NVEO
Natural Volatiles & Essential Oils

Technical Efficiency Of Rice Production In North Central Nigeria

Abiola M.O. Omhonlehin R.A. and T.P. Sani

Department of Agricultural Economics and Extension Federal University Oye Ekiti, Nigeri,

Abstract

Rice farmer faces the scenario of getting less than what is possible under the present production environment of banditry and kidnapping in Nigeria, Poor resource utilization impacts negatively on the farmer's income and business profitability. The concern of every farmer is the maximum yield realization. When this does not happen, the farmer feels bad. The unusual question is; are farmers getting the maximum rice yield. The main objective of the study is limited to the estimation of technical efficiency of rice farmers in the north central zone of Nigeria. Primary data were used to accomplish the objectives of the study. Multi stage proportional random sampling was used to select 360 respondents from Kogi, Benue, Niger, and Federal Capital Territory in North Central zone of Nigeria. The parametric stochastic frontier production function was estimated using a maximum likelihood estimator in two-stage approach. Results indicated that none of the rice farmers was technically efficient but rice farmers can increase their output by more than 63% without any increase in input utilization if the farmers adopt the farm practices of the technical leader. Education, years of farming experience, and age of rice farmers were significant predictors of inefficiency among rice producers in North central zone, Nigeria. Technical efficiency of farmers can be increased by training the farmer on best practices on rice production given that education has a reducing effect on technical inefficiency among farmers in the studied areas.

Keywords; Rice, Technical Efficiency, North central Nigeria

Introduction

The inability of the rice subsector to produce enough rice for local consumption is attributed to the poor performance over the years. The Coalition for African Rice Development (CARD) (2009), Cadoni and Angelluci (2013), Amaechi, and Eboh (2017) reported that rice yield under irrigation schemes in Nigeria has the potential to reach seven to nine tones/hectare, while rain-fed lowland has the yield potential of three to six tonnes per hectare The rain-fed lowland produces only one point five to three tones per hectare of rice, while irrigated rice produces three point five tonnes per hectare. The constant increase in demand for local rice consumption in Nigeria since 1970 has not been accompanied by a sizeable increase in local rice production, resulting in the widening of the local supply demand deficit (Damisa, et al., 2013). The deficit, Nigeria resulted in large expenditure rice importation (Amusan & Ayanwale, 2012.North Central Zone is the food basket of Nigeria. The failure of the zone spells a food disaster for the nation. The performance of the zone inters in food production is of great concern to everyone in

Nigeria. Measuring the current efficiency of rice as one of the major source of daily food intake in Nigeria is very crucial. Measuring production efficiency is an important issue in economics [Manyeki and Balaras, 2019]. A measure of a producer's performance is often useful for policy purposes, and the concept of efficiency provides a theoretical basis for such a measure [Aigner, Lovell, and Schmidt, 1977]. Generally, in productive efficiency measurements, we are familiar with three types of efficiency: technical, allocative, and economic efficiency. The study considers technical efficiency because it is one of the important interventions proposed by modern economic theorists that could enhance producer productivity by ensuring the technical efficiency of the factors of production that are at the producers' disposal (Farrell [1957; Manyeki and Balaras, 2019]. Technical efficiency is a measure of the ability of a firm or DMU (decision-making unit) to produce the maximum output from a given level of inputs and technology (output-oriented) or achieve a certain output threshold using a minimum quantity of inputs under a given technology (input-oriented) [(Manyeki and Balaras,2019].

Despite increased paddy production over the years, the average yields across Africa remain very low. Between 1990 and 2016, African yields only grew by 8%, while rice yields in Southeast Asia grew by 22% during the same period. This leaves a yield gap of around 2.1 MT/ha between African and Southeast Asian yields. Even within the African continent we see substantial variance in terms of rice yields. For instance, Madagascar shows average yields of more than 4 MT/ha while Mauritania achieves average rice yields of 5.3 MT/ha (Felix and Sophia 2018).

Rice yield in North Central Nigeria is still low when compared to other West African countries mentioned above (Joseph et al. 2016). Apart from biophysical and institutional factors, a key socio-economic factor in assessing crop performance is the resource use efficiency in the farm; they provide starting point information on why rice productivity is less than the desire in Nigeria. The few available resources are not perfectly applied and utilized in the production process. This scenario is witnessed to the application or under application of these resources with a consequent effect on poor productivity yield per hectare and income of farmers in rice production. Producers' efficiency measures and the changes that occur over time are an important policy tool. Its relevance is underscored by the relationship between output expansion and economic growth and general wellbeing of citizens. Achieving a higher level of efficiency, for example, by rice farmers, is a necessary condition to achieve higher output and economic growth. Thus, improvements in producers' efficiencies over time are major concerns for agricultural sector policy makers (Samuel 2016). In view of this, the government has taken a drastic measure by creating a suitable environment for Nigerian rice economy through some fiscal and monetary policy measures like the restriction of rice importation and Anchor Borrowers programmer, respectively. The ban on foreign rice importation by current government in Nigeria has led to a massive increase in rice cultivation and improvement in domestic rice processing to match foreign rice standards is generating serious attention. Nigerian rice consumption and acceptability is on the rise. The serious effort of Buhari government through the supply of critical farm inputs and ban on rice importation appears to be imparting positively on rice production. Based on this scenario; are there an improvement in farmer's performance. Are farmers getting what is possible under the current situation or the situation remains the same. This situation therefore provides a yardstick for an in-depth examination of resource use efficiency with a view to improving farmer's rice production performance in North central zone of Nigeria

