Asian Journal of Agricultural Extension, Economics & Sociology

39(1): 82-95, 2021; Article no.AJAEES.64477
ISSN: 2320-7027

Economics of Rice Production among Beneficiaries of Anchor Borrowers Programme in Gerie Local Government Area of Adamawa State, Nigeria

A. Bitrus[1*], H. Yakubu[1], T. Patrick[1] and S. F. Stephen[1]

[1]Department of Agricultural Economics, University of Maiduguri, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author AB designed the study and wrote the protocol and first draft of the manuscript. Author HY carried out the statistical analysis and authors TP and SFS supervised the study and literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAEES/2021/v39i130505
Editor(s):
(1) Dr. Muhammad Yaseen, University of Sargodha, Pakistan.
Reviewers:
(1) Pramod Kumar, Indian Agricultural Research Institute, India.
(2) Bindia Dutt, College of Community Science CSKHPKV, India.
Complete Peer review History: http://www.sdiarticle4.com/review-history/64477

Original Research Article

Received 18 November 2020
Accepted 22 January 2021
Published 13 February 2021

ABSTRACT

This study examined the economics of rice production among beneficiaries of the anchor borrowers programme (ABP) in Gerie LGA of Adamawa State, Nigeria. Multistage random sampling was employed to select respondents for the study. Structured questionnaires were the instruments used for data collection. A sample of 85 farmers was used for the study. Percentages, means, frequency, maximum, minimum, budgetary techniques and stochastic frontier production function were the analytical tools employed. The results of the socioeconomic characteristics of the respondents revealed that the majority (76%) of the farmers was headed by males; most (72.8%) were within the age range of 30 – 49 years and majority (90%) were married. Results from the budgetary techniques showed that the gross margin per hectare was ₦75,087.4 indicating production of rice among the farmers is profitable since the gross margin estimated has a positive value. The result also showed that mean economic efficiency (EE) recorded was 0.67 (67%), with maximum of 0.94 (94%) and a minimum EE of 0.34 (34%) indicating that the respondents are not fully economically efficient in rice production in the study area. The major constraints faced by rice farmers in the study area were identified among others to be inadequate credit, limited farm size and high cost of

**Corresponding author: E-mail: amosbits@gmail.com;*

transportation. Finally, it was recommended among others that policies geared towards investment in credit, land tenue and means of transportation towards achieving effective production should be formulated.

Keywords: Production; ABP; budgetary techniques; stochastic frontier production function; Gerie LGA Adamawa State; rice farmers.

1. INTRODUCTION

Rice (*Oryza sativa)* is one of the world's most important cereals, being the staple food for over 50% of the world population [1]. Among the cereal grains, rice is the second only to wheat in terms of total world production. A recent Food and Agriculture Organization (FAO) puts the 2017 world wheat production at 756.8.92 million tons followed by rice which is 504.6 million tons [2]. Rice cultivation is the principal activity and source of income for millions of households around the globe. It is a crop that cuts across regional, religious, cultural, national and international boundaries. China and India supply over half of the world's rice. Brazil is the most important non-Asian producer, followed by North and Central America. Nigeria ranks second in Africa after Egypt [3]. Today, rice is grown and harvested on every continent except Antarctica, where condition makes its growth impossible [4].

In Nigeria, Rice is cultivated and consumed in all parts of the country and is one of the major staple crops grown on over 3.2 million hectares of land [5]. Its production is primarily done by small-scale farmers, who do not measure their efficiency of production. Rice ranks sixth after sorghum, millet, cowpea, cassava and yam in Nigeria [6]. Its production in the country rose from 2.4 million metric tons in 1994 to 5.8 million metric tons in 2017, [2]. During the 1960's, the country had the lowest per capita annual consumption of rice in the West African sub-region with an annual average of 3kg. Since then, Nigeria's per capita rice consumption levels have grown significantly at the rate of 7.3% per annum [7]. Despite the rise in domestic production of the crop, still the demand/consumption far exceeds the local production. Nigeria's inability to meet her rice consumption needs through local production has resulted in high cash outlays for importation from a high level of US$ 60 million in 1994 to US$ 2.24 billion in 2010 [8].

In order to address the demand and supply gap in rice production, numerous agricultural programmes and policies were implemented over the years with the objective of increasing production by providing incentives to rice farmers for achieving rice self-sufficiency. These programmes include Federal Rice Research Station (FRRS) (1970), Abakaliki Rice Project (ARP) (1978), Presidential Initiative on Rice (PIR) (1999), National Rice Development Strategy (NRDS) (2009), and Rice Intervention Fund (RIF) (2011). However, most of these programmes and policies were terminated without achieving their objectives [9]. It is therefore necessary to measure the current production of the farmers, with the intention of reexamining the policy alternatives available for raising the present level of rice production. In order to address the problem of demand-supply gap in rice production in Nigeria, the Federal Government launched the Anchor Borrowers Programme (ABP).

The ABP was launched in 2015 to boost local production of rice and wheat [10]. The programme was initiated by the Central Bank of Nigeria (CBN) in its economic diversification drive to create an ecosystem that will link out-growers to integrated millers; ramp up domestic rice production to replace imported rice; increase operating capacity of integrated rice millers; and increase banks financing to the rice sector; build capacity of smallholder farmers; and target commodities which the country has comparative advantages to produce. ABP aims to make agriculture more productive and sustainable.

