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Farmers' Resource-Use Efficiency in Rice (*Oryzae sativa*) Production in Benue State, Nigeria

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ABSTRACT
This study examined the resource-use efficiency in Rice Production in Benue State Nigeria. Multi-stage sampling technique was employed to select 152 respondents on whom structural questionnaires were administered to collect data on input and output of rice farmers in the study area. Descriptive statistics, gross margin and multiple regression analysis were employed for data analysis. The analysis revealed that the mean age of respondents was 36 years with majority (64%) of the respondents having formal education, while majority (80%) of the respondents had more than 16 years of farming experience. costs, gross income and gross margin per hectare for rice production were N123,500, N180,000 and N56,500. The farmers were found to be efficient in the use of seeds, herbicides and labour whereas farm size and fertilizer were over utilized. It was recommended that financial institutions should consider making more credit available to rice farmers so as to enable them increase the use of the inputs that were underutilized. Also, the Federal and State governments as well as donor agencies intensify efforts aimed at introducing labour saving devices such as mechanization to remove inefficiencies associated with labour. It was also suggested that more extensive workers should be deployed in the study area to educate farmers on the need for correct use of farm inputs.

INTRODUCTION
Rice, which is widely believed to have originated from China and grown all over the world, except the Antarctic region, is one of the leading staple foods worldwide. The Nigeria rice industry is characterized by vast expanse of land suitable for rice cultivation and it is cultivated and consumed in all parts of the country. In spite of the availability of large scale rice farms dotted here and there, rice production in Nigeria and Benue State in particular is mainly a small holder activity and provides income to farmers and all other agents involved in its production and marketing. Resources used in any production activity constitute the inputs that drive the production process. Resource allocation and productivity are important aspects of increased food production which is also associated with the management of the farmers who employ those resources in production. Moreover, efficient utilization of available resources is a major determinant for a profitable farm business.

PROBLEM STATEMENT/JUSTIFICATION
Upon the realization that the agricultural sector has been neglected largely as a result of the oil boom, there has been a number of initiatives to step up agricultural production, including the production of rice. Most of these efforts tend to emphasise the provision of adequate production resources and improved technology to farmers as a way of boosting production (FGN 2011). But mere provision of production resources and improved technology cannot give rise to increased production if the productive resources are not efficiently used. A resource or input is said to be efficiently utilized when it is put to the best use possible and at minimum cost (Arene, 2002). It is therefore necessary to investigate whether these farmers are even making maxi n use of what is available to them in terms

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of inputs so that the stakeholders involved in efforts to boost agricultural production and the rice enterprise in particular will be convinced that the new inputs and technologies they intend to introduce to farmers will be used efficiently and cost effectively to boost rice output. Farmers might use resources rationally but not at the economic optimal level. As the aim of every producer is to maximize profit while minimizing cost, it is pertinent to determine efficiency of recourse-use in rice production

OBJECTIVES

This study will be carried out to determine and analyse the socio-economic characteristics of rice farmers, estimate the costs and returns of rice production, estimate the farm production function of rice production with the view of deriving the marginal factor productivity so as to estimate how efficiently the rice farmers in the study are using their resources.

LITERATURE REVIEW

Three types of efficiency are identified in the literature. These are technical efficiency, allocative efficiency and economic efficiency (Farrell, 1957, Olayide, and Heady, 1982). Technical efficiency is the ability of a farm to produce a given level of output with minimum quantity of input under a given technology. Allocative efficiency is a measure of the degree of success in achieving the best combination of different inputs in producing a specific level of output considering the relative prices of those inputs. Economic efficiency is a product of technical and allocative efficiency (Olayide and Heady, 1982). In one sense, the efficiency of a farmer is his success in producing as large an amount of output as possible from given sets of inputs. In Farrell (1957) framework, economic efficiency (EE) is an overall performance measure and is equal to the product of TE and AE (that is EE = TE + AE). From his analysis, a farm that is technically efficient in resource use operate on a production frontier, while a technically inefficient farm in resource use operates below the production frontier. Hence, the position of individual farm relative to the frontier could be influenced by factors ranging from climate, socio-economic and marketing etc. Mathematically, Farrell's production frontier function begins by considering a stochastic production function with a multiplicative disturbance term of the form:

$Y = f(Xa,; \square e^{E}$ ..... (1)

Where

Y = output; x = vector of input, $\square$ = vector of parameter; e = error disturbance term consisting two independent element "V" and "U"

Hence, $E = U + V$ ..... (2)

The symmetric element V account for random variation in output quantity attributed to factors outside the farmer's control (such as disease, weather). A one-sided component $U < O$ reflects technical insufficiency relative to the stochastic frontier.