The study addressed the following research questions; Are rice farmers technically efficient in the study area? and what are the determinants of inefficiency in the study area? Therefore, the objective of the study were to determine the technical efficiency of rice production and identify the determinants of inefficiency in the study area, Various efforts by many researchers like Sadiq (2018), Joseph (2016), Binuyo (2016) among others had concentrated on the efficiency of rain fed lowland rice production while there has been less effort to systematically study efficiency of rice production systems and choices to identify possible means for minimization of input and maximization of output among rice farmers. The Government of Nigeria has developed a blue print of enhancing the role of rice production in food and income security, but queries have been raised on the factors that would influence the success of government interventions in rice production. This is especially, with the changing macro-and micro- environment, which affects rice production, it is important to have a thorough understanding of the efficiency of rice farming systems and choices, to reinforce the government efforts of intervening in rice economy.

The potentials of rice in contributing to the national food security and boosting the Gross Domestic Product (GDP) are enormous. The ease of its production, the high and increasing demands in the market, all together point to the need to; identify possible ways of improving the efficiency of production resources, analyze the economic benefits obtainable by its production, and identify the constraints militating against its production, especially by the rural farmers who are involved therein, and who constitute the larger population of rice producers in Nigeria. This study will therefore provide information that will be useful in enlightening the farmers on its importance, its market value, and ways of improving its production to increase their profits. Hence, increasing the marginal output of the produce, the return on capital invested by the farmers, thereby producing the highest feasible output at the least possible cost per hectare with existing and available technologies, to reduce the drudgeries in production and make the rice enterprise more interesting and worthy of investing in, which will in turn improve the living standards of the farmers in the study area.

The output of this study will also add to the existing information that could be used by the government in formulating policies that could ensure a conducive rice economy especially to the farmers in the study area. The findings of this study may also go a long way in addressing the protracted efficiency problem in the study area. This is because the identification of inefficiency sources that are available among rice farmers will assist in formulating the right policies to address them. Policy makers could therefore find the study relevant for designing policies in line with the challenges of ensuring improved rice economy in the study area. The findings will also add to the existing literature on the issue of efficiency in Nigeria. In terms of contributions to knowledge, the study will illuminate comprehensive behavior patterns and characteristics of rice farming households, which could be useful in understanding the behaviors of the entire rural economy of Nigeria. Overall, the study contributes to social change as the outcomes of the findings will help to boost local rice production thereby reducing prices and curbing hunger, disease, and poverty.

Methodology

This study was conducted in North Central Nigeria. The zone is made up of Benue, Kogi, Kwara, Niger, Nasarawa, Plateau states, and the Federal Capital Territory (FCT), Abuja. The zone occupies of 32% of the land area of the country, with a population of about 20, 267, 257 people as at 2016 (NBS, 2016). It is located between longitude 2^0 30˝ to10^0 30˝ East and latitude 6^0 30˝ to 11^0 20˝ North of the Equator. The zone has two main seasons, namely; dry and wet seasons. The wet season occurs from the ending of March until the end of October, while the dry season begins from November and ends towards March. The annual rainfall ranges from 1,000 to 1,500mm with the average of about 187 to 220 rainy days, while the average monthly temperature ranges of 21^0C to 37^0C. The zone has vegetation that consists of the forest Savannah Mosaic, Southern Guinea Savannah and the Northern Guinea Savannah. Geographically, the zone is characterized by varying topographical landforms, such as the extensive and swampy features found around the lowland areas, along the valleys of rivers, Niger, and Benue; while large hills, mountains, plateaus and deep valleys make up the remaining parts of the land area. The vegetation, soil, and weather patterns of the zone favour the cultivation and production of a wide spectrum of agricultural foods, industrial, and cash crops of various types. The available rivers and dams enable irrigation, farming, and vegetables' gardening during dry seasons. There are more than 40 ethnic groups in the zone, with Idoma, Tiv, Egbira, Gbagyi (Gwari), Koro, Gade, Gwandara, Bassa, Gana-gana, Nupe, Hausa, Kadara, Kambari, Kamuku, Agatu, Basa, and Eggon ethnic groups, among others. The people in this zone are mainly farmers, hunters, fishermen, handicraftsmen, and women. The major crops grown in the zone include rice, maize, millet, sorghum, yam, potatoes, cassava, soybean, and vegetables. Nigeria geo-political zones are presented below