The ABP was introduced in 2017 in Adamawa State targeting rice production. Rice is one of the most important cereal crops grown in the State and is consumed in a variety of ways, its cultivation is merely on a small-scale basis using an unimproved farming system [11]. Adamawa state however produces about 4 percent of the total rice output in Nigeria. Despite the availability of fertile land and good climate conditions for rice production, there is still low productivity of rice in the state [12]. The average yield of rice in Adamawa State was 3240 kg/ha (3.2ton/ha) in 2018, which is lower than the average yield of 3.3 ton/ha in 2017 [13]. The ABP therefore was launched to address the problem of low rice production as well as to improve farmers' standard of living in the state. The programme provides cash for labour and inputs packages such as improved seed, fertilizer and agrochemicals to farmers to support rice production. It embodies management and cultural practices which if implemented can solve the problem of demand-supply gap in rice production in Gerie Local Government Area, Adamawa State.

The objective of the study was to analyses the economics of rice production among beneficiaries of ABP in Gerie Local Government Area, Adamawa State; while specific objectives were to examine the socio-economic characteristics of rice farmers; determine the cost and returns associated with rice production; determined technical, allocative and economic efficiencies of rice production and determined the constraints associated with rice production.

2. METHODOLOGY

2.1 Background to the Study Area

The study was carried out in Girei Local Government Area of Adamawa state. The area lies between latitude $9^{o}\ 11^{1}$ and $9^{o}\ 39^{1}$ North and Longitude $12^{o}\ 21^{1}$ and $12^{o}\ 49^{1}$ East. The local government is boarded by Song Local government area in the north, Fufore local government area in the east, while river Benue acts as a physical boundary between the local government area and Yola North and Demsa local government areas (Adebayo. 1999). It has a total population of 129,855 persons [14].

Girei LGA experiences dry and wet seasons with temperature and humidity varying with seasons. The local government area falls under the Sudan Savannah type of vegetation and it experiences distinct dry and wet seasons with temperature and humidity varying with seasons [15]. The wet or rainy season falls between April and November, which is characterized by some single maxima in August. Seventy percent of the total rainfall in the area happens to fall within four months of May –August. The area has an average of 62 rainy days while the average amount of rainfall recorded in the area is 972mm. The dry season which is the harmattan period is between December to March.

Temperature in Girei is relatively high all year round. The temperature of Girei ranges from 27-40°C. The coldest months which are December and January are of the average temperature 15°C, while the hottest period within the area being April and May with an average temperature of 34°C. It has an average minimum temperature of 25^{0}C and maximum temperature of up to 40^{0}C [16].

The monthly global solar radiation is not uniform throughout. The peak of radiation being the month of March, April, May and June. The least value of global solar radiation is in January; this could be explained in terms of peak of cold harmattan season. The wet season is basically during the months of August and September [17]. The major crops grown in the area include: maize, groundnut, rice and cowpea.

2.2 Sampling Procedure

A multistage sampling procedure was employed to select farmers for the study. The first stage involved a purposively selection of seven villages with the highest number of beneficiaries in ABP and that are prominent in rice production and accessible with regards to security, out of the twenty-five adopted villages. These villeges are; Mudari, Tambo, Daneyel, Damare, Labondo, Girei and Viniklang. The second stage involved estimation of sample size from the sample frame using (equ 1) [18]. Finally, the number of respondents in each village were selected randomly using (equ 2) [19] as shown in Table 1. Using the sampling frame, 90 farmers were randomly chosen. However, 85 questionnaires were used for analysis. This was necessary because some vital information was not satisfactory provided in some of the questionnaires. The sampling frame is the list of rice farmers benefiting from ABP in the selected villages which was obtained from Adamawa State Agricultural Development Programme (AADP) office.

The sample size for the study was calculated using:

$$n = \frac{N}{1 + N(e)^2} \quad (1)$$

Therefore, sample size (n) = $\frac{900}{1 + 900(0.1)^2}$

n = $\frac{900}{10}$ = 90

Where

n = Sample size
N = Population size
e = level of precision

The number of respondent in each village was obtained with the help of the formula below as shown in Table 1

$$NI = \frac{n}{N} \times Ni \quad (2)$$

Where

NI = sample size in each village
n = total number of sample size
N = total number of farmers in the targeted population, that is total sample frame
Ni = total number of farmers in each village

2.3 Data Collection

The data for the study were collected from both primary and secondary sources. Primary data were collected through administration of structured questionnaires. Trained enumerators were used to assist in data collection. The questionnaires sought information relating socioeconomic characteristics of rice farmers, environmental and institutional factors relevant to the study. It also featured questions that elicit information on production variables used and outputs obtained with prices paid and received respectively on rice production in 2018 cropping season. The secondary data were obtained from the records of Adamawa State Agricultural Development Programme. The secondary information entailed the list of ABP beneficiaries.

2.4 Analytical Techniques

Data collected were analysed using descriptive statistics, budgetary techniques and inferential statistics.

2.5 Descriptive Statistics

These were used in analysing the socio-economic characteristics of the respondents and the constraints associated with rice production. The tools used include mean, percentages and frequency distribution.

2.6 Budgetary Techniques

The budgetary technique used was the gross margin analysis. This was used to determine the cost and returns associated with rice production.

The gross margin is expressed as

$$GM=GR-TVC \quad (3)$$

Where
GM=Gross margin of rice production (₦/ha)
GR= Gross Revenue (₦/ha)
TVC= Total Variable Cost (₦/ha)

The gross margin analysis was used under the assumption that fixed cost of production is negligible.

