Technical Efficiency and Production Risk of Rice Farms under Anchor Borrowers Programme in Kebbi State, Nigeria

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ABSTRACT

Abstract: This study estimates technical efficiency and production risk of rice farms under Anchor Borrowers Programme (ABP) in Kebbi State, Nigeria. The study employed Stochastic Frontier Production (SFA) with flexible risk specifications to a sample of 231 rice producers surveyed in 2016 production season. The findings shows that seed, fertilizer, agrochemicals and labour inputs influenced rice output positively. The production technology characterizing rice farms in the study area exhibit increasing returns to scale. Fertilizer and agrochemicals are estimated to decrease variance of the value of output while seed and labour are estimated to increase the variance of the value of output. This implies that a risk-averse farmer will use more of fertilizer and agrochemicals and less of seed and labour than a risk neutral farmer. The mean technical efficiency estimates was 85.3 percent. Several characteristics of the farmers such as education, farming experience, extension contact, land cultivation technique and planting technique significantly decrease technical inefficiency of the farmers. The study concludes that, on the average 14.7 percent of potential output is lost due to technical inefficiency and production risk in inputs and recommends the use of best farm practice to produce rice efficiently. Policy option should also consider the incorporation of production risk in technical efficiency analysis if the inputs are non-neutral in risk.

Keywords: *Technical efficiency, production risk, Anchor Borrowers Programme, SFA.*

1. INTRODUCTION

In an attempt to tackle the problems militating against agricultural production, diversify Nigerian economy and reduce the nations over dependence on petroleum revenue necessitates the launch of Anchor Borrowers Programme (ABP) in 2015. Available records showed that exports of unrefined petroleum generate only eight point eight million naira (₦ 8.8 million) for Nigeria at independence in 1960 and this covered only 2.7 percent of the total exports earnings, while the proportion of the non-oil sector added up to ₦ 321.2 million covering 97.3 percent of the total exports in the same time. However, by 1976, the exports of unrefined petroleum increased tremendously to ₦ 6,321.6 million representing 93.6 percent of the total exports, while non-oil trades in Nigeria's foreign earnings had declined substantially to 6.4 percent at ₦ 429.5 million and the trend has remained over the years[1].

Nigerian domestic economy depend largely on the non-oil sector. For example, the contribution of unrefined petroleum and natural gas to the country's Gross Domestic Product (GDP) in 2011 and 2015 stood at 14.96 percent and 9.61 percent respectively, while the agricultural sector contributed 23.35 percent and 23.11 percent in these respective years [2]. Further, oil refining has been contributing less than 0.5 percent to the country's GDP as Nigeria only exports unrefined petroleum whose price is fixed externally. Regrettably, unrefined petroleum prices has been on the decrease over the most recent four years. From an average of US$ 113.5 in 2012, a barrel of unrefined petroleum sold under US$ 50.00 in 2015 and the greater part of 2016 [3, 4]. It is against this foundation that calls for diversification of Nigerian economy from oil to other sectors. Nigeria is endowed with abundant agricultural resources. The nation is covering an area of 910.8 thousand square kilometers out of which 77.7 percent is cultivable [5].The soil and climatic condition can support different crops and livestock potential outcomes. It has the biggest population in sub-Saharan African evaluated at 180.7 million in 2014 [2]. In perspective of the abundant agricultural resources, the sector would convey the journey to diversify the Nigerian economy. It is also worthy to note that, the bulk of Nigerian population earn their living from the non-oil sector with agricultural sector alone providing employment for over 70 percent of the populace[6].

But, throughout the years the performance of the agricultural sector failed to meet up with the rapidly growing population, prompting the imports of food and industrial raw materials. These incorporate; wheat, processed rice, raw cane sugar, whole milk powder and additionally fish and fish items, a large portion of which can be produced locally [2]. For instance, Nigeria is reported as the second largest rice importer in the world over the most recent five years of the most recent decades (2000 to 2005)[7]. Nigerian government expanded an outrageous US$ 2.41 billion on importation of rice between 2012 and 2015[8]. The situation in the Nigerian agricultural sector has been followed to various constraints militating against the effective performance of the sector. Noticeable among them are: dominance of smallholder farmers accounting for about 80 percent of the country's total farmers population [6]. These smallholder farmers are confined to the rural areas characterized with low productivity, low level of mechanization and input use, poor infrastructure, high level of post-harvest losses due to pest and disease and poor transport, processing and storage facilities [6, 9].