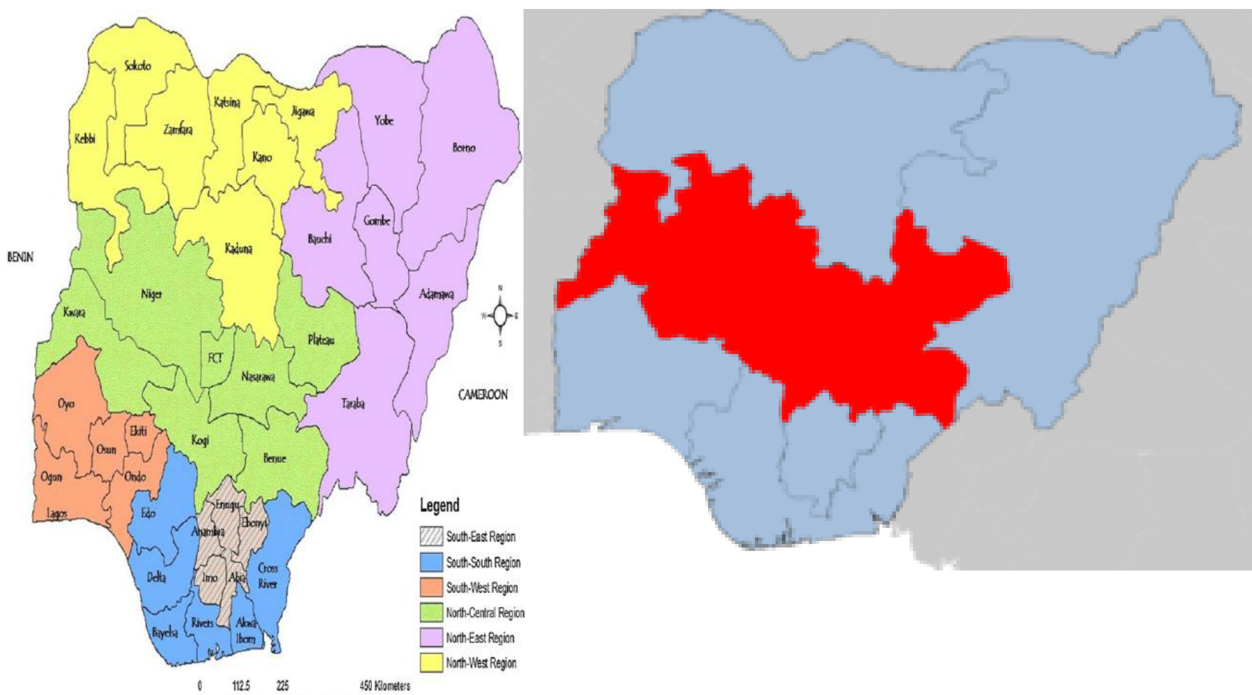

Figure 3.1 Map of North Central Nigeria

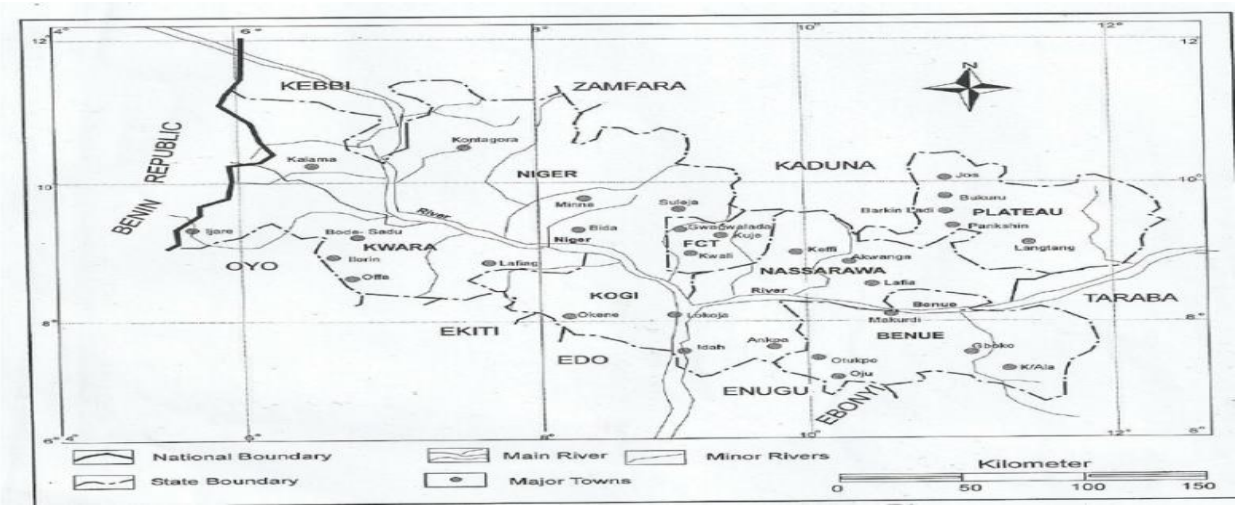

Table .1: Description of the six states of the Study Area

State	Geographical Location	Vegetation	Land Area	Population	Rainfall (mm)/annum	Temp.	Major Crops Grown
Niger	From Latitude 3.20^0 East and Longitude 11.30^0 North of the Equator	Guinea Savannah	76, 363 Km^2	3, 950, 29	1,100mm -- 1,600mm	23^0 -- 37^{0}C	Cassava, cowpea, yam maize, rice and sorghum
Kogi	Between Latitude 7.49^{0}N and Longitude 6.45^{0}E	Mixture of Guinea forest Savannah	9,833Km^2	3,278,487	1,016mm and 1,524mm	22.8^0 to 33.2^{0}C	Palm produce, yam, cassava millet, rice, owpea, cocoa, and cashew
Benue	Between Latitude 6^{0}25N and Longitude 75^{0}10E	Guinea Savannah	34,059Km^2	4,219,244	Ranges between 1,100mm and 1,500m	Ranges from 25^0 to 37^{0}C	Potato's cassava soya beans guinea corn flax, yams