Thus $U = O$ for farm output below the frontier as $N - (O, \quad U^{2} V)$. $\square$us equation (i) becomes

$Y = f(X_{a/}; \square^{u+v}$ ..... (3)

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Several empirical applications have followed the stochastic frontier specification. The first application of the frontier model to farm level data was by Bathese and Coelli (1995) who estimated deterministic and stochastic Cobb-Douglas Production frontier for the economics of scale in sheep production in Australia. The variance of farm effects was found to be in a highly significant proportion of the value of sheep production in Australia. Their study did not however, directly address the technical efficiency of farms. Similarly, Bagi (2004) employed the stochastic frontier Cobb-Douglas production function model to investigate differences in technical efficiencies of sole and mixed enterprise farm in West Tennessee. The study found that the variability of farm effects was highly significant. The mean technical efficiency of mixed enterprise farms was found to be smaller (0.76) than for sole crop farms (0.85).The study show that, mixed enterprise farms were inefficient as compare to the sole crop farms as demonstrated by their various efficiency ratios.

The use of the stochastic frontier analysis in the study of agriculture in Nigeria is a recent development. Such studies include that of Udoh (2003), Okike (2006) and Amaza (2000). Udoh (2003) used the maximum likelihood estimation of the stochastic production function to examine the land management and resource use efficiency in South-Eastern Nigeria. The study found a mean output-oriented technical efficiency of 77% for the farmers, this indicates that farmers can still expand production by 23%. The 0.98 indicates 98% for the most efficient farmers and 0.11 indicating 11% for the least efficient farmers. Okike (2006) investigated crop-livestock interaction and economic efficiency of farmers in the Savannah zones of Nigeria. The study found average economic efficiency of farmers are higher in the low-population – low market domain; Northern Guinea Sudan Savannah ecological zones; and crop-based Mixed Farmers farming system. Also Amaza's (2000) work on small scale farm size and resource use efficiency in Kwara State opined that, one of the means of proper utilization of farm inputs for greater efficiency is through farm size adjustment. The result was collaborated by the mean cost efficiency of 1.161 obtained from the data analysis which shows that an average farm in the sample area is about 16% above the frontier cost, indicating that they are relatively efficient in allocating their scarce resources.

METHODOLOGY

The Study Area

The study area is Benue State. Benue State derives its name from River Benue, the second largest river in Nigeria. Benue State was created in 1976 and is situated in the Middle-Belt region of Nigeria, approximately between latitude 6.20° and 7.55°N and longitude 7.30° and 9.40°. She has a total land area of about 30,955km^2. The state shares boundaries with five states namely: Nassarawa to the North, Taraba to the East, Cross River to the South-East, Enugu to the South and Kogi to the West. The South Eastern part of the state also shares boundary with the Republic of Cameroun. She is blessed with two rivers namely: River Benue and River Katsina-Ala (BNARDA, 1995). Benue State has an estimated population of 4,219,244 and is made up of 413,159 farm families (National Population Commission, 2006, 2009).

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Benue State is referred to as the "Food Basket of the Nation". The state has a tropical climate which manifests two distinct seasons. The rainy season is from April to October, while the dry season is from November to March. Annual average rainfall varies from 1750mm in the southern part to 1250mm in the North. Average temperature ranges between 32°C and 38°C with high humidity. The state has undulating hills and grassy open space in the North and derived Savannah in the South. About 80.1% of the state population is small scale farmers (BNARDA, 1995). The state is a major producer of food crops such as yams, beniseed, rice and sorghum. She is one of the notable producers of soya beans in the country. Tree crops such as cashew, mango, citrus and coconut also grow well in the state. Other crops produced in the state are sugarcane, cassava, millet, groundnuts, sweet potatoes and beans. This is in spite of the fact that small scale farmers most often make use of farmer-saved seed (Umeh, 1988). The livestock resources include goats, poultry, sheep and pigs which are traditionally reared on free range by small holder farmers (BNARDA, 1995). Benue State consists of 23 Local Government Areas and is broadly divided into three agricultural zones.