2.7 Efficiency Analysis

The stochastic frontier production function was used in efficiency analysis. The use of this stochastic frontier production function has some important advantages in that it allows the decomposition of the error term into random error and inefficiency effects rather than attributing all errors to random effects [20]. The model specified output (Y) as a function of inputs (X) and a disturbance term (a).

$$Y_i=f(X_i:ß) + (V_i-U_i) \quad (4)$$

Where

Y_i= output by i^{th} farmer
X_j= Input quantities of the j^{th} firm
ß= Vectors of unknown parameters
V_i= Assumed to account for random factors such as weather, risk and Measurement error
U_i= due to technical inefficiency.

2.8 The Explicit Stochastic Frontier Production Function

This model was applied to be accomplished by maximum likelihood estimation (MLE) available in frontier 4.1 version, this technique was developed by [21] and has been used extensively by various authors in estimating efficiencies among crop farmers. It employs a cobb-Douglas production function to simultaneously estimate the random disturbance term (V_i)which is outside the control of the production unit and inefficiency effects (U_i).

The explicit form of the function is specified as follows:

$$LnY_1=ß_0+ß_1lnX_1+ß_2lnX_2+ß_3lnX_3+ß_4lnX_4+ß_5ln X_5+ß_6lnX_6 +V_1-U_1 \quad (5)$$

Where:

Y=Output of rice in kg
X_1= Cultivated land area for rice in hectares
X_2= Quantity of fertilizer in kg
X_3= Quantity of rice seed planted in kg

X_4= Quantity of herbicide used in litres
X_5= Family labour used (in man-days)
X_6= Hired labour used (man-days)
V_1= random error term with normal distribution
U_1= a non-negative random variable called technical efficiency effects associated with technical inefficiency of production of farmers involved.
Ln= the natural logarithm (i.e to base e)
$ß_0$-$ß_6$= parameters to be estimated.

The technical efficiency of rice production for i[th] farmer, is defined by the ratio of observed product as to the corresponding frontier production associated with no technical inefficiency. (Y*/Y)

$$TE=Exp\ (-U_i) \text{ so that } 0\leq TE \leq 1 \quad (6)$$

Variance variable parameters are:

$$\sigma^2= \delta^2_v+ \delta^2_u \text{ and } i= \delta^2_u/ \delta^2 \quad (7)$$

The inefficiency is defined as:

$$U_1=\delta_2+\delta_1Z_1+ \delta_2Z_2+ \delta_3Z_3+ \delta_4Z_4+ \delta_5Z_5+\delta_6Z_6+ \delta_7Z_7 \quad (8)$$

Where:

U_1=inefficiency effects
Z_1= Age of farmers (in years)
Z_2= Literacy level (in years)
Z_3= Farming experience (in years)
Z_4= Extension contact (1 contacted, 0 not contacted)
Z_5=Gender of the farmer (1 male and 0 female)
Z_6= Family size (total number of person in the household)
Z_7= Access to formal credit (1 access to credit and 0 no access to credit)

2.9 The Explicit Stochastic Cost Function

The corresponding cost function was adopted in the estimation of total cost of production as applied by [22] which is specified as follows:

$$LnC_i=ß_o+ß_1lnF_1+ ß_2lnF_2+ ß_3lnF_3+ ß_4lnF_4+ ß_5lnF_5+ V_i+Ui \quad (9)$$

Where:

C_1= Total cost of production of the i[th] farmer
F_1= Cost of acquiring land (₦)
F_2= Cost of fertilizer
F_3= Cost of herbicide used
F_4= Cost of hired labour (in man-days)
F_5= Cost of ploughing (tractor and animal traction)

The allocative efficiency of individual farmer is defined in terms of the ratio of predicted minimum cost (C_1) given the available technology

$$AE=C_1^*/C_1=f\ (P_1, \gamma_1, ß) + (V+U)/ f(P_1, \gamma_1,:ß) + (V)= exp\ (U) \quad (10)$$

Where:

AE= allocative efficiency
C_i^*= the observed cost and represent the frontier total production cost or least total
C= Predicted minimum cost

AE ranges between Zero and one with one referring to allocative efficiency. The cost inefficiency effects are also defined as:

$$a_1=\delta_o+ \delta_1Z_1+ \delta_2Z_2 + \delta_3Z_3 + \delta_4Z_4 + \delta_5Z_5 + \delta_6Z_6 + \delta_7Z_7 \quad (11)$$

Where:

U_1= Allocative inefficiency effects
Z_1= Age of farmers (in years)
Z_2= Literacy level (in years)
Z_3= Farming experience (in years)
Z_4= Extension contact (no of contact per month)
Z_5= Gender of the farmer (1 male and 0 female)
Z_6= Family size (total number of person in household)
Z_7= Access to formal credit (1 access to credit and 0 no access to credit)

Economic efficiency combines both the technical and allocative efficiency

3. RESULTS AND DISCUSSION

3.1 Socio-Economic Characteristics of the Farmers

The socio economic characteristics of the rice farmers discussed here include age, gender, marital status, farming experience, level of education, land ownership, farm size, extension contact, access to credit and labour utilization.

