ANALYSIS OF THE TECHNICAL EFFICIENCY OF CENTRAL BANK OF NIGERIA ANCHOR BORROWER PROGRAMME RICE FARMERS IN KANO STATE, NIGERIA

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ABSTRACT
Sustainable agriculture can be promoted through access to technologies, resources, land, water, education, knowledge and agricultural advice. This study analyzed the economic efficiency of Central bank of Nigeria Anchor Borrower Program rice farmers in Kano State, Nigeria. Multistage sampling technique was adopted for this study. Data were collected through the use of a well-structured questionnaire from 50 sampled small-scale rice farmer beneficiaries in the study area. The stochastic production frontier statistical and econometric tool was used to achieve the stated objectives. Evidence from the technical efficiency model revealed that the coefficient of seed ($P<0.01$), fertilizer ($P<0.01$), farm size ($P<0.01$) and labour ($P<0.01$) positively and statistically influenced rice production.. The study also showed that contact with age($P<0.01$), education ($P<0.01$),farming experience ($P<0.01$) and household size ($P<0.01$) were positive and significant determinants of technical efficiency with the exception of household size which had a negative influence of technical efficiency. Based on the findings in this study it was recommended that that access to quality inputs, promote farmer education, and improve land use practices should be essentially enhanced. Additionally, supporting older and experienced farmers and improving the impact of extension services can play pivotal roles in reducing inefficiencies.
Key words: Technical, efficiency, Central Bank Anchor, Borrower, Rice, Farmers, Kano,
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1. INTRODUCTION

More than half of the world's population relies on rice as an important staple food (Udemezue, 2018). After wheat and corn, it is the third most widely grown crop worldwide (Ajala and Gana, 2015 and USAID, 2016). China and India are world leaders in rice production and dominate the Asian continent. Although countries in Africa, Latin America, while rice consumption is significant in the Middle East and the Middle East, Asian countries contribute the largest share of global rice production. Nigeria ranks 16th in global rice production, with China leading the way with over 210 million tonnes of paddy rice in 2017, followed by India with milled rice Consumption is over 210 million tons.
Moreover, rice is an important traditional crop in Nigeria and is the country's second largest grain crop after maize. Nigeria leads in paddy rice production in Africa, producing 6.7 million tonnes with an average yield of 2.2 tonnes per hectare, FAOSTAT (2023). Although rice cultivation extends across all agro-ecological zones in Nigeria, production is concentrated in the north, particularly in the west and central states.The diversity of agro-ecological production

systems allows Nigeria's food sub-sector to display a wide variety of staple crops. Rice has grown to a position of prominence among the key foodcrops such as maize, sorghum, millet, tubers, legumes and others (Vihi*et al.*, 2020). Challenges such as low agricultural investment, financial problems, processing and marketing difficulties affect Nigeria's rice productivity and negatively impact rural farmers, Saheed*et al.,* (2018). Rice occupies an important place in the diet of many African nations, including Nigeria, but excessive imports affect local yield and efficiency Durand-Morat*et al.,* (2019).
Furthermore, smallholder farmers, the major rice producers in Nigeria, face numerous obstacles such as inadequate inputs, outdated production methods, high input costs, land degradation and lack of capital USAID (2016); Osanyinlusi and Adenegan (2016). In response, the federal government initiated programs to promote local investment and rice production with the aim of reducing dependence on imported rice. Launched in 2015, the Anchor Borrowers Program (ABP) provides essential agricultural inputs to farmers through a financial model involving anchor companies, CBN, NIRSAL and state governments. Although the ABP reportedly increased local rice production, challenges remain and its impact on poverty alleviation and food security remains controversial (Osanyinlusi and Adenegan, 2016).
However, agricultural credit facilities contribute significantly to the low productivity of Nigerian farmers (Saheed*et al.,* 2018). Due to limited resources, subsistence farming prevails in rural areas, making it difficult for farmers to meet the country's growing food needs. Inefficient resource utilization, environmental and institutional problems, and failure to maximize resource yield are identified as major constraints to domestic rice production in Nigeria. Despite being the second largest rice producer in Africa, Nigeria still faces challenges in fully exploiting its rice production potential.
Rice consumption exceeds domestic production in Nigeria, making it the second largest rice importer in the world after China OECD/FAO (2019); Durand-Morat*et al.,* (2019). The government's ongoing efforts to achieve self-sufficiency include strategic investments in production, milling, sorting, marketing and infrastructure. The broad objective of the study is to identify factors affecting the technical efficiency of ABP rice farmers in the study area. Eight years after the introduction of the ABP, analyzing its impact on the yields and socio-economic status of farmers in Kano State is critical. The aim of this analysis is to guide policy decisions and contribute to the expansion of rice cultivation and self-sufficiency in Nigeria. The study is based on the belief that the Central Bank of Nigeria's lending programs should have had a positive impact on productivity, employment and agricultural production over the eight-year period (Dori, 2018).