Different policies and financing arrangement activities have been initiated to enhance the performance of these farmers and transform the agricultural sector. However, the desire objectives have not been accomplished as a result of some peculiarities of the smallholder agriculturists.Conspicuous among these are their poor access to credit and lucrative markets to dispose their produce, which have abandoned them in a vicious cycle of poverty [10] .Keeping in mind the end goal is to diversify the economy by addressing these two basic issues of the smallholder agriculturist, the CBN through its developmental mandate propelled ABP in 2015. The ABP is like the contract farmer concept found in other developing countries like India and Malaysia [11]. The wide goal of the programme is to make financial linkage between smallholder farmers and respectable large scale processor with a view to increase agricultural output and significantly enhanced the capacity utilization of the coordinated factories .Other objectives include: increase banks financing to agricultural sector, decrease agrarian item importation and save foreign reserves, make new age of agriculturists and business, and lessen the level of poverty among smallholder farmers[3, 11].

The credit is focused at smallholder farmers engaged in production of identified commodities of comparative advantage in different states of the nation. The focused commodities include but not constrained to: cereals (rice, wheat, maize, etc.), cotton, roots and tubers (cassava, potatoes, yam, ginger, etc.), sugarcane, tree crops (oil palm, cocoa, rubber, etc.), legumes (soya bean, sesame seed, cowpea, etc.), tomato, livestock (poultry, ruminants, etc.), fish and any other commodity that will be introduced by the CBN from time to time. The farmers are mandated to organize into groups/cooperatives of between 5 and 20 for ease of administration. The credit shall be disbursed to farmers through qualified Participating Financial Institutions (PFIs). The Anchor shall be private large- scale incorporated processors who have gone into agreement with Smallholder Farmers (SHFs) to purchase the harvested produce at agreed price or as might be audited by the Project Management Team (PMT) .The State Government may go about as Anchor after meeting the prescribed conditions. The CBN states that the credit would be given from the two hundred and twenty billion naira (₦ 220 billion), Micro, Small and Medium Enterprises Development Fund (MSMED). The interest rate under the ABP shall be guided by the rate on the ₦220 billion MSMEDF, which is presently at 9 per cent for each annum (all inclusive, pre and post disbursement charges). The PFIs shall access at 2 per cent from CBN and loan at a most extreme of 9 per cent for every annum. The loan term under the ABP shall be the gestation time frame (i.e. the time it takes for a crop or animal to develop and be prepared for market) of the identified commodities. Loan conceded to SHFs shall be reimbursed with the harvested produce that shall be obligatorily conveyed to the anchor at assigned collection in line with the provisions of the agreement signed. The produce to be delivered must cover the loan principal and interest [3, 11].

Kebbi State being the rice hub of the country was quick to key into the programme due to its comparative advantage on dry season rice production and the commitment of the state governor to tackle poverty and provide employment opportunities. The pilot project was launch by the Federal government of Nigeria in November, 2015 in Kebbi State to connect smallholder agriculturists to the integrated rice scheme [3, 11]. Thus, this study estimates the technical efficiency and production risk of rice farms under ABP in Kebbi State, Nigeria.

The next section briefly explained the materials and methods which include: the study area, theoretical framework, conceptual framework and empirical model specification, statements of hypothesis, data and sampling technique. Results are then presented and discussed. The last section presents conclusion and some policy implications.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in Kebbi State, Nigeria. Kebbi State lies between latitude 11^0 30'N Longitude 4^0 15'E on the equator. The State is located in North-western Nigeria with capital in Birnin Kebbi. It covers a total area of 36,229 square kilometers of which 12,600 square kilometers is under agriculture [12]. The state is characterized with distinct wet and dry season. Wet season start from April and end October, while dry season last for the remaining part of the year. Kebbi state is made up of twenty one Local Government Area (LGA) and four Agricultural Development Zones[13]. It is endowed with water bodies such as River Niger, Rima River and river Ka. The climate, soil and vegetation allow for the cultivation of staple crops like rice, millet, guinea corn, maize, wheat, beans, soya bean, groundnut, vegetables among others. The source of income for people living in Kebbi State depend greatly on farming.