Table 1. Distribution of respondents in the study area

Local government area	Villages	Sample Frame	NI=$\frac{n}{N} \times Ni$	Sample size
Girei	Mudari	102	(90/900) ×102	10
	Tambo	94	(90/900) ×94	9
	Daneyel	181	(90/900) ×181	18
	Damare	96	(90/900) ×96	10
	Labindo	84	(90/900) ×84	9
	Girei	154	(90/900) ×154	15
	Viniklang	189	(90/900) ×189	19
Total		900		90

Source: Reconnaissance survey, 2019

The result in Table 2 on age distribution of the respondents shows that 72.8% were within the age ranges of 30-49 while only 5% of them were 60 years and above. The maximum age was 62 years and the minimum age was 22 with a mean age of 41 years. This finding further revealed that majority of the farmers in the study area are relatively young and physically active thus they are expected to possess energy needed to carry out rice production which demand much energy for its cultivation which is in line with the findings of [23] who carried a study on the analysis of the technical efficiency of rain-fed farmers in Taraba state, posited that youth are vibrant and economically productive.

The result on the gender analysis of the respondents in the study area revealed that male farmers constitute the majority (76%) while only few (26%) were female which implies that there are more male farmers than female farmers engaged in rice production among the beneficiaries in the study area possibly because male could exert more physical labour that is required for such enterprise as posited by [24] in their study on Econometric analysis of rice production in Anambra state.

Results of the analysis on marital status in Table 2 shows that the majority 90% of the respondents are married, 5% are single,4% are widows/widowers while only 1% is divorced. This implies that family labour is likely to be abundant for the family which may provide a large cheaper source of labour for cultivation [24].

The result of family size of the respondents in Table 2 shows that many (42.4%) of the respondents have 6-10 persons in their household, 30.6% have 11-15 persons in their household and 18.8% have 1-5 persons while 8.2% have 16 and above as their household size. The mean family size is about 10 persons while the maximum and minimum number of persons per family is 31 and 1 respectively. The implication is that farmers have enough family labour force for rice production as posited by [25] in their study on Economic Analysis of Rice Production in Cross River State.

Distribution of farming experience of the respondents as shown in Table 2 reveals that many (43.5%) of the respondents had farming experience of 6-10 years. 21.2% had between 11-15 years, 16.5% had between 16-20 years while 8.2% and 10.6% are within the ranges of 1-5 and >20 respectively. The mean family experience was 13.2 years and the maximum was 35 years while the minimum experience recorded among the respondents was 2 years which implies that farmers in the study area have considerable experience in rice farming capable of boosting their efficiency level and their productivity as well. This is in agreement with [26] who reported that years of farming experience improve productivity and overall efficiency in food crop production in their study on Analysis of Technical Inefficiency in Food Crop Production Systems among Small-scale Farmers in some Selected Local Government Areas of Adamawa State.

The result of the literacy level of respondents as stated in Table 2 reveals that 83.3% of the respondents had some form of formal education. Thus, literacy level is high among the respondents and this could have implications for agricultural production in the area. This result is in line with [26] who reported that Education affects productivity through a choice of better inputs and output, and through a better utilization of existing inputs. This will reduce technical inefficiency in food crop production.

3.2 Gross Margin Analysis

The cost and return of production was estimated using the gross margin technique. The result

Table 2. Socioeconomic characteristics of the rice farmers (n=85)

Socioeconomic Variables	Frequency	Percentage	Mean	Maximum	Minimum
Age					
<29	7	8.2			22
30 – 39	33	38.8			
40 – 49	29	34	41		
50 – 59	12	14			
> 60	4	5		62	
Gender					
Male	65	76			
Female	20	24			
Marital Status					
Single	4	5			
Married	77	90			
Divorced	1	1			
Widow/widower	3	4			
Family Size					
1 – 5	16	18.8			
6 – 10	38	42.4	10		
11 – 15	26	30.6			
> 16	7	8.2			
Farming Experience					
1 – 5	7	8.2			2
6 – 10	37	43.5			
11 – 15	18	21.5	13.2		
16 – 20	14	16.5			
> 20	9	10.6		35	
Literacy Level					
No Formal	14	16.5			
Primary	17	20			
Secondary	28	33			
Tertiary	26	30.5			

Source: Field Survey, 2019

Table 3. Average cost and returns/per hectare for rice farmers

Variable	Value (₦)	Percentage Share total in variable cost
Cost of rent on land	1,372.2	2.1
Cost of fertilizer	15,023.9	23.2
Cost of herbicides	6,510.8	10.1
Cost of labour	22876.6	35.4
Cost of ploughing	10,315.6	15.9
Cost of empty sacks	2,195.6	3.4
Cost of transportation	6,401.8	9.9
TVC/ha	64,696.4	
B: Return		
Total output (Kg)	395,200	
Total Revenue per ha	139,783.8	
C: Gross Margin		
Gross Margin/ha	75,087.4	

Source: Field Survey, 2019

shows that the average variable cost per hectare was₦64,696.4 and the total revenue per hectare was ₦139,783.8. The gross margin per hectare was ₦75,087.4. The result further revealed that labour constitutes about 35.4% of the total variable cost followed by the cost of fertilizer which constitutes 23.2% of the variable cost. Cost of rent on land (21%) has the least. However, the finding revealed that the production of rice among Anchor borrowers programme beneficiaries in Girei local government area is profitable since the gross margin estimated has a positive value.

3.3 Efficiency Estimation of the Respondents

This section presents the result of the analysis of the factors that determines the technical, allocative and economic efficiencies in rice production in the study area. These efficiencies of the farmers were estimated using stochastic frontier production functions.

