in equation 3 will be positively related to the dependent variable (Y) i.e $\partial y/\delta x > 0$ for i = 1,2, ...,7

Following Lawal (2008) return on Naira invested (ROI) was obtained as follows:

$$ROI = \frac{\text{Total revenue}}{\text{Total production cost}} \quad (4)$$

Multiple Regression Analysis was employed to determine factors influencing income from NERICA variety production and the resource use efficiency of the farmers involved in the study area. The implicit model for NERICA variety households in the study area is model as:-

$$Y = f\,(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8\ e_t) \quad (5)$$

Where, Y = Output (Kg)
f = functional form
X_1 = Farm size in Hectares
X_2 = Nerica seed in Kg
X_3 = Labour in Man-days
X_4 = Fertilizer used in Kg
X_5 = Rice farming experience in years
X_6 = Age in years
X_7 = Access to credit expressed as dummy, 1 for access and 0 for no access

X_8 = Number of extension contact in years
e = error term

Three (4) functional forms namely linear, semi-log, double-log and exponential were fitted to data generated using ordinary least square (OLS) technique under the assumption that data fulfilled the assumptions of the multiple regression models.
The explicit forms of this model are as follows:-

$$Y = b_o + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + e_t \text{ (Linear)} \quad ..(6)$$

$$LnY = bo + b_1LnX_1 + b_2Ln\ X_2 + b_3LnX_3 + b_4LnX_4 + b_5LnX_5 + b_6LnX_6 + b_7lnX_7 + b8lnX_8 + et \text{ (Double-Log).} \quad (7)$$

$$Y = b_o + b_1lnX_1 + b_2lnX_2 + b_3lnX_3 + b_4lnX_4 + b_5lnX_5 + b_6lnX_6 + b_7lnX_7 + b_8lnX_8 + e_t \text{ (Semi-Log).} \quad (8)$$

$$LogY = b_o + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + e_t \text{ (Exponential).} \quad (9)$$

On a priori basis it is expected that each of the independent variable (Xi) in equation 3 will be positively related to the dependent variable (Y) i.e $\partial y/\delta x > 0$ for i = 1,2, ...,8.
The data were crosschecked for outlier and multicollinearity before the model was estimated, Outliers were defined as observations that appear to deviate remarkably from other observations in the sample. Identifying an observation as an outlier is a function of the underlying distribution of the data; we assume normal distribution and tested it using the skewness and kurtosis tests.

Tabachnick and Fidell, (2000) reported that skewness describes asymmetry from the normal distribution in a set of statistical data while kurtosis measure whether the data are peaked or flat relative to a normal distribution. The skewness coefficients estimates were different from zero which suggests that all variables have asymmetric distribution, The kurtosis of all variables were greater than zero, indicating the tails of their distribution to be closer to normal distribution. In addition to checking the normality assumption we generate a normal probability plot, the lower and upper tails of the normal probability plot can be a useful graphical technique for identifying potential outliers. Outliers were detected using the Modified Grubbs' test as recommended by Iglewicz and Hoaglin (1993). The modified Grubbs test score is defined as

$$Mi = \frac{0.6745\,(xi - x)}{MAD} \quad (10)$$

with MAD denoting the median absolute deviation defined as; Median ($|\bar{Y} - \bar{Y}|$) where Y is the median of the data and $\bar{Y}$ is the absolute value of Y. and $\tilde{x}$ denoting the median. Based on the work of Iglewicz and Hoaglin (1993) modified Z-scores with an absolute value of greater than 3.5 were labelled as outliers. Outlier identification and adjustments were performed only over the non-zero observations for each variable. After adjusting the data for outliers, multicollinearity diagnosis was performed. Olayemi (2000) reported that multicollinearity exists whenever two or more of the predictors in a regression model are moderately or highly correlated *variance inflation factors* (VIFs) was used to detect multicollinearity among the variable in our regression equation 3. Olayemi (2000) also defined VI as VIF = 1/1- R_k^2 where R_k^2 *is* the R^2 value obtained by regressing the *kth* predictor on the remaining predictors. R_k^2 should be close to 1, if the *kth* predictor is nearly a linear function of the other predictors, then, *VIFk* will be large. That is, the variance of the estimated regression coefficients will be inflated by a factor of *VIFk*. On the other hand, R^2 should be close to 0, if the *kth* predictor is not linearly related to the others, then *VIFk* will be close to 1. Variance inflation factors greater than 4 suggest that the multicollinearity should be investigated (O'Brien, 2007).