2.2 Theoretical Framework

The technique of investigation proposed for this study is in line with the frontier method which was independently proposed by [14, 15]. Nevertheless, the traditional specification of a stochastic production function has a feature that may genuinely limit its potentials to describe production technology appropriately. The major drawback of the model is the implicit assumption that if any input has positive effect on output then a positive effect of this input on output variability is also imposed [16]. Just and Pope Illustrates that, the effects of inputs on output should not be tied a priori to the effects of inputs on output variability. The authors proposed a broader stochastic frontier model that incorporates two general functions; one indicates the effects of the inputs on the mean output and another determines the effects of inputs on the variance output. Just and Pope Approach was modified by [17] and they came up with stochastic frontier production with flexible risk specification. However, the model imposes the same variable inputs, as well as a functional form on the heteroscedasticity in stochastic noise (V) and inefficiency term (U).Kumbhakar further generalized the model to allow the effects of the variable inputs and functional form to differ on the heteroscedasticity in V and U [18]. This study used the generalized Kumbhakar model specified as:

$$Y_i = f(x_i;\alpha) + g(x_i;\Psi)v_i - q(z_i;\delta)u_i \quad (1)$$

Y_i Represents the observed output produced by $i-th$ farm, $f(x_i;\alpha)$ is the mean production function, $g(x_i;\Psi)$ is the output risk function, and $q(z;\delta)$ represents the technical inefficiency model. α is a vector of unknown parameters of mean output function, Ψ is a vector of output risk parameters, δ are the inefficiency parameters to be estimated, x_i are input variables, z_i are inefficiency variables, v_i is the random noise, representing production risk and u_i is the non-negative random variable representing farm specific technical inefficiencies. Given the values of the inputs, the inefficiency effects, u_i, the mean output of the $i-th$ farmer is given by:

$$E(Y_i / x_i, u_i) = f(x_i;\alpha) - g(x_i;\Psi)u_i \quad (2)$$

The technical efficiency of the $i-th$ farm is given by equation (3) which is consistent with Kumbhakar specifications.

$$TE_i = \frac{E(Y_i / x_i, u_i)}{E(Y_i / x_i, u_i = 0)} = \frac{f(x_i;\alpha) - g(x_i;\Psi)u_i}{f(x_i;\alpha)} = 1 - \frac{g(x_i;\Psi)u_i}{f(x_i;\alpha)} \quad (3)$$

According to equation (3), mathematically, technical efficiency is therefore, defined as:

$$TE_I = 1 - TI \quad (4)$$

The technical inefficiency TI, is represented as;

$$TI_I = \frac{g(x_i;\Psi)u_i}{f(x_i;\alpha)} \quad (5)$$

Production risk or variance of output is presented as;

$$Var(Y_i / x_{i,} u_i) = g^2(x_i;\Psi) \quad (6)$$

The marginal risk can be positive as well as negative, depending on the signs of $2g(x;\Psi)$ and $g_i(x;\Psi)$, where the latter is the partial derivative of g with respect to input i. A positive marginal risk means the input has an increasing effect on the output risk and a negative value means that the input has a decreasing effect on the output risk [16]. Relaying on the distributional assumptions of the random errors a log likelihood function for the observed farm output is parameterized in terms of $\delta^2 = \delta_v^2 + \delta_u^2$ and $\lambda = \delta_u^2 / \delta_v^2 \geq 0$ [14].

2.3 Conceptual Framework

The principle focal point of this investigation is the topic of whether the efficiency performance of rice cultivates under Anchor Borrowers Programme in Kebbi State, risk properties of technological inputs and socio-economic/institutional factors leads to issue of low productivity and yield fluctuation and if this is true, what conceivable measure ought to be taken.