3.3.1 Technical efficiency estimation

The maximum likelihood estimates (MLE) of the production function was employed to explain the influence of the explanatory variables (production inputs) on the output of rice and also the effects of each of the variables on the technical efficiency of the farmers. Table 4 shows that all the variables carry the expected positive signs and were also found to be significant except for the quantity of herbicide used and hired labour which were not significant. This implies that an increase in the use of any of these variables would bring an increase in output of rice in the study area. The elasticity estimates (β_1-β_6) of the explanatory variables were all positive, indicating that they are important determinants of the output. The sum of the elasticities is 1.24 indicating increasing returns to scale, this shows that the farmers were operating in Stage I of the production surface meaning that the efficiency of the resource use has not attained an optimum level (below the production frontier). Therefore, increase in input allocation *ceteris paribus* would result in more than a proportionate increase in output.

The sigma squared (0.16) is statistically different from zero at 1% level. This indicates a good fit and the correctness of the specified distributional assumption of the composite error term. Also, the variance ratio defined by Gamma (γ), was estimated at 0.74 and is statistically significant at 1% level implying that the existence of technical inefficiency among the farmers account for about 73.87% of the variation in the output of rice grown in the area. It also implies that the effect of technical inefficiency is significant and that a classical regression model of production function based on ordinary least squares estimation would be an inadequate representation of the data. Thus, the diagnostic statistics confirm the relevance of the stochastic production function.

Farm size was significant at 1%. It is one of the most important factors of rice production. The elasticity coefficient of farm size (x_1) was 0.84 which indicates that a unit change in farm size would bring about 84% increase in the total output of rice in the area. This is in agreement with the findings of [27] on the determinants of food crop production and technical efficiency in the northern guinea savanna of Borno State, Nigeria, that farm size is a major factor associated with changes in the output of food crops.

Quantity of fertilizer was significant at 5% with elasticity of 0.076 implying that a unit increase in the quantity of fertilizer applied would lead to an increase in output by 8%. Quantity of seed is significant at 5% implying that it is also an important factor in rice production. Seed used had an elasticity coefficient of 0.112 which means that a unit increase in the quantity of seed used would bring about 11% increase in the quantity of output produced which is in agreement with the findings of [28] on determined the farm-level technical efficiency in maize production among farms in Yola North and South Local Government areas of Adamawa State, who revealed that material inputs (fertilizer and seed) contributes to output.

Family labour was significant at 1% with the elasticity coefficient of 0.15 implying that a unit increase in the family labour will lead to an increase in output by 15%, this also implies that families with larger house size have a better chance of improving their output. This is similar to the findings of [29] who found out that family labour influences the technical efficiency level of farmers.

The inefficiency model revealed that age (z_1), literacy level (z_2), extension contact (z_4) and family size (z_6) were significant. Age of the rice farmers (z_1), literacy level (z_2) and extension contact (z_4) were all significant at 1% and also carry the expected negative signs, implying that the variables are highly important determinants of technical efficiency in rice production in the area.

Table 4. Maximum likelihood estimates of the parameters of the stochastic frontier production function

Variable	Parameters	Coefficient	Standard error	t-ratio
Production factors				
Constant	β_0	3.064	0.189	16.212***
Farm size (x_1)	β_1	0.839	0.120	6.978***
Quantity of fertilizer (x_2)	β_2	0.076	0.014	2.057**
Quantity of seed (x_3)	β_3	0.112	0.466	2.413**
Quantity of herbicide (x_4)	β_4	0.052	0.055	2.752***
Family labour (x_5)	β_5	0.152	0.055	2.752***
Hired labour (x_6)	β_6	0.015	0.015	1.013
Inefficiency effects				
Age (z_1)	δ_1	-0.248	0.081	-3.073***
Literacy level (z_2)	δ_2	-0.757	0.229	-3.313***
Farming experience (z_3)	δ_3	0.206	0.288	0.715
Extension contact (z_4)	δ_4	-0.255	0.046	-5.502***
Gender (z_5)	δ_5	-0.036	0.055	-0.656
Family size (z_6)	δ_6	-0.160	0.066	-2.430**
Access to credit (z_7)	δ_7	0.074	0.055	0.013
Diagnostic statistics				
Log likelihood ratio	LR	79.97*		
Sigma squared	(σ^2)	0.158	0.030	5.221***
Gamma	(γ)	0.739	0.215	3.441***

Source: Computer output from Frontier 4.1

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

The coefficient of age (δ_1) being -0.248 implies that 24.80% reduction in technical inefficiency of rice farmers in the area can be attributed to the age of the farmers. This implies that the age of the rice farmers is positively related to technical efficiency of rice production in the area. Literacy level has a coefficient of -0.757 on the technical inefficiency model, implying that 75.70% reduction in inefficiency of rice farmers in the study area can be due to literacy level of the farmers. The implication of this is that education plays a vital role in skills acquisition and technology transfer. It enhances innovation, adoption and ability of the farmers to plan and take risks. Farmers with higher levels of education are likely to be more efficient in the use of inputs than their counterparts with little or no education. This finding agrees with comparable findings by [27] and [30] who also found a positive relationship between education and technical efficiency. The coefficient of extension contact being -0.255 and statistically significant at 1% level indicates that increased extension services to farmers tend to decrease technical inefficiency 25.50% in rice production. Extension visits affords the farmer the opportunity to learn improved technologies and how to acquire the needed inputs and services.

Family size was also found to be an important variable, as it is significant at 5% and has a coefficient of -0.160 indicating that family size reduces technical inefficiency of rice farmers in the study area by 16.00%.

3.3.2 Allocative efficiency estimation

The maximum likelihood estimates of the stochastic frontier cost function shows that the entire coefficients were positive and carry the expected signs meaning that increase in the cost of all the variables will increase cost of production in the study area. The entire coefficients were significant at 1%. However, the result implies that all the variables have a significant relationship with the total cost of rice production in the study area. By implication 1% increase in the cost of land, fertilizer, herbicide, hired labour and cost of ploughing will increase total cost of production by approximately 1.90%, 4.80%, 59.90%, 3.90% and 3.40% respectively.