SAMPLING TECHNIQUE

The data were collected from primary sources using structured questionnaire from three local government areas, one local government each from the three agricultural zones. The selection was purposely based on the prevalence of the crop in the areas using multi-stage sampling technique. The local government areas selected are Katsina-Ala, Buruku and Agatu. In the second stage, two villages were randomly selected in each of the three selected local government areas. Finally, (third stage), from the sampling frame of population of farmers that was obtained from the zonal offices of BNARDA, 15% of the population of rice farmers in the selected local government areas were randomly selected as shown in table 1. These were administered with questionnaire.

Table 1: Distribution of respondents in the study area.

LGAs	Villages	Sample Frame	Sample size (15%)
Agatu	Obagaji	235	35
	Enumgbe	108	16
Buruku	Adi	205	31
	Dura	154	23
Katsina-Ala	Agber	181	27
	Afaakaa	127	19
Total	6	1010	152

Source: BNARDA, 2018

METHOD OF DATA ANALYSIS

Descriptive Statistics, Gross Margin Analysis, Ordinary Least Square (OLS) methods were used to analyse the results.

i. Descriptive Statistics: Percentages and frequency tables were used in the analysis of the socio-economic characteristics of the farmers.

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ii. Gross Margin Analysis: Gross Margin Analysis was used to analyse the profitability of Rice in the study area which is expressed as:

$GM = Pyi\ Yi - \Sigma Px_j\ X_j$

Where;

Gm = Gross Margin (N)

Pyj = Unit price of the output of rice (N)

Y_j = yield of Rice (kg/ha)

Pxi – unit price of input (N)

Xi = Total quantity of the input

Σ = Summation Sign

iii. Ordinary Least Squares (OLS) Model specification: Ordinary Least Squares (OLS) regression was used to obtain the farm production function. The Cobb Douglas Production function was used in this study and is specified as:

$$\ln Y = \ln\beta o + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + P_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \mu$$

Where:

Y = Rice output (kg)

X_1 = Farm size (ha)

X_2 = quantity of seed (kg)

X_3 = Herbicide (litre)

X_4 = Pesticide (litre)

X_5 = Quantity of fertilizer (kg)

X_6 = Labour (man days)

β_o = The intercept parameter

β_1 - β6 = Regression coefficients

μ = Random error term.

The coefficients were the marginal productivities of the corresponding inputs with respect to output. To ensure maximum profit and efficiency of resource, a famer must utilize resources at the level where their marginal value product (MVP) is equal to their marginal factor cost (MFC) under perfect competition (Kabir et al 2006). The efficiency of a resource was determined by the ratio of MVP of inputs (based on the estimated regression coefficients) and the MFC. The efficiency of resource is given as:

$r = {}^{MVP}/_{MFC}$

where r = Efficiency Coefficient

MVP = Marginal Value Product

MFC = Marginal Factor Cost of inputs Xi

MVP is obtained from the expression, $MVP = MPP \times P_y$

Where

MPP = Marginal Physical Product

And Py = Unit Price of output

The MPP is obtained from the estimated regression coefficient which are the elasticity of production (E).

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$MPP_{xi} = \frac{\vartheta y}{ox}$ but $Ex = \frac{\vartheta y}{ox} \quad \frac{x}{y}$

Hence $Ex \, X \frac{x}{y} = \frac{\vartheta y}{ox} = MPP_{xi}$ where $MVP_{xi} = E_x \, X \, \frac{y}{x} \, X \, P_y$

Y = Mean value of output,

X = Mean value of input X

MVP for each input will be obtained by multiplying the regression coefficient of that input with the ratio of the mean value of output and that input and with the unit price of output. MFC of each input will be obtained from data collected on the unit market prices of the various inputs during 2016 production season. The decision rule for the efficiency analysis is if:

r = 1; resource is been used efficiently

r > 1; resource is underutilized and increased utilization will increase output.

r < 1; resource is over-utilised and reduction in its usage will lead to maximization of profit

RESULTS AND DISCUSSION

The socio-economic characteristics of rice farmers were considered in this study because of their perceived effects on agricultural activities as shown in table 2. The mean age of farmers was 36 years which implies that the farmers are still in their active age and can make positive contribution to agricultural production. This is because the older the farmer, the more experienced he/she is expected to be. So, as the farmers grow older, they will acquire more experience which will help them in decision making. 98 farmers representing 64% of the sample had formal education. That means they could read and write in the English language and interpret message relating to their farm operation in the instruction manuals on input and machinery uses as well as appraise extension services. Response in farming experiences shows that 39 percent of the farmers in the study area had been cultivating rice for a period of 16-25 years. This implies that farmers in the study area have been in farming profession for quite some period of time and are not new comers to rice production.