In addition majority of these farmers do not use better inputs or appropriate production techniques, which accounts for low yields across the country (USAID, 2016). High input costs, diversion of subsidized agricultural inputs, land degradation, annual bush burning depleting soil organic matter, land problems, lack of capital, neglect of the agricultural sector, inadequate crop inputs, market failure, inadequate technical know-how in the region, the use of fertilizers and improved seeds as well insufficient essential inputs for rice farmers are other factors contributing to the poor performance of the subsector in Nigeria (Osanyinlusi and Adenegan, 2016).
In response, the federal government has launched programs to promote local investment and rice production to reduce the country's over-reliance on imported rice. Despite the mixed results of these measures, the government stuck to its mission and changed some programs and policies while launching and implementing new ones. The Anchor Borrowers Program was introduced in 2015. The initiative, one of CBN's intervention programs, aims to alleviate farmers' difficulties by providing them with essential agricultural inputs such as seedlings, cash, farm implements, fertilizers, water pumping machines and cultivation services, among

others. The program uses a financial model in which anchor companies CBN, NIRSAL and state governments organize the out-growers and ensure they comply with the terms of the contract. Rice yield or output in Nigeria grew annually from 5.5 million tons in 2015 to about7.5 million tons in 2016 courtesy of these particular initiatives even though a sizable shortfall of about 3.8 million metric tons still exist (Udumeze, 2018).

However, to increase farmers' productivity, resources need to be used more effectively with a focus on achieving production targets without wasting them (Ume and Nwaobiala, 2012). Efficiency can be achieved either by increasing production from available resources or by reducing the resources needed to produce a particular output. Production efficiency is crucial for increasing output. This involves optimizing already available resources to ensure the highest possible production under the current technological limits. Technical efficiency is the ability of a company to achieve the highest possible turnout with a given amount of inputs and available technology. Efficiency is a critical component of productivity growth, particularly in our emerging agricultural sector where resources are scarce and opportunities to develop and implement improved technologies are currently declining (Onyenweaku and Effiong, 2005). Therefore, improving farmers' production efficiency will lead to higher production and profitability as well as improved food security for the country.

Efficiency is the missing link that remains an important topic of empirical study, particularly in developing countries where the majority of farmers are resource poor. Farmers' resistance to using the right combination of inputs is a very tough nut to crack. If the savings rate in agricultural technology increases, the return on investment generally also increases with high production efficiency. However, beyond this, there is little or no thorough and up-to-date information on the level of efficiency of farmers in using resources, as the few studies currently available in the study area have largely focused on farm profitability without going into depth on that farmer efficiency. To fill this gap, this study was designed to analyze how economically efficient farmers in the study area are. Specifically, the study aims to achieve the following goals:

- Determine the technical efficiency of rice farmers;
- Examine the determinants of technical efficiency;

2. LITERATURE REVIEW

2.1 Theoretical Literature

The study follows contemporary production theory that explores the implications of recent work using duality and translog specifications of production functions for agricultural research (Debertin, 2002; Nguyen *et al.,* 2008). These theoretical developments have broad applicability for research in production economics and demand analysis for agricultural problems at different levels of aggregation. Operational efficiency is the ability of a business to produce its output without wasting resources. An economically efficient operation is one that operates at the interface between the production isoquant and the isocost line for a given production (Coelli et al., 2005). Given the situation in the Nigerian rice sector, farmers are faced with the decision of whether or not to increase their production levels. According to economic principles, only producers who achieve low-cost production by pursuing economies of scale and managerial efficiency through the appropriate use of production technologies can survive over time. Therefore, it is very important to understand the differences in farmers' efficiency in using resources (land, seeds, fertilizers, pesticides and labor) to achieve their goals.