Similarly, the inefficiency effects revealed that all the coefficients were negative and carry the expected sign except for literacy level which carries the positive sign. A negative coefficient implies positive effect on cost efficiency and vice-versa. This signifies that with the exception of the literacy level (z_2), all other variables have influence on the rice farmers' efficiency in cost allocation.

The estimated coefficient of age of the farmers was negative and statistically significant at 1% indicating that increased age of the farmers tend to decrease cost inefficiency in rice production in the study area.

Extension contact z_4 and family size z_6 were statistically significant at 1% while gender of the farmer z_5 is statistically significant at 5% level indicating that gender also has a significant effect in reducing inefficiencies in rice production in the study area.

Sigma squared (δ^2) is statistically different from zero and also significant at 1% level, implying the presence of good fit and the correctness of the distributional form assumed for the composite error term in the model. Gamma (γ) was found to be 0.84 and is statistically significant at 1%. This means that 84% variation in output was accounted by variation in their efficiency in cost allocations.

3.3.3 Technical efficiency of the respondents

The distribution of farmers' technical efficiency (TE) indices extracted from the stochastic production function analysis is presented in Table 6. Generally, the technical efficiency of the farmers is less than 1.0, indicating that rice farmers in the study area are producing below the maximum efficiency frontier. There exists a difference in technical efficiency among the rice farmers. This implies that the best farmers (16.5%) were within a technical efficiency range of 0.90-0.99, while about 18.8% were regarded the least with technical efficiency range of 0.5-0.59. The mean technical efficiency is 0.76 (76%) which means that, on the average, the respondents were able to obtain over 76% of optimal output from a given mix of production inputs. Thus their mean technical efficiency can be increased by 24% to attain the technical efficiency frontier. The maximum technical efficiency recorded among the farmers is 0.98 (98%), the farmer has five years of farming experience, had a farm size of 1 hectare, planted 50kg of seed, harvested 17bags (100kg) of rice and had total revenue of ₦136,000. On the other hand, the minimum technical efficiency recorded is 0.54 (54%). For the farmer with the least technical efficiency 0.54 to attain the highest farmers' specific technical efficiency in the population, the farmer requires an efficiency gain of 0.44 (44%).

Table 5. Maximum likelihood estimates of the parameters of the stochastic frontier cost function

Variable	Parameters	Coefficient	Standard error	t-ratio
Cost factors				
Constant	β_0	2.043	0.174	11.731***
Cost of land (f_1)	β_1	0.019	0.006	3.207 ***
Cost of fertilizer (f_2)	β_2	0.048	0.009	5.160***
Cost of herbicide (f_3)	β_3	0.599	0.043	13.867***
Cost of hired labour (f_4)	β_4	0.039	0.008	5.234***
Cost of ploughing (f_5)	β_5	0.034	0.011	2.999***
Inefficiency effects				
Age (z_1)	δ	-1.233	0.483	-2.556***
Literacy level (z_2)	δ_2	0.046	0.041	1.117
Farming experience (z_3)	δ_3	-0.322	0.237	-1.358
Extension contact (z_4)	δ_4	-0.197	0.077	-2.568***
Gender (z_5)	δ_5	-0.442	0.208	-2.132**
Family size (z_6)	δ_6	-0.173	0.059	-2.931***
Access to credit (z_7)	δ_7	-0.0152	0.038	-0.397
Diagnostic statistics				
Log likelihood ratio	LR	55.79*		
Sigma squared	(σ^2)	0.085	0.026	3.233***
Gamma	(γ)	0.835	0.029	28.648***

Source: Computer output from Frontier 4.1

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

3.3.4 Allocative efficiency of the respondents

The allocative efficiency (AE) of the rice farmers deduced from the stochastic frontier cost function is presented in Table 7. The result revealed that a variation in allocative efficiency exists among the farmers, as the minimum allocative efficiency recorded was between 0.40-0.49, whereas the maximum was between 0.90-0.99. The mean AE was 0.88 (88%) meaning that an average farmer in the study area has a chance of increasing allocative efficiency by 12%. The highest allocative efficiency recorded was (0.98) 98% the farmer has two years of farming experience, had a farm size of 1 hectare, planted 50kg of seed, harvested 18bags (100kg) of rice and had total revenue of ₦126,000 while the lowest was (0.46) 46%. The result also showed that the vast majority of the farmers' allocative efficiency falls within the range of 0.80-0.99, which collectively accounted for 85.9%. This shows that there is a little variation in allocative efficiency among the sampled population.