							and beniseed
Kwara	Between Latitude $11^0$15'N and Longitude $7^0$23'E	Derived Guinea Savannah	36,82 Km²	2,371,08 9	Ranges between 1,000mm to and 1,500mm	Ranges from 23^0 35^0C	Rice,maize, groundnut, cassava yams, sorghum
Plateau	Between Latitude $80^0$24'N and Longitude $80^0$32' and $100^0$38'E	Guinea Savannah	26,89 9Km²	3,178,71 2	Ranges from 1,317.5m m to 1,460mm	Ranges between 18^0 and 22^0C	Potatos cassava soya beans, sorghum and yams
Nasarawa	From Latitude $8^0$35'N and Longitude $8^0$2'E	Guinea Savannah	27,11 6.8 Km²	1,863,27 5	Ranges from 1311.75 mm to 1,500mm 1, 405, 20	Ranges between 24^0 and 37^0C	Rice,maize, groundnut, cassava yam, and sorghum
FCT	Between Latitude 9^0 00'N and Longitude 7^0 00'E	Guinea Savannah	923,768 Km²	170,123, 740	Range 1,100mm to	ranging 37^0C 24^0 and	Rice,maize, cassava, soya beans

S

Sampling Technique and Sample Size

The study adopted the multistage technique in the selection of the respondents. The first stage involved the random selection of Niger, Kogi, and Federal Capital Territory (FCT), Abuja, due to their preponderance of different rice production systems (lowland,upland, and irrigated). The second stage also involved random sampling of two local government areas in each state selected; Wushishi and Katcha Local Government in Niger and Yagba and Kogi inKogi State; Kwali and Abaji Area Council in F C T . Stage three involved the random selection of two villages from each sampled Local Government Areas, giving a total of 12 villages. The fourth stage involved a proportional random sampling of rice farmers with a total of 360 paddy rice farmers for the study. Therefore (Tedrowos 2017) estimator used is presented below

$$nh = \frac{n\,Nh}{N}$$

Where
nh = the sample size to be determined
n = the number of the targeted respondents
nh = total number of population size
N = targeted population

The sampling frame of rice producers was obtained from the Agricultural Mechanization and Farmers Development Authority, State Ministry of Agriculture, Village heads, and farmers association, through a reconnaissance survey.

Table .2 Sample Population and Proportional Random Sample size

State	Local Govt.	Village	Sample Frame	Sample Size
NIGER	Borgu	Swashi	208	208/2090 X 360 = **36**
		Saminaka	170	170/2090 X 360 = **29**
	Katcha	Katcha	238	238/2090 X 360 = 41
		Badeggi	242	242/2090 X 360 = 42
KOGI	Yagba West	Omi	198	198/2090 X 360 =34
		Ejiba	220	220/2090 X 360 =37
	Kogi	Giryan	250	250/2090 X 360 = 43
		Panda	180	180/2090 X 360 = 31
F C T	Kwali	Dabi	85	85/2090 X 360 =15
		Gadabiu	109	109/2090 X 360 =19
	Abaji	Yaba	100	100/2090 X 360 =17
		Pandagi	9	90/20 X 36
3	**6**	**12**	**2090**	**360**

Source; Fied Data 2021

Primary and secondary data were utilized in this study. The primary data were collected with the use of a detail questionnaires designed to address the objectives of the study. It was complimented with interview schedules and focus group discussions. Enumerators were trained to collect data and local village heads were used to locate and identify practicing rice farmers

Stochastic frontier production model.

The frontier production function is a parametric method of measuring efficiency. Stochastic Frontier Analysis (SFA) was originally and independently proposed by Aigner et al. (1977) and Meeusen and van der Broeck (1977). Manyeki and balasz 2019 concluded that the two most widely used methods of production efficiency measurement: parametric are; SFA and nonparametric DEA. The nonparametric DEA has some limitations in that its deterministic frontier attributes all deviations from the frontier to inefficiency and ignores any stochastic noise in the data; therefore parametric SFA is preferred on the basis for this preference lies in its stochastic treatment of deviations from the frontier, which are decomposed into a non-negative inefficiency term and a random disturbance term that accounts for measurement errors and other random noise so that the measure is more consistent with the potential production under 'normal' working conditions. However, the traditional the empirical model of the stochastic frontier model for rice farmers is explicitly linearized into log form as follows

$$Y = \beta o + \beta_1 lnX_{1i} + \beta_2 lnX_{2i} + \beta_3 lnX_{3i} + \beta_4 lnX_{4i} + \beta_5 lnX_{5i} + \beta_6 lnX_{6i} + (Vj - Ui)$$

Where In = natural logarithm

Yi=total output of rice (kg)

X_1 = cultivated farm size (hectare)

X_2 = Labour (man-days)

X_3 = Fertilizer (kg)

X_4 = quantity Agrochemical (litres)

X_5 =quantity of rice Seed planted (kg)

X_6 = manure (kg)

β = parameters to be estimated

V i= normal random error (with zero mean and unknown variance)