There are three different approaches to measuring firm efficiency based on production, cost and profit functions (Parikh and Ali, 1995; Shaik, 2014). Coelli et al. (2005) distinguish between technical and allocative efficiency as a measure of production efficiency using a production frontier or a cost function. The cost function represents the dual approach because technology is viewed as a constant for the optimization behavior of companies (Chambers and Quiggin, 1998). The cost function can be used to simultaneously predict both the technical and allocative efficiency of a firm (Coelli, 1994). This study is based on a stochastic cost frontier approach (Coelli et al., 2005). This approach is stochastic and the observations may be outside the norm due to inefficiency or due to random shocks or measurement errors. The cost function approach is preferred over the profit function approach to avoid estimation problems that can arise in situations where farmers earn zero or negative profit at prevailing market prices (Gronberg et al., 2012). Kumbhakar et al. (1991) defined the stochastic cost function as:

$$Cu= f (yit, wit) + (uit + vit)$$

Where, vit values are assumed to be independently and identically distributed $N(0,\sigma2\ v)$ two sided random errors, independent of the uit. uit are non-negative unobservable random variables associated with cost inefficiency or economic inefficiency, which are assumed to be independently and identically distributed as truncations at zero of the \N(0,σ2 u)\ distribution, µit being a vector of effects specific to smallholder rice farmers, Cit is the cost associated with rice production, yit is the rice output and wit is the vector of input prices. In the cost inefficiency effects model, the error term is composed of two components: cost inefficiency effects and statistical noise. The two error components represent two entirely different sources of random variation in cost levels that cannot be explained by output and input prices. The cost inefficiency effects could be specified as:

$$Uit = \delta zit + Wit$$

Where zit is a vector representing possible inefficiency determinants, and δ is a vector of parameters to be estimated. Wit, is defined by the truncation of the normal distribution with mean zero and variance σ2 . The parameters of the stochastic frontier and the inefficiency model are simultaneously estimated. uit provides information on the level of cost inefficiency of farm i. The level of cost inefficiency CIit may be calculated as the ratio of frontier minimum cost (on the cost frontier) to the observed cost conditioned on the level of the farm output. This measure has a minimum value of one. Cost inefficiency can therefore be defined as the amount by which the level of production cost index for the firm is greater than the firm cost frontier.

2.2 Empirical Literature

A comparative analysis was conducted by Gona*et al.,* (2020) to evaluate the profit efficiency of Anchor Borrowers Programme (ABP) beneficiary and non-beneficiary rice farmers in Kebbi State, Nigeria. Multistage sampling technique was used to select 499 ABP beneficiary and non-beneficiary rice farmers each giving a sample size of 998. A well-structured questionnaire was administered in order to collect data. Data collected were analyzed using Stochastic Frontier Profit Function Model. The results revealed that farm efficiency index varied from one farmer to another and ranged from 0.44 to 0.99, with a mean of 0.94 for the beneficiary farmers, while for non-beneficiary farmers, the maximum efficiency was 0.90 with 0.11 minimum efficiency and a mean of 0.74 The results revealed that the two categories of farmers were not efficient in maximizing profit, however, ABP beneficiary rice farmers were more profit efficient than the non-beneficiary rice farmers.

In another development, Salisu*et al.,* (2022) examined the effects of Anchor Borrowers' Programme (ABP) on the productivity of rice farmers in Kebbi State, Nigeria. A multi-stage sampling technique was used to collect data from 221 ABP rice farmers with the aid of structured questionnaire which were analyzed, using descriptive statistics, Total Factor

Productivity (TFP) and Ordinary Least Square (OLS) regression. The results obtained showed that the average age of the respondents determined was 46years, out of which 69.27% of them were male and 93.21 % married. Majority of the respondents' primary occupation is farming with an average farming experiences and household size of 20years and 14 persons respectively. The mean productivity index of the ABP rice farmers estimated was 6.24 with the minimum and maximum values of 1.89 and 14.45 respectively. The result on OLS regression which found that ABP credit was statistically significant at 1% level of significance has a positive effect on the productivity of the rice farmers. Lack of awareness, bureaucratic bottlenecks and high interest rate are found to be severe constraints limiting small scale rice farmers' access to ABP credit.
Olusola*et al.,* (2021) focused on the effects of Anchor Borrowers' Programme (ABP) on rice farmers in Ifelodun/Irepodun Local Government Area, Ekiti State. Primary data were collected with the use of a well-structured questionnaire from a total of 120 rice farmers in the study area. Multi-stage sampling procedure was employed to select rice farming households head for the study. The analytical tools used were descriptive, farm budgetary techniques, and regression analysis. The major constraints as ranked include unpredictable climatic conditions, transportation problem, inadequate extension services, and inadequate of finance. Input supply, farming equipment, and trainings were the major benefits received from the ABP. The average net profit for ABP beneficiaries of N562,295±20,012 was higher than N263.709±22,317 for ABP non-beneficiaries. Years spent in school, years of rice farming experience, and anchor borrower's awareness were statistically significant at 5% level and had a positive relationship with the level of rice farmers' participation in ABP. Also, farm size was statistically significant at 1% level and had a positive effect on rice farmers' participation in the programme.