The estimated VIFs for age and farming experience were 6.5 suggesting that multi-collinearity is probably an issue. Bivariate correlation was run among the independent variables to detect a high level of association. The result shows high bivariate correlation (r = 0.869) between age and farming experience. The standard error of regression model that included the two variables was large. This reduces significantly when only one of the variables was included in the model. Age was subsequently dropped for farming experience to follow the notion of Shulth (1975) that as far as adoption and adaptation to new technology are concerned, experience not age is the best teacher. This decision is supported by Admassie (1998) and Rahji (2006) who dropped age for the same reason and in similar study.

Following the corrections for outliers and multicollinearity, the final estimated model is of the form:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, e_t) \quad (11)$$

Where, Y = Output (Kg)

f = functional form

X_1 = Farm size in Hectares

X_2 = Nerica seed in Kg

X_3 = Labour in Man-days

X_4 = Fertilizer used in Kg

X_5 = Rice farming experience in years

X_6 = Access to credit expressed as dummy, 1 for access and 0 for no access

X_7 = Number of extension contact per years

e = error term

Elasticity of Production and Return to Scale Measurement

Other estimates derived from our regression equation 12 for NERICA Variety farming households are elasticity of production (EOP) and return to scale (RTS). To estimate EOP for Xi from Cobb- Douglass functions;

$EOPi = b_i(Q)/X_i * X_i/Q = bi$

Where; b_1= regression coefficient of resource X_i

Q = Output

X_i = Resource whose elasticity of production is to be estimated.

To estimate RTS (v) = ∑ bi

And v > 1 (increasing return to scale)

v < 1(decreasing return to scale)

v = 1 (constant return to scale)

To determine the productivity of resource used in Nerica Variety production by the farmers, the following relationship is used.

MVP (MRP) = UFC

Where; MVP is the marginal value product or marginal revenue product which is the additional revenue generated as a result of a unit increase in input usage.

UFC is the unit factor cost.

When,

MVP = UFC, resources are efficiently utilized

MVP > UFC, resources are under utilized

MVP < UFC, resources are over utilized

Results and Discussion

Socioeconomic characteristics of the respondents

Table 1 show that the modal age group was 41 – 50 years. The average age of the respondent was 43 years. About 65% of the sampled household's head were below 50 years. This implies that rice production is with the young energetic and active members of the sampled rural communities. This result is similar to the findings of Lawal (2008) that reported that head of farming households in North Central Nigeria were mostly young men. The result also revealed that although majority of the household head were illiterate but reasonable percentage (34%) of the sample was literate. In fact, about 21% has a minimum of secondary education. Level of education can have positive effect on adoption (Adewumi and Omotesho, 2002). The average farm size was 2.22 hectares held in about 1- 3 locations. This result is in line with that reported by Rahji (2006) and Lawal (2008) that average farm size was 2.46 hectare held 1 – 3 plots – which shows that rice cultivation is still in the hand of small scale farmers which corroborates the finding of Umeh *et al*., 2004 and Daramola 2005.

Table 1: Socioeconomic Characteristics of NERICA Rice Farming Household in Niger State

Variables	Frequency	Percentage
Age in years		
21 – 30	10	6.67%
31 – 40	39	26.00%
41 – 50	49	32.67%
51 – 60	27	18.00%
>60	25	16.67
Highest Educational Level		
No Formal Education	41	27.33
Quranic	58	38.67
Primary	19	12.67
Secondary	26	17.33
Tertiary	6	4
Farm size (Hectares)		
0.1 –2.0	43	28.67
1.1 – 4.0	86	57.33
4.1- 6.0	21	14.00

Source: Field survey, (2011)

Costs and return analysis

The estimated budgetary analysis for NERICA variety production in Niger State is shown in Table 2

Table 2: Cost and Return of NERICA rice variety production in Niger State Southern Guinea Savanna Nigeria.
Production Cost for One Hectare