Table 6. Distribution of the technical efficiency of the respondents

Range of technical efficiency	Frequency	Percentage
0.50-0.59	16	18.80
0.60-0.69	14	16.50
0.70-0.79	21	24.70
0.80-0.89	20	23.50
0.90-0.99	14	16.50
Total	85	100
Maximum	0.98	
Minimum	0.54	
Mean	0.76	

Table 7. Distribution of the allocative efficiency of the respondents

Range of allocative efficiency	Frequency	Percentage
0.40-0.49	**1**	**1.20**
0.50-0.59	**0**	**0**
0.60-0.69	**3**	**3.50**
0.70-0.79	**8**	**9.40**
0.80-0.89	**17**	**20.00**
0.90-0.99	**56**	**65.90**
Total	**85**	**100**
Maximum	0.98	
Minimum	0.46	
Mean	0.88	

Source: Field survey 2019

3.3.5 Economic efficiency of the respondents

The overall efficiency otherwise termed as the economic efficiency is the product of both technical and allocative efficiency which must optimally add up to 1.0, is presented in Table 8. Thus farmers have to be technical efficient (technical efficiency of 1.0) and allocate efficiently (allocative efficiency of 1.0) to be able to attain the economic efficiency frontier (1.0), the mean economic efficiency obtained is 0.67 (67%), implying that an average farmer in the study area need to gain about 33% level of efficiency so as to raise their economic efficiency to one (economic frontier). The highest economic efficiency recorded was 0.94 (94%) the farmer has five years of farming experience, had a farm size of 1 hectare, planted 50kg of seed, harvested 17bags (100kg) of rice and had total revenue of ₦136,000. while the least was 0.34 (34%). Majority (72.9%) of the farmers collectively fall within the range of 0.50 to 0.79 of the entire farmers in the study area. The result further shows the farmer with the least economic efficiency requires an economic efficiency gain of 60% (0.94-0.34) in order to reach the level of the most efficient farmer in the sample population.

Table 8. Distribution of the economic efficiency of the respondents

Range of economic efficiency	frequency	percentage
0.30-0.39	2	2.40
0.40-0.49	3	3.50
0.50-0.59	17	20.00
0.60-0.69	22	25.90
0.70-0.79	23	27.00
0.80-0.89	16	18.80
0.90-0.99	2	2.40
Total	85	100
Maximum	0.94	
Minimum	0.34	
Mean	0.67	

Source: Field survey, 2019

3.4 Constraints Faced by Rice Farmers

The major constraints affecting rice production are presented in Table 9. The result revealed that the majority (76.5%) of the farmers indicated inadequate credit facilities as the major problem affecting their production, about 69.4% reported limited farm size for rice production. Good number (62.4%) indicated high cost of transportation as their constraint. Other

Table 9. Constraints of rice production in the study area

Constraint	Frequency	Percentage	Ranking
Inadequate credit	65	76.50	1
High cost of labour	10	11.80	7
Cannot afford ox-plough/tractor	47	55.30	6
Pest attack	49	57.60	5
High cost of transportation	53	62.40	3
Limited farm size to produce more	59	69.40	2
Inadequate information on innovation	52	61.20	4

Source: Field survey, 2019

constraints indicated are pest attack (57.6%) and inadequate access to ox-plough/tractor (55.3%). This is in line with [31] in his study on Resource use efficiency in rain-fed rice production in Mubi local government of Adamawa state and [32] in their study on economic analysis of rice production in shelleng Local Government area of Adamawa state who pointed out that inadequate credit, high cost of transport and lack of innovation constitute major production constraints faced by rice farmers.

4. CONCLUSION AND RECOMMENDATION

Rice production in the study area was dominated by men, who were married, small scale farmers cultivating an average of 2.1 hectares of land which are mostly owned by inheritance. Most of the respondents have access to formal education and little of them had access to credit and extension services. The gross margin result revealed that rice production is profitable in the area in spite of the numerous challenges confronting the farmers.

The estimated coefficient of farm size, quantity of seed, quantity of fertilizer and family labour are related to rice production and age, literacy level, extension contact and family size increased the technical efficiency of the farmers. The maximum likelihood estimates of the stochastic frontier cost frontier model were significant at 1% level. Land, fertilizer, herbicide, hired labour and ploughing were statistically significant with cost of rice production. The mean economic efficiency recorded was 0.67 (67%), with a maximum of 0.94 (94%) and a minimum EE of 0.34 (34%) showing that the respondents are not fully economically efficient in rice production in the study area.

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

I. ABP should increase the quantity of rice distributed to its beneficiaries in order to achieve its objective of improving agricultural productivity.
II. To increase technical, allocative and economic efficiencies of the farmers, government should improve farmer's educational status through adult education and literacy campaigns by the extension agents.
III. Government should revive its policy on input subsidy to make inputs accessible to the farmers and policies geared towards investment in credit, land tenue and means of transportation should be formulated.

5. LIMITATION OF THE STUDY

Most of the respondents' estimates were provided by memory recall because of the non-keeping of farm records. Probe styles and cross questioning were, however, used to elicit accurate and reliable information as much as possible.

CONSENT

As per international standard or university standard, Participants' written consent has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Samarendu, M. Trends in global rice consumption. Rice Today. International Rice Research Institute. 2013;12(1).
2. FAO. FAO website; 2018. Available:http://www.fao.org/faostat/en/data/QC/visualize.