2.3 Literature Gap And Value Addition
Most of the cited literature, such as Okoruwa and Ogundele (2006) and Shehu*et al.,* (2010), is over a decade old, making their findings potentially less relevant to the current socio-economic environment. The present study uses more recent data (2022), providing an up-to-date analysis of the technical efficiency of rice farmers, and potentially uncovering new trends and influencing factors those older studies did not capture.
It makes significant contributions to the literature on technical efficiency in rice farming, particularly within the framework of government agricultural programs like the ABP. These findings not only enhance the understanding of the drivers of efficiency but also provide actionable insights for improving the productivity and livelihoods of rice farmers in Nigeria.

3. METHODOLOGY
The study area was Kano State, Nigeria. Kano State is located in the Northern Guinea and Sudan ecological savannah zone in northern Nigeria. It has a population of 9,383,682 people who are mostly Hausa and Fulani NPCs (2006). According to KNSG (2004), other ethnic groups live in the state, including all major and minor tribes of Nigeria such as Igbo, Yoruba, Nupe, Kanuri, Ebira, Urhobo as well as other races from the Middle East, particularly from Lebanon and Yemen and Syria. The state lies at latitude 10033' North to 12037 North and longitude 70 34 to 9029 East in the Sudan Savanna vegetation zone. The major crops grown in the state include rice, millets, groundnuts, pepper, sorghum, maize and paddy, which are grown everywhere due to the availability of irrigation facilities made possible by the construction of artificial water bodies such as earthen dams across the state. The primary source of information was used to collect data from small rice farmer beneficiaries of the Anchor Borrowers Programme for the 2022 farming season using a

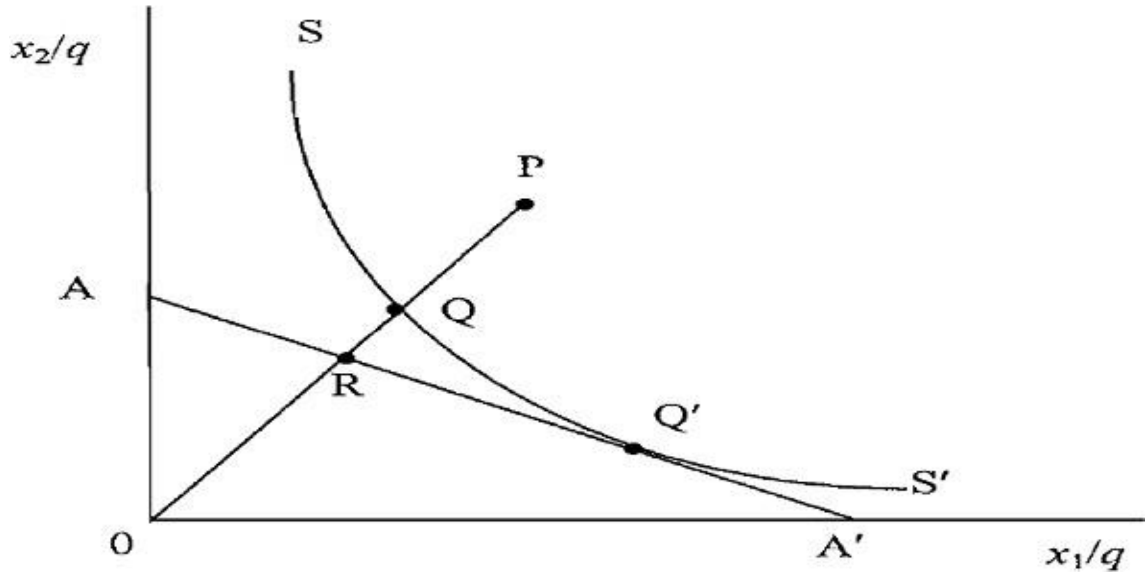
well-structured questionnaire. Using a multi-stage sampling technique, 50 rice farmers were selected for the study.

3.1 Theoretical Framework

Farrell (1957) classified efficiency as technical (physical), allocative (price) and economic (overall) efficiency. Technical efficiency shows the ability of farmers to produce the greatest amount of output possible with the existing level of inputs. On the other hand, allocative efficiency measures the ability of farmers to utilize inputs in an optimal ratio considering the prices of inputs and outputs. A firm is economically (overall) efficient if it achieves both technical and allocative efficiency.

For a given firm, the two inputs (X1 and the isoquant SS' represents the different combinations of the two inputs that the firm uses to produce a given quantity of output. The deviations from the isoquant indicate technical inefficiency of the firm; If for example, the firm uses inputs at point P to produce a unique output on the isoquant. The technical inefficiency of a firm is represented by the segment QP, which indicates the amount by which all inputs could be proportionally reduced without affecting the level of output decreases (Coelli*et al.,* 2005).