Variable Items	Cost (₦)	% of Total Cost	
Land rentage	2,000.00	1.70	
Nerica seed	10,560.00	8.96	
Labour	**85, 495.00**	**72.55**	**%of Labour Cost**
Land preparation	18, 500.00	15.70	21.64
Planting	9, 650.00	8.19	11.29
Weeding	26, 924.80	22.85	31.49
Harvesting	17, 395.20	14.76	20.35
Threshing and winnowing	9, 750.00	8.28	11.40
Others	3, 275.00	2.78	3.83
Fertilizers	8, 697.60	7.38	
Transportation	8, 800.00	7.47	
Total variable cost	**115,552.6**		
Depreciation of fixed items	2, 275.00	1.93	
Total cost	**117, 827.60**		
Revenue (₦)			
Average yield of Nerica Variety (Kg)	1, 909.70		
Average price per bag (65 Kg)	5500		
Gross Return	161,590.00		
Gross Margin/ha	**46, 037.40**		
Net Farm Income	**43, 762.40**		
Return on Naira investment	**1.3714**		

Source: Field survey (2010)

The estimated Gm/Ha in Nerica variety production was ₦46,037.40. Fixed cost was negligible so Gm/Ha was used as proxy for measure of profitability. The farm return on Naira investment (ROI) was estimated at ₦1.37; this implies that 37k was realised as return on every naira invested in NERICA rice production in the study area during the survey. With the interest rate at 22%, it can be concluded that NERICA variety production is profitable in the study area. However, we may need to ask if the profit regime of the crop is competitive enough to attract households to divert productive resources to its production? It could be observed that the ROI was smaller (1.37) when compared with 1.76, 1.68, 1.30 and 1.71 reported by Sanusi and Salimonu (2006); Alabi *et al.*, (2008) ; Lawal and Tsado (2008) and Lawal (2013) for yam; yam –tomatoes intercrop; sweet potatoes and maize respectively. These crops have better opportunity cost for resource allocation than NERICA production based on the results of this study.

Labour cost is the most important component that drives the Nerica variety production cost to be high. Cost saving devices that reduces labour cost is key to profitability, ROI and competitiveness of NERICA rice production. Labour cost constitutes about 72.55%

of total cost of production. The three operations that required high level of labour were land preparation {21.64% of labour cost (LC)}, weeding (31.49% of TC) and Harvesting (20.35 of TC). The survey shows that labour saving devices in form of mechanization of land preparation and use of herbicide is not widespread. Only about 34 percent of the households surveyed use mechanization to prepare land while only about 38 percent of the sample households use herbicide which is mostly for post emergence weeding.

Resource- Use Productivity Analysis

The regression coefficient and other related statistics for the regression equation 12 are presented in Table 3.

Table 3: Regression Estimates for Factors Affecting NERICA Variety Production in Niger State, Southern Guinea Savannah Nigeria

variables	Constant	X_1	X_2	X_3	X_4	X_5	X_6	X_7	R^2	F
Functional Forms										
Linear	67.786	0.546	2.677	-7.015	8.391	3.571	2,874	6.913	0.637	124*
SE	31.234	0.248	1.452	4.564	2.603	2.954	0.952	4.895		
	(2.17**)	(2.290**)	(1.844)	(-1.537)	(3.224***)	(1.209)	(3.019***)	(1.412)		
Semi log	- 86.13	0.745	6.486	-9.411	63.852	27.241	34.196	33.567	0.704	278*
SE	32.56	0.372	3.982	4.105	36.515	10.740	28.421	16.648		
	(2.64**)	(2.002**)	(1.629)	-(2.293**)	(1.749)	(2.536**)	(1.203)	(2.017**)		
Double	46.69	1.926	3.688	0. 4 86	1.171	0.465	1.316	0.978	0.863	466*
log	26.45	0.891	1.274	0. 225	0.421	0.205	0.485	0.316		
SE	(1.99**)	(2.161**)	(2.895**)	(-2.16**)	(2.781**)	(2.268**)	(2.713**)	(3.095***)		
Exponenti	38,90	1.986	1.576	-2.664	-0.695	0.825	1.446	1.897	0.734	545*
al	23.65	0. 672	0.961	0.915	0.213	1.088	0.424	0.566		
SE	(1.64)	(2.955**)	(1.640)	(2.911**)	(-3.262***)	(0.758)	(3.410***)	(3.352***)		