The average farm size for rice in the area was 1.5 ha which implied that farmers in the study area generally cultivate rice on small size terms. This agrees with the fact that Nigeria rice production is characterized by small size farms. This could pose a hindrance to mechanization and commercialization of rice production, given rise to foot insecurity. The household size of most farmers (59%) ranged between 1-6 members. This is considered to be small by African standards. Although large family size can sometimes be an asset to the famers in terms of available work force, often times a farmer is faced with the challenges of providing social and welfare facilities such as feeding, education, sheltering, health care and other living expenses for such a large number of dependants. Those expenses account for low saving at the end of every harvest season. Apart from the fact that most farm produce are consumed by the large household member, majority of the farmers (96%) are members of co-operative societies with 50 percent spending 1-5 years with a cooperative society. Naturally, membership of Cooperative societies enable farmers to benefit from credit facilities from formal and semi-formal financial institutions since such requirement is one of the determinant factors. Also, majority of the farmers (88 percent) have access to

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extension services and considering that 99 percent had more than six years of farming experience, the managerial ability of the farmers can be inferred to be reasonable. This finding is in agreement with that of Obare et al (2010) that the number of years of farming experience has a positive and significant relationship with a farmer's economic efficiency. Again through extension visit, farmers become better informed about farm management planning and new technologies hence improving their efficiency in production. This agrees with Mbanasor and Kalu (2008) that the number of extension visits had a significant positive relationship with economic efficiency of commercial vegetable farmers in Akwa Ibom State, Nigeria.

Table 2: Distribution of Rice farmers by socio-economic characteristics

Variable	Frequency	Percentage
Age (years)		
20-30	20	13.16
31-40	90	59.21
41-50	20	15.16
51-60	12	7.89
60 and above	10	6.58
Education		
Non-formal	54	35.53
Formal	98	64.47
Farming experience (years)		
6-15	30	19.74
16-25	60	39.47
26-35	50	32.89
36 & above	12	7.89
Farm size (HA)	104	68.42
0.1-2.0	38	25.00
2.1-4.0	10	6.58
4.1 & above		
Household size (adult equivalent)		
1-5.9	89	58.55
6-10.9	24	15.79
11-15.9	23	15.13
Mean (AE)	16	10.53
Co-operative Society (years)		
0	58	38.16
1-5	76	50.00
6-11	10	6.58
12 & above	08	5.26
Extension Contact		
1-3	13	87.50
4-7	15	9.87
8 & above	4	2.63

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Source: Survey data, 2018

Profitability Analysis of Rice Production

Profitability is an important criteria for measuring efficiency. However, profitability cannot be taken as a final proof of efficiency. Sometimes satisfactory profits can mark inefficiency and conversely, a proper degree of efficiency can be accompanied by an absence of profit. The net profit figure simply indicates a satisfactory balance between the values received and value given (James and John, 2005). The profitability analysis (Gross Margin) presented in table 3 has shown that the total variable cost (TVC/ha) incurred by the respondents was ₦123,500/ha, with an average gross income (GI) of ₦180,000/ha, which resulted to a gross margin (GM) of ₦56,500/ha. A confirmation of profitability of Rice production is shown by the gross margin (GM) of ₦56,500/ha and an operating ratio of 0.69 with returns on every naira invested of ₦0.46. The finding is in agreement with that of Ngaski et al (2009) who reported that 34.2 percent of a sample of beneficiaries of Fadama II project in Yauri Emirate, Kebbi State earned over ₦150,000 per season.