Figure 1: Graphical representation of Technical and allocative efficiencies



Source: Coelli, *et al.*, 2005.

It is also assumed that the efficient production function which is the ability of an efficient firm to produce maximum output from the given set of inputs is known. X and Y are two factors of production. P shows the combination of two inputs to produce a single output. Q is the point on which the ratio of an efficient firm uses the two inputs is the same as in Point P. SS' is the isoquant which shows the different combination of inputs that an efficient firm should use to produce a single output. QP is the amount of inputs that can be given up to produce the same level of output and which is also known as technical inefficiency. The ratio QP/OP shows the percentage reduction of inputs of achieving technical efficiency. The ratio OQ/OP is the Technical efficiency of a firm. The distance QP shows the technical inefficiency of the firm which is the amount by which the inputs could be reduced while the output remains the same. The value of T.E lies between 0 and 1. When the value is 1 the firm is technically efficient. When the value is less than 1 the firm is technically inefficient .AA' is the line on which the slope and the ratio of the prices of two inputs are the same at point Q'. The ratio of OR/OQ shows the allocative efficiency of a firm. The ratio OR/OP shows the overall efficiency (Economic Efficiency) of a firm (Farrell, 1957). Thus, the technical efficiency of a firm is one minus the ratio of QP /OP as shown in the equation. On the other hand, allocative

efficiency is measured by the ratio of input prices represented by the slope of isocost line AA', whereas economic (overall efficiency) is the product of technical and allocative efficiencies (Coelli*et al*., 2005). Technical efficiency TE = OQ /OP.
The technical efficiency is also defined as the ratio between the observed output and the corresponding frontier or maximum output.
TE=Yi/Y* …………………………………. (2.1)
Where by

$Y_i = f(X_i, \beta) \exp(v_i - u_i)$,
$Y^* = f(X_i, \beta) \exp(v_i)$
Therefore equation (2.1) can be written

$$T.E = \frac{f(Xi,\beta)\exp(vi - \mu i)}{f(Xi,\beta)\exp(vi)} = \exp(-u_i)$$

Allocative efficiency AE =OR/OQ

Economic efficiency EE = TE × AE = (OQ/OP) × (OR/OQ) = OR/OP

The range of technical efficiency is between 0 and 1. If ui = 0 it means that farmers are fully efficient and lie on the frontier. In this case, the stochastic frontier production function is reduced back to simple production function which indicates that there is no inefficiency and the error term is only the factors that are outside from the farmer control. If ui> 0 it means that farmers lie below the frontier which indicates that farmers are inefficient producers and make losses.

3.2 MODEL SPECIFICATION

The stochastic frontier analysis was employed to achieve the objective of this study. The stochastic frontier analysis has been used by Nyagaka*et al.,* (2010), Akinbode*et al.,* (2011), Ahmed and Melesse (2018), Okello*et al.,* (2019) and Gela *et al.,* (2019). The stochastic frontier production function model for estimating farm level technical efficiency was specified as:

$Qj = f(Xj; \beta j) + \varepsilon j \quad j = 1,2,..., n$

where: Qj= output of the jth farm, Xj= vector of input quantities used by the *j*th farmβj= vectors of unknown parameters to be estimated$f(Xj;\ \beta j)$ = production function(Cobb-Douglas, trans log, etc.)εi= error term that is composed of two elements, that is, $\varepsilon j = Vj - Uj$which represents the traditional deterministic production function formulation.

$Y = f(X;\beta) + v - u)$

Vj= assumed independent distributed random errors.

It is assumed to be independent, identical and normally distributed with a mean of zero and constant variance$\{Vj \sim N(0, \sigma v2)\}$ and independent of Ujgiven the stochastic structure of the frontier. Uj– technical inefficiency effects. It is assumed to be independently, identically and normally distributed$\{Uj[N|(0, \sigma u2)]\}$ and independent of Vj. Also, the technical inefficiency effects in the stochastic frontier above are expressed in terms of various explanatory variables (assumed to be related to farm and farmers in relation to socio-economic characteristics) which include socioeconomic characteristics such as age, sex, etc.
The technical efficiency of rice farmers was analyzed using stochastic production frontier analysis in particular Cobb-Douglas functional form to estimate the coefficients of the parameters of the production function and also to predict efficiencies of the rice farmer. This model is chosen because it allows for the presence of technical inefficiency while accepting that random shocks(weather or

disease) beyond the control of the farmer can affect output. The Cobb-Douglas production form of the frontier that was used for this study was specified as:

$LnQ = \beta 0 + \beta 1 lnx1 + \beta 2 lnx2 + \beta 3 lnx3 + \beta 4 lnx4 + \beta 5 lnx5 + \beta 6 lnx6 + \beta 7 lnx7 + Vj - Uj$

where:*Ln* = natural logarithm (i.e. logarithm to the base *e*); *Qi* = output of farmer (kg)*X*1 = farm size (ha); *X*2 = seed (kg); *X*3 = fertilizer (kg); *X*4 = labour (man days)*X*5 = agrochemicals (litres). The factors hypothesize to affect efficiency include age, household size, education (years); membership of farmers' associations, farming experience (year)and extension contactTE takes values within the interval zero and one (i.e. between 0 and 1), where 1 indicates a fully efficient farm.

4. RESULTS AND DISCUSSION

This output shows the results of a stochastic frontier analysis (SFA) aimed at measuring technical efficiency among a group of farmers. The model consists of two parts: (1) the stochastic frontier, which explains the production function and input-output relationship, and (2) the inefficiency model, which explains the factors that contribute to inefficiency.

Table 1: Technical Efficiency Estimates of ABP Rice Farmers

Variable	Parameters	Coefficient	Std. Error	t-stat
Stochastic Frontier				
Constant	β_0	-546.61	180.88	-3.0218***
Seeds	β_1	24.625	3.1777	7.74960***
Fertilizer(kg)	β_2	8.77098	0.75056	11.6859***
Agrochemicals(ltrs)	β_3	395.211	9.11432	43.3615***
Farm Size(ha)	β_4	755.245	60.6830	12.4457***
Labour (man-days)	β_5	0.39217	0.05420	7.23496***
Inefficiency Model				
Constant	a_0	568.887	49.6790	11.45124
Age of respondent (years)	a_1	-656.836	119.036	-5.5179***
Education (years of formal schooling)	a_2	-2336.43	203.874	-11.460***
Experience (years)	a_3	-8.76262	1.99509	-4.3920***
Household size (No. of H/H members)	a_4	186.707	17.0901	10.9248***
Membership of Association	a_5	-0.19115	0.21753	-0.87871
Extension Visits (No. of visits/month)	a_6	355.276	256.045	1.38755
Variance Parameters				
Gamma	γ	0.74311		
Sigma-squared	σ^2	0.19488		
Log-likelihood function		0.13070		

Source: Field Survey, 2022. *** Significant at 1% ($p<0.01$), ** at 5% ($p<0.05$), * at 10% ($p<0.10$)

Table 1 shows parameter estimates from the stochastic production frontier, focusing on various inputs in rice production. The coefficient for rice seeds (24.63) is both positive and highly significant at the 1% probability level, indicating that an increase in seed quantity corresponds to an increase in production yield. This finding is consistent with the research of Okoruwa and Ogundele (2006) on technical efficiency in rice production in Nigeria. Similarly, the coefficient for fertilizers (8.77) is positively and significantly associated with 1% probability level, indicating that proper use of fertilizers can increase paddy rice production. Furthermore, the coefficient for agrochemical use is positive and statistically significant with a probability of 1%, indicating that increased use of agrochemicals directly increases paddy rice production, which is consistent with the results of Shehu et al. (2010)

The coefficient for farm size was also statistically significant and positive with a probability of 1%, indicating that increasing farm size leads to higher paddy production and higher profits. This corroborates the research of Rahman and Umar (2009) on technical efficiency in crop production in Nigeria. Likewise, the labor coefficient is statistically significant and positive with a probability of 1%, indicating that an increase in labor has a positive impact on rice production. This is in line with the findings of Nwaobiala and Adesope (2015) on the relationship between labor costs and swamp rice production.

The stochastic frontier production function includes variance parameters represented by gamma (γ) and sigma squared (δ^2). The gamma value (γ), measured at 0.74, deviates significantly from zero at the 1% probability level, indicating that about 74% of the variation in rice farmers' production levels is due to technical inefficiencies. Farmers should focus on reducing the influence of the γ effect to increase technical efficiency and increase yield. The sigma squared value (δ^2), estimated at 0.19, also deviates significantly from zero at the 1% probability level, confirming that the assumed distribution shape for the error term fits the data well. When studying technical sources of efficiency, the sigma coefficient (δ) was used. The estimated coefficient for age (a1) is negative and statistically significant at 1% probability, indicating that older farmers tend to be more efficient due to accumulated experience.