U i= technical inefficiency effect (independent of V is such that

U is is the nonnegative truncation (at zero) of a normal distribution with mean u iand variance σ2; u iis defined as,

u = i*0 + *1Z1i +*2Z 2i + *3Z 3i + *4Z 4i …..+ *nZni

Technical efficiency (TE) measure refers to the ability of a decision making unit (DMU) to produce the maximum output from a given set of inputs. If a farm is technically efficient, it means that the farm is not in any way utilizing any available inputs (Gabdo et al., 2014). The ratio takes the value of between zero and one, indicating the degree of technical efficiency of farms. A rice farmer who has a ratio of one is described as fully technical efficient, and a farmer with a score of zero is fully technical inefficient. The model in equation 7 will be used for the farmers in the production system. The individual farmer's level of technical efficiency (TEi) is calculated as

$$\text{TEi} = \frac{Y_i}{Y^*} = \frac{f(X_{ij}\beta)exp(Vi - Ui)}{f(xij\beta)\exp(Vi) - \exp(Ui)}.$$

Where:

TEi= technical efficiency of farmer j

Yi= observed output from ithfarm

Y*= frontier output Xij,
Vi, Ui=as explained above
TE ranges between 0 and 1 and the maximum efficiency has a value of 1.
Such that $0 \leq TE \leq 1$
Battese and Coelli (1995), expressed the technical inefficiency as:
Ui= Ri+ wit
Where: wit is a random variable which is defined by the truncation of the normal distribution with zero mean and variance, such that the point of truncation is - Ri, i.e. w ≥ Ri.
The inefficiency model was stated as: $Wi^*=\delta_O + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} + \delta_6 Z_{6i} + \delta_7 Z_{7i} + \varepsilon i$
Where:
Wi* = t technical inefficiency of the jth farmer
Z_{1i} = Education (No. of years of formal schooling)
Z_{2i} = Years of experience in rice production (years)
Z_{3i} = Age of respondents
Z_{5i} = Extension contact (No. of time visited by the extension agent during the last cropping season)
Z_{6i} = Membership of the cooperative of the ith farmer (If the respondent is member = 1, otherwise a = 0)
Z_{9i} = Credit access (Amount received as credit in Naira)
Z_{10i} = Farm size allocated to rice crop by i^{th} farmer (in hectares)
δ = Coefficients
εi = Error term

The estimation of the technical inefficiency model was accomplished through two-stage techniques. The compares of the coefficient of technical inefficiency of the production systems therefore follows as that of the technical efficiency. The variance of the random error $\sigma^2 v$ and that of the technical and allocative inefficiency effect $\sigma^2 u$ and the overall variance of the model are related as follows:
$\sigma^2 = \sigma^2 v + \sigma^2 u$
$\gamma = \sigma^2 u / \sigma^2$
γ measures the total variation of output from the frontier which can be attributed to technical or allocative inefficiency and is defined such that 0. The σ^2 indicates the goodness of fit and the correctness of the distributional form assumed for the composite error term (Battese and Corra, 1977). .

Research Hypotheses

(a) HO=Age of rice farmers, farming experience and education status of respondents do not explain the inefficiency in rice production in North central zone of Nigeria

Where, $H_0: \delta_1 = \delta_2 = \delta_3 = 0$

(b) HO 2=Fertiliser and labour are not predictors of rice output in North central zones of Nigeria
c; HO=Combine power of all explanatory variables in the production model has zero effect on rice yield

Technical Efficiency of Rice Production in North Central Nigeria

The results indicated that none of the rice farmers in the north central zone of Nigeria was technically efficient given that none of the farmers had a technical efficiency estimate of one. The farmers operated below the frontier output, indicating that they were all producing less than what was possible under their production circumstances. The technical leader in the studied area got an efficiency estimate of 0.96 while the worst performer had an estimate of 0.32 with an average of 0.81 for 360 sampled rice farmers in the six states of North central zone of Nigeria. This zone is known as the food basket region of Nigerian accounting for the bulk of food production. The farmer had a return to a scale of 1.2 indicating that farmers were producing rice at stage one thereby underutilizing inputs. The explanatory variable included in the model explained 80% variation in the output of rice and was found significant with F calculated value of 6.18 greater than F statistic value of 3.16. About 58% of rice farmers under review had technical performance that were above average indicating that such a farmer can improve their output by 15% by adopting the farm practice of technical leader while a farmer that got the minimum can improve their output by64% if they adopt the farm practice of technical leader. Possibilitys exist for a farmer with a technical efficiency estimates of average can increase the output by 68% if the technical leader is efficient. The distribution of technical performance indicates that the mean was not a measure of central tendency because the mean skewed to the right with an estimate above the average of 50% and the majority accounting for more than 90% having a technical performance of above 50%. However, none of the rice producers operates on the frontier, Tables 4 and 5.