Figure in parenthesis are t values; ** significant at 5%; *** significant at 1%

Source: Computed from field survey data 2011

All the variables with the exception of farming experience (X_3) in the fitted regression equation have the appropriate sign and accounted for between 64% and 86% of the total variability observed in Nerica variety production. Double log function was selected as the lead equation based on the magnitude of coefficient of multiple determination (R^2), the number of significant ($p < 0.05$) variables and the appropriateness of the sign of regression coefficients based on economics theory and agricultural logic (Olayemi, 2000). Double–log is considered the most appropriate function to represent agricultural production data (Nwoko, 1997). The explicit model of the lead equation is specified as

$$\text{Log } Y = 46.69 + 1.92 \log X_1 + 3.69 \log X_2 - 0.49 \log X_3 + 0.08 \log X_4 + 0.47 \log X_5 + 1.32 \log X_6 + 0.98 \log X_7 + u$$

The coefficient of multiple determination of the lead equation shows that the included variables accounted for about 86% of the total variation in the output of Nerica variety production in the study area. The F –test which is the overall test of significance of the regression equation is significant ($p < 0.01$) showing that the regression equation is adequate and that the joint effects of the included independent variables are significant. All the independent variables; Farm size (X_1), Nerica seed (X_2), Labour (X_3), fertilizer used (X_4), Rice farming experience (X_5) access to credit (X_6) and number of extension contact (X_7) are positive and significantly ($p < 0.05$) related to output(Y). These indicate that by increasing the quantity use of each input individually or collectively the output of yam can be increased. The return to scale measured by the sum of the regression coefficient of the lead equation was 7.97 implying an increasing return to scale which support increased use of all inputs to obtain optimal return.

Table 4 shows the marginal value Product for all the physical inputs in the regression equation

Table 4: Measure of Resource Use Efficiency in NERICA Variety Production By Farming Households in Niger State, Southern Guinea Savannah Nigeria

Resources	MVP	UFC	MVP/UFC
Farm size (X_1)	10,615	2000	5.31
Labour (X_3)	2,673	650	4.11
Fertilizers(X_4)	6440.5	5,000	1.29
Nerica seed (X_2)	20,295	10,560	1.92

Source: Field survey, 2011

The MVP/UFC ratio for all physical inputs in the regression equation is greater than one which shows that the resources were underutilised and increasing the level of use would lead to increased level of output. During the survey a typical households cultivated about 1 26 hectares of Nerica variety where 25 kg of seeds is planted and about 85kg of fertilizer is utilized. Labour cost was expensive because farming households have to pay prices comparable to what labour earned in alternative job mostly in construction and motorcycle taxi (Kabukabu). Manday was paid ₦650 during the survey and labour cost accounted for about 73 % of production cost so there is an urgent need to utilize labour saving devices to improve on productivity and competiveness of Nerica variety production. This result corroborates earlier study by Fatoba 2007 and Lawal 2008 that reported underutilization of resources among small scale farmers in southern guinea savanna of Nigeria.

Conclusion and Recomendation

The key findings of the study suggest that NERICA variety is profitable and competitive in upland crop system with a gross margin and net farm profit of ₦92,948.00 and ₦90, 302.66 per hectare respectively. The return on Naira investment of 2.02 is greater when compared with 1.76, 1.68, 1.30 and 1.71 reported by Sanusi and Salimonu (2006); Alabi et al., (200p) ; Lawal and Tsado (2008) and Lawal (2013) for yam; yam –tomatoes intercrop; sweet potatoes and maize respectively. Labour cost accounted for 68% of production cost and there was low level of use of fertilizer, herbicides and mechanization of land preparation. To increase the profitability of NERICA variety production the study supports increasing use of tractor for farm mechanization and herbicides to reduces labour input and production cost to support the farm size expansion policy recommended. Assess to purchase input such as seeds and fertilizer as well as credit should be made available at subsidized cost to encourage use by NERICA variety producers.

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