Table 3: Gross Margin of Rice per hectare cultivated

Description	Average quality	Unit price	Value ₦/ha
Gross Income (GI)			₦180,000
Inputs			
Seeds (kg)	50	1000	50,00
Herbicides (litres)	85	3,000	25,000
Fertilizer (kg)	200	100	20,000
Labour (many days)	160	175	28,000
Total variable cost (TVC)			**123,500**
Gross Margin (GM)			**56,500**
Returns to investment (GM/TVC			**0.46**
Operating Ratio (Toc/GI)			**0.69**

Source: Computed from field survey, 2018

Input-output Relationship in Rice Production

Ordinary Least Square (OLS) estimate for inputs-output relationship in rice production as shown in table 4 indicates that the coefficient estimate of the input (farm size, seed, herbicide and labour) have positive and statistically significant relationship with the output of rice at 1% and 10% level of probability. This implies that a unit increase in any of these variable inputs (farm size, seed, herbicide and labour) in rice production holding all other explanatory variables constant will lead to an increase in the output. Higher seed rates, all things being equal, implies a greater yield. The same thing applies to herbicides, farm size and labour. As long as these inputs are not overused, it is expected that it will lead to an increase in output. Furthermore, the adjusted R^2 shows that the input variables explained 49.52% variations in the output of rice farmers in Benue State. Also, the null hypothesis which states that there is no statistically significant difference in the input-output relationship in rice production was rejected, since the test statistics with an F-statistic of 10.3301 was significant at 1% level of significance. The results were similar to that of Baba

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and Wando (1998) in their study on Resource Use, crop yield and farm income in Niger State.

Table 4: Ordinary Least Square (OLS) estimates for input-output relationship in Rice.

Variables	Coefficients	Standard Error	T-Stat
Intercept	5.0358***	0.7351	7.1345
Farm size (x_1)	0.5704***	0.2031	3.1425
Seed (x_2)	0.7617***	0.2716	2.8815
Herbicide (x_3)	12.1453***	4.7501	3.2460
Fertilizer (x_4)	0.0911	0.2781	0.3254
Labour (x_5)	3.0166*	1.6533	1.7003
Adjusted R	**0.4952**		
F Statistics	**10.3301**		
Observations	**152**		

Source: Computed from field survey data, 2018
*** P<0.01 * P<0.01

Resource Use efficiency in Rice Production

Results on resource use efficiency is presented in table 5. It can be observed from the table that seed, herbicide and labour were the inputs being under-utilised as their efficiency were greater than one respectively. To increase output, there is the need for the farmers to increase the utilization of seed, herbicide and labour. On the other hand, farm size and fertilizer were over utilized as their efficiency coefficients were less than one respectively. This implies that there is the need for the farmers to decrease the utilization of these inputs in order to increase the output of rice in the study area. The summation of the regression coefficients in table 5 shows a return to scale index (RTS) of 16.4751 which implies that rice production is characterized by an increasing return to scale. That is if all inputs can be increased by 100 percent, the output of rice will increase by 47 percent. The implication of this result is that as rice production expands, farmers will enjoy economics of production and as such, they may be able to employ better equipment and borrow cheaply and procure services of efficient labour with a view to making more profit.

Table 5: Resource use efficiency in Rice Production

Variables	MPP	MVP	MFC	$R = \frac{MVP}{MFC}$	Efficiency Gap
Farm sixe (X_1)	0.5915	120.57	295.00	0.4087	174.43
Seed (X_2)	0.7618	146.10	121.14	1.2060	24.96
Herbicide (X_3)	12.1353	236.24	771.47	3.0632	1591.77
Fertilizer (X_4)	0.0800	15.30	64.53	0.2370	49.23
Labour (X_5)	2.9265	522.14	420.51	1.2416	101.63
Total (RTS)	16.4751				

Source: computed from field survey data, 2018

CONCLUSION

The study has revealed that rice production is a profitable and viable economic means of earning a livelihood. The farmers were found to be efficient in the use of seed, herbicides and labour as their efficiency were greater than one. On the other hand, farm size and fertilizer were over utilized as their efficiency coefficients were less than one. This means that enough potential exist for increased rice production in the study area. Rice production could be increased through appropriate use of seeds, herbicides and labour. The findings of the study implies that financial institutions should consider making more credit available to rice farmers in the study area so as to enable them increase the use of the inputs that were underutilized. The Federal and State Governments and donor agencies should intensify efforts aimed at introducing labour saving devices such as mechanization to avert inefficiencies associated with the use of manual labour in the state. Also, more extension workers should be deployed in the study area to educate the rice farmers on the need for increased use of hire labour, seeds and also the right quantities of fertilizers and farm size to be cultivated so as to promote profitable rice production

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