3. United State Development Agency (USDA). Rough Rice Production in Major Producing Countries in Each Continent of the World; 2009. PSD online june 10th 2009.
4. Omotesho AO, Muhammad-Lawal A,Yusuf YK. Economics of small scale rice production in Patigi andEdu Local Government Areas of Kwara State, Nigeria. African Journal of Agricultural Research 2010;5(4):87-97
5. United States Department of Agriculture;2018
6. Central Bank of Nigeria. Annual Report and Statement of Accounts. Abuja, Nigeria: CBN Publication; 2003.
7. Bamidele FS, Aboyomi OO, Esther A. Economic analysis of rice consumption pattern in Nigeria.Journal of Agric. Science Tech. 2010;12:1-11.
8. FMARD. Agricultural Transformation Agenda: We Will Grow Nigeria's Agricultural Sector (Draft). Abuja: FMARD; v2011.
9. Apata, TG, Folayan A, Apata OM, Akinlua, J. The economic role of Nigeria's subsistence agriculture in the transition process: Implications for rural development. A paper presented at the 85th Annual Conference of the Agricultural Economics Society, Warwick University. 2011;18 – 20.
Available:http://ageconsearch.umn.edu/bitstream/108942/2/64apata_folayan_apata_akinlua.Pdf
10. Chioma A. Appraising Central Bank of Nigeria Anchor Borrowers' Programme; 2016.
Available:http://Reporters.com/2016/07/903611/Appraising Central-Bank- of- Nigeria-Anchor Borrowers-Programme
11. Adebayo EF, Onu JI. Economics of rice production in Yola North and Yola South Local Government Areas of Adamawa State. Nigerian J. Trop. Agric. 1999;1:15–20.
12. Shehu JF, Mshelia SI, Tashkalma AK, Gabdo BH. Economics of small-scale rain-fed upland rice production in Adamawa State. African Journal of Agricultural Research and Development. 2009;2(1):28-33.
13. Bitrus A, Sulumbe IM, Ibrahim A, Yakubu H. Analysis of scale-efficiency of rice production among beneficiaries of anchor borrowers programme in Adamawa State, Nigeria. Asian Journal of Agricultural Extension, Economics & Sociology. 2020;38(11):189-198.
Available:https://doi.org/10.9734/ajaees/2020/v38i1130467
14. National Population Commission, National population commission. Population census of the Federal Republic of Nigeria. Census Report. National Population Commission, Abuja; 2006.
15. Saka MG, Jatau DF, Olaniyi WA. Status of indigenous tree species in Girei Forest Reserve of Adamawa State. Department of Forestry and Wildlife Management, Modibbo Adama University of Technology, Yola, Adamawa State, Nigeria; 2013. Department of Forest Resources Management, University of Ibadan, Ibadan, Nigeria. Jfewr Publications. FAO: FAOSTAT; 2002.
Available: www.fao.org
16. Adebayo AA. Climate I. (Sunshine, Temperature, Evaporation and Relative Humidity).In: Adebayo AA, Tukur AL (Eds). Adamawa State in Maps Paraclete Publishers; 1999.
17. Medugu DW, Yakubu D. Estimation of mean monthly global solar radiation in Yola, Nigeria using angstrom model. Department of Pure and Applied Physics, Adamawa State University, Mubi Adamawa State; 2011.
18. Yamane T. Statitics, an introductory analysis, 2nd E.D; New York: Harper and Row; 1967.
19. Shaikh SA, Hongbing O, Khan K., Ahmed M. Determinants of rice productivity: An analysis of Jaffarabad District- Balochistan, Pakistan European Scientific Journal 2016;32(12):41-50.
20. Ogundele OO. Technology differential and resource efficiency in rice production in Kadunna State, Nigeria. Unpublished PhD Thesis Department of Agricultural Economics University of Ibadan Nigeria; 2003.
21. Coelli TJ, Prasada DS, Batesse GE. Introduction to Efficiency and Productivity Analysis.Kiuwa Academic Publishers, London; 1998.
22. Maurice DC. Optimal Production Plan and Resource allocation in food crop production in Adamawa State, Nigeria. Unpublished PhD Thesis. Modibbo Adama University of Technology Yola. 2012;21-28.
23. Adamu T, Bakari UM. Analysis of technical Efficiency of rain-fed farmers in Taraba State. Journal of Agriculture. 2015;2(4).

24. Okonkwo II, Okonye BC, Onuoha C, Asumugha GN, Nwaru JC. Econometric analysis of rice production: A case study of food security in Anambra State. Proceedings of the 47th Annual Conference of the Agricultural Society of Nigeria Ibadan;2013.
25. Odoemenem IU, Inakwa JA. Economic analysis of rice production in Cross River State, Nigeria. Journal of Development and Agricultural Economics. 2011;3(9):469-474.
26. Maurice DC, Joseph M, Garba A. Analysis of technical inefficiency in food crop production system among small-scale farmers in some selected Local Government Areas of Adamawa State, Nigeria. ATBU, Journal of Science, Technical and Education (JOSTE). 2015;3(1):78-87.
27. Amaza PS, Bila Y, Iheanacho AC. Identification of factors that influence technical efficiency of food crop production in West Africa: Empirical Evidence from Borno State, Nigeria. Journal of Agriculture and Rural Development in the Tropics. 2006;107(2):139-147.
28. Jongur AAU, Maurice DC, Obidi CNC. Technical efficiency in maize production in Yola, Adamawa State, Nigeria. Journal of Arid Agriculture3. 2010;19:41-45.
29. Oluwatayo IB, Sekumade AB, Adesoji S. Resource- use efficiency of maize farmers in rural Nigeria: Evidence from Ekiti State. World Journal of Agricultural Sciences. 2008;4(1):91-99.
30. Shehu JF, Mshelia SI, Tashikalma AK. Analysis of technical efficiency of small-scale rain-fed upland rice farmers in North-West Agricultural Zone of Adamawa State, Nigeria. Journal of Agriculture and Social Science.2007;*3*(4): 133-136.
31. Musa BV. Resource use efficiency in rain-fed rice production in some selected villages of Mubi North Local Government of Adamawa State. MSc. Thesis Unpublished Yola. Modibbo Adama University of Technology Yola; 2014.
32. Mohammed AB, Jibril SA, Amiyini K. Economics analysis of rice production in Shellenge Local Government of Adamawa State. Savannah Journal of Agriculture. 2009;4(1):5-13.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/64477