Fertilizer had a negative coefficient estimate because of wrong usage and improper application rate. Fertilizer is expected to have an increasing effect on rice yield, but because of the wrong application rate and dosage it has a negative effect on yield. Inefficiency had a negative association with education, farming experience, and age of rice farmers in the zone indicating that these parameters were very important factors in increasing rice output in the studied areas .The outcome of the second stage of regressing inefficiency on socioeconomic characteristics of the farmer indicates that farming experience and education had a reducing g effect on inefficiency and thereby promotes the capacity of farmers to move toward operating on frontier therefore improving the technical performance of rice farmers in north central zone of Nigeria. Two variables had an increasing effects on inefficiency. The approach of Farrell 1957, Anger, Lovell and Schmitt 19991 was adopted with the capacity to identify the source of inefficiency making the parametic approach more appropriate than Kumbakac 1995 approach which appears inappropriate because it estimates inefficiency without effort to identify the source of factors under farmers control. The importance of two-stage estimation is that it provides the opportunity to identify the source of error and the possibility of correcting such errors for better performance. The outcome of the study on rice production is supported by many previous empirical studies that farmers in Nigeria are producing possible output of many staple crops such as maize, rice, sorghum, Guinea corn, among others. This position is supported by Egbodion and Ahmadu 2015 who work on rice production in eastern Nigeria and Ayanwale and Abiola 2007 reported technical inefficiency in vegetable production in South- South zone of Nigeria. The concern is that despite several reports indicating inefficiency in food production, efforts geared toward amending this situation has not yielded the desired result leading to food insecurity and rice cost of stable food in all zones of Nigeria. Inefficiency in food production accounts for poverty among farmers who mostly operate in small scales and operates in most cases far below the frontier, implying that farmers are producing far below what is possible in their own environment and beyond.

Table 3; Maximum Likelihood Estimation of Stochastic Frontier Production and Inefficiency Function

Variables	Coefficients	Standard error	t-ratio
Intercept	0.62	0.46	0.13
Farm size	0.16	0.16	0.23
Labour	0.23	0.32	-0.47
Fertilizer	-0.84	0.18	-0.11
Pesticide	0.62	0.48	-0.17
Seed	0.26	0.43	0.61
Organic manure	0.10	0.43	0.23
Herbicide	-0.10	0.45	-0.22
Weeding	0.24	0.57	0.41
Inefficiency function			
intercept	0.14	0.11	-0.12
Education	-0.88	0.32	0.27
Age	-0.93	0.55	0.16
Farming experience	-0.34	0.14	-0.24
Household size	-0.34	0.11	-0.40
Extension contact	-0.35	0.15	-0.22
Membership of cooperative	-0.25	0.10	-0.24
Credit access	0.53	0.311	-0.17
Sigma squred	0.28	0.25	0.10
Gamma	0.31	0.64	0.47
LR	-0.24		

Source; Field Data,2021

Table 5; Technical Efficiency of Respondents

Group	**Frequency**	**Percentages**
< 0.31	0.00	0.00
0.32—0.600	15.00	4. 10
0.61----0.800	135.00	37.50
0.81—1.00	210.00	58.40
> 1.000	0.00	0.000
Total	360.00	100.00
minimum	0.32	
mean	0.81	

maximum	0.96	

Source; Field Data 2021

Conclusion

The study established that rice farmers in North central zone of Nigeria were technically inefficient. Farmers were produced below the frontier with a mean estimate of 0.81, minimum estimate of 0.32, and maximum estimate of 0.96. Education, farming experience, and age of respondents had a decreasing effect on inefficiency indicating in-service training or retraining is a potential factor to boost the technical performance of rice farmers in the studied area.

References

Ayanwale A,B.andM,O,Abiola 2007 Efficiency of Fluted pumpkin production under tropical condition, International Journal of Vegetable Science 63;89-96

Abdulrahman, S., Oladimeji, Y. U., Abdullahi, M. Y., Biniyo, G. &Abdullahi, M. M. (2018). Analysis of farmer's choice among alternative rice output market in Kano State, Nigeria. Journal of Agricultural economics, Extension and Social Sciences 1 (1), 28- 31.

Agom, D. I., Ohen, S. B., Itam, K. O., &Inyang, N. N. (2012). Analysis of technical efficiency of smallholder cocoa farmers in Cross River State, Nigeria. International Journal of Agricultural Management and Development (IJAMAD), 2 (3), 177-185.

Aigner, D. J., Lovell, C. A. K & Schmidt, P. (1977). Formulation and estimation of stochastic frontier production function models. Journal of Econometrics 6 (4), 21–37.

Akintayo, O. I., Rahji, M. A. Y., Awoyemi, T. T. &Adeoti, A. I. (2011). Determinants of yield gap in lowland rice production in North Central Nigeria. Agroseach 11 (1), 1 – 10.

Alam, S., Kowari, M. S., Chowdhury, N. Y., Islam, M. M. &Haque, S. (2016). Factors affecting land allocation for maize cultivars in Lalmonirhat District of Bangladesh. Progressive Agriculture 27 (3), 346- 354.

Ali, A., Amirhossein, P. & Mohammed, M. (2014). Modeling and analizing affective factors on dispersion of farming land in paddy workers viewed at Sari Township. Bulleting of environment, pharmacology and life sciences 3 (3) 275- 282

Aliyu, A. A. (2015). Evaluation of the Effects of Federal Government Policies on Competitiveness and comparative Advantage of rice production in Kaduna State, Nigeria. Unpublished PhD thesis Submitted to the Department of Agricultural Economics and Rural sociology. Faculty of Agriculture, Ahmadu Bello University, Zaria Nigeria.

Amaechina, E. C. &Eboh, E. C. (2017). Resource use efficiency in rice production in the lower Anambra irrigation project, Nigeria. Academic Journals 9 (8), 234-242.