Likewise, the coefficient estimate for education was negative and significant at 1% probability, suggesting that higher levels of formal education contribute to higher technical efficiency. The coefficient estimate for experience was negative and significant at the 1% probability level, meaning that more experienced rice farmers tend to be more efficient. However, the coefficient estimate for household size was positive and statistically significant with a 1% probability, suggesting that larger household size leads to greater technical inefficiency.

5. CONCLUSION AND RECOMMENDATIONS

The stochastic frontier analysis reveals that factors such as seeds, fertilizers, agrochemicals, farm size, and labour significantly contribute to increasing productivity among farmers in Kano State, Nigeria. Among these, agrochemicals and farm size have the most profound impact. However, inefficiency is influenced by factors such as age, education, farming experience, and household size, with older; more educated, and experienced farmers exhibiting greater efficiency, while larger household sizes contribute to inefficiency.

To improve technical efficiency and bridge the productivity gap, it was recommended that access to quality inputs, promote farmer education, and improve land use practices should be essentially enhanced. Additionally, supporting older and experienced farmers and improving the impact of extension services can play pivotal roles in reducing inefficiencies. Policymakers should also focus on financial support systems to ensure that farmers can maximize their productivity potential. Addressing these challenges holistically will lead to more efficient and sustainable agricultural development in the State.

REFERENCES

Ahmed, M.H., andMelesse, K.A. (2018). Impact of Off-farm Activities on Technical Efficiency: Evidence from Maize Producers of Eastern Ethiopia.*Journal of Agricultural and Food Economics, 6(1), 1-15.*

Ajala, A. S., and Gana, A. (2015).Analysis of Challenges Facing Rice Processing in Nigeria.*Journal of Food Processing, 2015, Article ID 893673*.

Akinbode, S.O., Dipeolu, A.O., Ayinde, A.I. (2011). An Examination of Technical, Allocative and Economic Efficiencies in Ofada Rice Farming in Ogun State, Nigeria. *Afr. J. Agric. Res., 6(28), 6027–6035.*

Chambers, R.G. and Quiggin, J., (1998). Cost Functions and Duality for Stochastic Technologies.*American Journal of Agricultural Economics 80(2):288–295.*

Coelli, T., Prasada, D.S.R., Battese, G., E. and O'Donnell, J.C., (2005).An Introduction to Efficiency Analysis.Springer, USA.

Coelli, T., Rao, D. S. P., &Battese, G. E. (1998).An Introduction to Efficiency and Productivity Analysis.Kluwer Academic Publishers.

Coelli, T.J., (1994). A Guide to Frontier Version 4.1: A Computer Programme for Stochastic Frontier Production and Cost Function Estimation" Centre for Efficiency and Productivity Analysis (CEPA) Working Papers 7(96):1–33.

Debertin, D.L. (2002). Contemporary Production Theory: The Factor Side. In Agricultural Production Economics (pp. 366–397). Lexington, KY: University of Kentucky Press.

Dori, N.A (2008).The Impact of Central Bank of Nigeria's Agricultural Credit Guarantee Scheme Fund on Agricultural and Economic Development of Nigeria.*International journal of political science and Development, 4*(3), 63-74

Durand-Morat, A., Chavez.E., and Wailes. EN (2019). International Rice Outlook, International Rice Baseline Projections, 2018-2028. International Rice Outlook.

FAO (2023). Wood Food Situation: FAO Cereal Supply and Demand Brief. Food and Agriculture Organization

Farrell, M. J. (1957). The Measurement of Productive Efficiency.*Journal of the Royal Statistical Society: Series A (General), 120(3), 253-290.*

Gela, A., Haji, J., Ketema, M., and Abate, H. (2019). Technical, Allocative and Economic Efficiencies of Small-scale Sesame Farmers: The Case of West Gondar Zone, Ethiopia. Rev. Agric. Appl. Econ., 22(2), 10–17.

Gona A., Alhaji I. O., and Kaka, Y. (2020).Relative Profit Efficiency of Anchor Borrowers Programme (ABP) Beneficiary and Non-beneficiary Rice Farmers in Kebbi State, Nigeria.*Journal of development and agricultural economics*, 12(4), 238-245.

Gronberg, T., Jansen, D., and Taylor, L.(2012). The Relative Efficiency of Charter Schools: A Cost Frontier Approach. Economics of Education Review, 31(2)

Kumbhakar, C., Soumendra, G. and McGuckin, T.J., (1991). A Generalized Production Frontier Approach for Estimating Determinants of Inefficiency in U.S. Dairy Farms" Journal of Business and Economic Statistics 9 (3): 279–86.