Amusan, C. A., &Ayanwale, A. B. (2012). Gender analysis of rice production efficiency in Osun State: Implication for the Agricultural Transformation Agenda. Paper presented at the 13th National Conference of the Nigerian Association of Agricultural Economists, ObafemiOwolowo University.

Ayinde, O. E., Ojehomon, V. E. T., Daramola, F. S.1 &Falaki, A. A. (2013). Evaluation of the effects of climate change on rice production in Niger State, Nigeria. Ethiopian Journal of Environmental Studies and Management, 6(6), 763-773. Retrieved from

Battese, G. E. &Corra, G. S. (1977). Estimation of a Production Frontier Model: with Application to the Pastoral Zone of Eastern Australia. Australian Journal of Agricultural Economics. 21:167 - 179.

Belotti, F., Daidone, S., &Ilardi, G. (2012). Stochastic frontier analysis using STATA. The STATA Journal, 5 (2), 1-39.

Brent, R. (2020). How Education and Trsining affect the economy. Retrieved on 7/12/2020 from www.investopedia.com/article

Binuyo, G., Abdulrahman, B., Yusuf, D. & Timothy, A. J. (2016). Technical efficiency of rain-fed lowland rice production in Niger State. Asian Journal of Agricultural Extension, Economics and Sociology 9 (4), 1-12.

Cadoni ,P. &Angelucci, F. (2013). Analysis of incentives and disincentives for rice in Nigeria. Technical notes series MAFAP, FAO, Rome. pp. 7-10.

Chidieberi-Mark, N., Donatus, O., Polycarp, O. & Steve, O. (2019). Profitability of rice production in different production systems in Ebonyi State, Nigeria. Open Agriculture 2 (4) 237-246

Coalition for African Rice Development (CARD) (2010). Mapping of PRSP, Sector Strategies and Policies related to Rice Development in Nigeria. Paper Prepared by DamolaAdejumo-Ayibiowu for the (CARD) assessed at http//www.riceforafrica.org on 7/11/2018.

Coelli, T. J., (2000). On the econometric estimation of distance function: Representation of the production technology [Working paper]. Universitécatholique de Louvain, Center for Operations Research and Econometrics (CORE). Retrieved from: http://alfresco.uclouvain.be/alfresco/download/attach/workspace/SpacesStore/c293 b3c6-0b32-4353-9da0-ce048b06e104/coredp_2000_42.pdf

Coelli, T., O'Donnell, C., &Battese, G. (2005). An introduction to efficiency and productivity analysis (2nd ed.). New York, NY: Springer Science and BusinessCoelli, T..J. (1996). A guide to Frontier version 4.1. a Computer Programme for Stochastic Frontier Production and Cost Function Establishment Mimeo Department of econometrics, university of New England, Armidale, pp. 32.

Covarrubias, K., Davis, B., Bakouan, A. &Diguseppe, S. (2013). Household income generation strategies. Background paper for the world development report 2013. World Bank Washinton DC.

Damisa, M. A., Sanni, S. .A., Abduoulaye, T. Kamara, A. Y. &Ayowale, A. (2011). Household Typology based analysis of livelihood strategies and poverty status in the sudan savannah of Nigeria: Baseline Conditions. Learning Publics Journal of Agricultural and .Environmental. Studies; 2(1), 146 – 160.

Deprins, D., Simar, L. &Tulkens, H. (1984). Measuring labor efficiency in post offices.In M. Marchard, P. Pestieau and H. Tulkens (Eds.), Performance of public enterprises: Concepts and measurements (pp. 243-267). Amsterdam, Netherlands: Elsevier.

Egbodion, J. &Ahmadu, J. (2015). Production cost efficiency and profitability of Abakaliki Rice in Ihialia Local Government Area of Anambra State, Nigeria. Journals of Apply Science and Environmental Management 19 (2), 327-333.

Ernoiz, A. (2015). Comparativeness and cost efficiency of rice farming in Indonisia .Journal of rural problems 51 (2), 74- 85.

Evans, N.Y. (2015). Comparative Economic Analysis of Upland and Lowland Rainfed Rice production in selected Local Government Areas of Kaduna State, Nigeria. Thesis submitted to school of post graduate studies, Ahmadu Bello University Zaria in partial fulfillment of the requirements for the award of Degree of Doctor of Phillosophy in Agricultural Economics.

Fakayode, S. B. (2009). Technical efficiency and factor productivity in upland and lowland rice production systems in Kwara State, Nigeria. A thesis submitted in partial fulfilment of the award of Doctor of Philosophy, University of Ilorin, Nigeria.Retrievedfrom https://wvww.unilorin.edu.ng/graduatetheses/agriculture/Agriculture_Agric%20Economics_2009_FAKAYODE.pdf

Farrell, M. J. (1957). The measurement of productive efficiency. Journal of the Royal Statistical Society, Series A. General, 120(3), 253–282.

Federal Ministry of Agriculture and Rural Development (FMARD), (2016). The Agricultural Promotion Policy (2016 – 2020) Building on the successes of the ATA, Closing key Gaps pp 10 – 15.

Federal Ministry of Agriculture and Rural Development, Rice transformation project proposal. FMARD, Abuja, 2012.

Felix, F. & Sophia, S. (2018). Overview on rice in Africa. Competitive African Rice Initiative (CARI). Deutsche GesellsSchaft for internationeleZusummenasbeitGmbit, 11b MousaTrourecresent, Abuja.

Ferdushi, K. F, Abdulbasah-Kamil, A., Mustafa, A. &Batan, A. (2013). Factors affecting rice farm in Bangladesh Journal of Sustainable Agriculture, 7(5) ,426-432.

Fred, N., Enoch, K. T. & Philip, K. N. (2012) Resources use efficiency in rice production; the case of kpong irrigation project in the Dangure West District of Ghana, International journal of Agriculture and forestry 2(1,) 35-40.

Gabdo, B. H., Abdlatif, I. B., Mohammed, Z. A., &Shamsuddin, M. N. (2014). Comparative estimation of technical efficiency in livestock-oil palm integration in Johor, Malaysia: Evidence from full and partial frontier estimators. Journal of Agricultural Science, 6(3), 140-150.

Linus, I. O. (2016) A comparative study of some selected agricultural crops in the North Central Nigeria.International journal of Agriculture and Earth Science 2 (1) 102 -109.

Longtau, S. R. (2003). Multi-agency partnerships in West African Agriculture: A review and description of rice production systems in Nigeria. Eco-Systems Development Organisation, Jos, Plateau, Nigeria,

Malubrhan, A., George, M. & Hyacinth, E. (2018). Farmers Crop Choice Decision: Trend and Determinants in Nigeria and Uganda. International Food Policy Research Institute (IFPRI). Discussion paper 01716, March 2018.

Meeusen, W., & van den Broeck J., (1977).. Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error. International Economic Review 18 (2), 435-444.

National Bureau of Statistic (NBS) (2016) Poverty and Welfare in Nigeria, Lagos Pp. 34.

Nchuchuwe, F. F., (2012). The challenges of agriculture and rural development in Africa: The case of Nigeria.International Journal of Academic Research in Progressive Education and Development, 1(3), 89- 95.

Nwaobiala C. U. & Ume, S. I. (2013). Economic analysis upland rice production in Eboyi Southern Agricultural Zone of Ebonyi, State. International Journal of Agriculture and Rural Development 16 (2), 1503-1508.

Ojo, M. A., Nmadu,J. N., Tanko, L. &Olaleye, R. S. (2013). Multinomial logit analysis of factors affecting the choice of enterprise among small holder yam and cassava farmers in Niger State , Nigeria. Journal of Agriculture 4 (1), 7-12.

Okoruwa, V. O., Ogundele, O. O. &Oyewusi, B. O. (2016). Efficiency and productivity of farmers in Nigeria, A study prepared for presentation at the international association of Agricultural Economist conference, Gold cost, Australia.

Olaf, E., Frederic, L., Akande, S. D., Titilola, S. O., Akpokodje, G. &Ogundele, O. O. (2003). Rice production system in Nigeria. West Africa Rice Development Association (WARDA) Abidjan Cote d Ivoire.

Punch Newspaper (2018). Nigeria to lose 80 million dollars on rice production. Published 23/12 2018. Editor: Anna Okon.

Rika, T., Zainalabidin M. &Nue-syuhada, Z. (2016). Determinants of farmers adoption of clearifield production system in Malaysia. Agricultural and agricultural science procedia 9 (3) 103- 107.

Sadiq, M. S., Singh, l. P., &Yakubu, G. M (2018). Improving efficiency and TFP of Low land Paddy Rice farmer in Kwara State of Nigeria. Journal of Agricultural Science 3(2) 110-129.

Samuel, C. R. (2016). Evaluating the impact of Policies on production Efficiency of Nigeria's rice economy. Ph.D thesis submitted to college of social and behavioral Science walden University. Retrieved on 20/July/2017 from http://scholarwork. Waldennu.edul dissertations.

Teklewold, H., Kassie, M., Shiferaw, B. &Köhlin. G. (2013). Cropping System Diversification, Conservation Tillage and Modern Seed Adoption in Ethiopia: Impacts on Household Income, Agrochemical Use and Demand for Labor." Ecological Economics 2 (93) 85–93.

Teklewold, H., &Mekonnen. A. (2017). The Tilling of Land in a Changing Climate: Empirical Evidence from the Nile Basin of Ethiopia." Land Use Policy 67: pp 449–459.

Tewodro, B. A. (2017). Assessment of factors affecting performance of Agricultural cooperative on wheat marketed in Ethopia. Academic Journals 11(16)393-414.

Thibbotuwawa, M., Mugera, A., & White, B. (2013). Production efficiency and technology gap in irrigated and rain-fed Rice farming systems in Sri Lanka: Non parametric Approach. In 2013 Conference (57th), February 5-8, 2013, Sydney, Australia, Australian Agricultural and Resource Economics Society. Retrieved from http://ageconsearch.umn.edu/bitstream/152181/2/CP%20Thibbotuwawa.pdf

Watkins, K. B., Hristovska, T., Massanti, R., Wilson, C. E., & Schmidt, L. (2014). Measurement of Technical, Allocative, Economic, and Scale Efficiency of Rice Production in Arkansas Using Data Envelopment Analysis. Journal of Agricultural and Applied Economics, 46, 89-106. doi: 10.1017/S1074070800000651.

.

Zhang, X. & Whitney, E. (2012). Policy options to strengthen the cassava and rice supply Chains, (NSSP Policy Note No.32), Washington, DC: International Food Policy Research Institute (IFPRI).