Nguyen, D., Keith, T. Mclaren, M. and Zhao, X., (2008). Multi-Output Broadacre Agricultural Production: Estimating A Cost Function Using Quasi-Micro Farm Level Data From Australia. In AARES 2008 CONFERENCE.

Nwaobiala, C.U. andAdesope, O.M., (2013). "Economic Analysis of Smallholder Rice Production Systems in Ebonyi State, South-East Nigeria."*Russian Journal of Agricultural and Socio-Economic Sciences, 23(11), 3-10*

Nyagaka, D.O., Obare, G.A., Omiti, J.M. and Ngoyo, W. (2010). Technical Efficiency in Resource Use: Evidence From Smallholder Irish Potato Farmers in Nyandaura North District, Kenya. *Afr. J. Agric. Res., 5(11), 1179–1186.*

OECD/Food and Agriculture Organization of the United Nations (2019), "Overview of the OECD-FAO Outlook 2014-2023", in OECD-FAO Agricultural Outlook 2019, OECD Publishing, Paris.

Okello, D.M., Bonabana-Wabbi, J., and Mugonola, B. (2019). Farm Level Allocative Efficiency of Rice Production in Gulu and Amuru Districts, Northern Uganda. Agricultural and Food Economics, 7(19).

Okoruwa, V.O. and Ogundele, O.O. (2006) Technical Efficiency Differentials in Rice Production Technologies in Nigeria. In *African Economic Research Consortium Research Papers*; African Economic Research Consortium: Nairobi, Kenya, 2006; p. 4

Olusola, A. T., Kamila, A. O., Lawrence, B. O., Olatunbosun, J. L., and Oluwanisola, A. M. (2021). Effects of Anchor Borrowers' Programme on Rice Production in Irepodun/Ifelodun Local Government Area, Ekiti State.*Journal of life and physical science*, 13 (1), 13 – 25

Onyenweaku C.E and Effiong E.O. (2005). Technical Efficiency in Pig Production in AkwaIbom State, Nigeria. *International Journal of Agricultural Rural Develop ment, 6(3), 51-57*

Osanyinlusi, O. L., Adenegan. K. O (2016). The Determinants of Rice Farmers' Productivity in Ekiti State, Nigeria.*Greener journal of Agricultural sciences* (ISSN: 2276.7770).(2): 049-058

Parikh, A. and Farman A., (1995).Measurement of Economic Efficiency in Pakistani Agriculture.*American Journal of Agricultural Economics 77(3):675–85.*

Rahman, S.A. and Umar, H.S. (2009).Measurement of Technical Efficiency and Its Determinants in Crop Production in Lafia Local Government Area of Nasarawa State, Nigeria. *Journal of Tropical Agriculture, Food, Environment and Extension, 8(2), 90-96*

Saheed. Z., Alexander. A., Isa. A., and Adeneye. O (2018). Anchor Borrower Programme on Agricultural Commodity Price and Employment Generation in Kebbi State, Nigeria. *European Scientific Journal*, 14(13): 213-256.

Salisu, J., Adebayo, C. O., Jirgi. A. J., and Ojo, A. O. (2022). Effects of Anchor Borrowers Programme (Abp) Credit on the Productivity of Beneficiary Rice Farmers in Kebbi State, Nigeria.*FUdma Journal of Agriculture and Agricultural Technology*, 8(1), 329-338.

Shaik, S., (2014). Re-Examination of Production, Cost, and Restricted Profit Functions Using Quantile Regression Approach." Agricultural Economics (United Kingdom) 45 (2): 199–212.

Shehu, J.F., Iyortyer, J.I., Mshelia, S.I. and Jongur, A.A.U. (2010).Determinants of Yam Production and Technical efficiency among Yam Farmers in Benue State, Nigeria.*Journal of social science. 24(2):143-148.*

Udemezue J,C. (2018). Analysis of Rice Production and Consumption Trends in Nigeria. *Journal of Plant Sciences and Crop Protection 1(3), 1-6*

Ume S.I, and Nwaobiala CU. (2012).Economic Efficiency of Upland Rice Farmers Across Gender in Anambra Agricultural Zone of Anambra State, Nigeria. *Agricultural Journal, 41(2), 37-45*

USAID (2016).Nigeria Early Generation Seed Study: Country Report. USAID Bureau of Food Security.USAID.

Vihi S.K, Jesse B, Dalla A.A, and Tor LG. (2020). Analysis of Household Consumption Preference for Local and Imported Rice Brand in Jos South LGA, Plateau State, Nigeria, 3(1), 78 –88, May , 2020. A Publication of Department of Agricultural Economics & Extension University of Jos, Nigeria,