The investigation conceptualizes that rice (output) realized comprise of three segments (Figure 2.1). These segments are production model (mean output function), factors influencing technical efficiency (inefficiency function) and production risk (output risk function). This investigation is consistent with production function of [18] which enable mean production function, production risk and technical inefficiency to be evaluated at the same time in stochastic frontier framework. The technological input factors that is; land, seed, fertilizer, agrochemicals, and labour are considered to influence both the mean output and output risk. Factors that influence technical efficiency are classified into three sections that comprise of; demographic, technological and institutional factors.

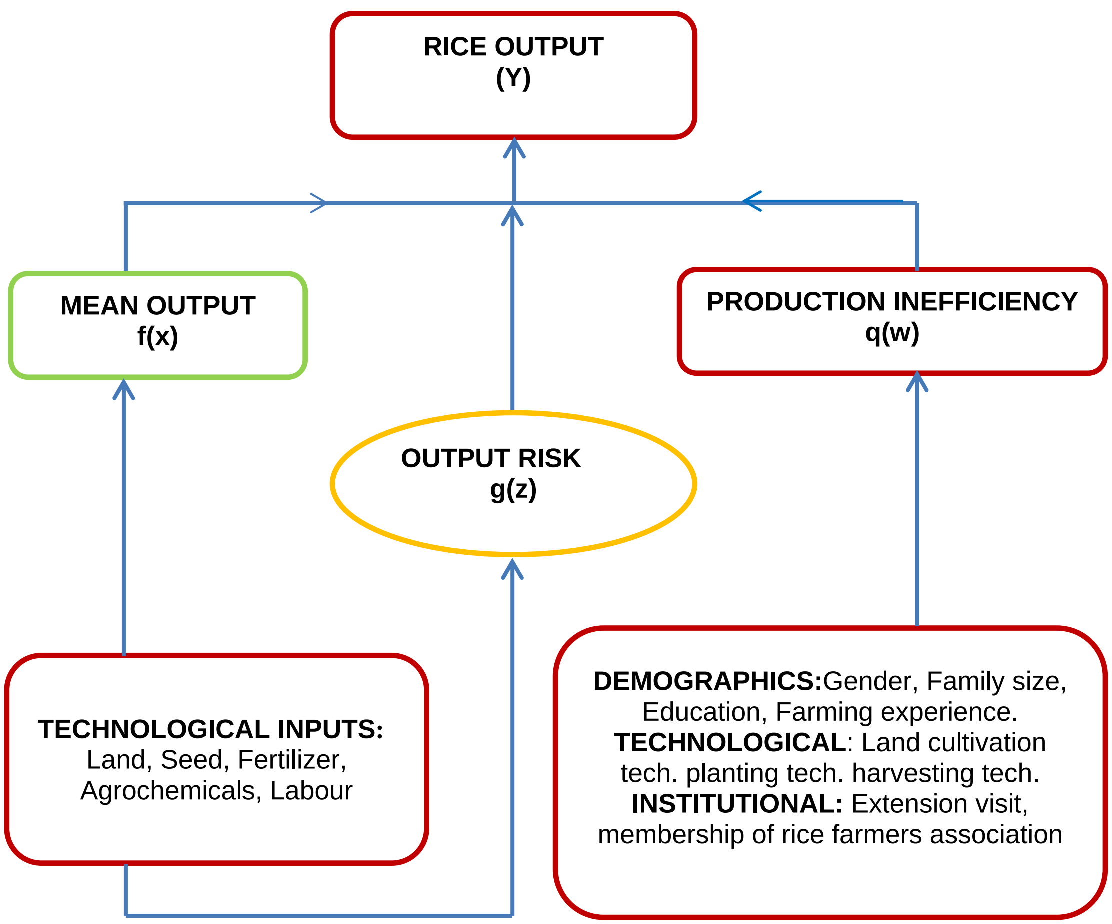

Figure 2.1: Conceptual Framework

2.3 Empirical Model Specification

This study employed trans-log stochastic frontier production function model with flexible risk specification as follows:

$$\ln Y_j = \alpha_0 + \sum_{j=1}^{4} \alpha_{ji} \ln x_i + 0.5 \sum_{j=1}^{4} \sum_{k=1}^{4} \alpha_{jk} \ln x_{ji} \ln x_{kj} + \varepsilon_j \qquad (7)$$

Where the stochastic disturbance term, ε_j is presented as:

$$\varepsilon_j = g(x:\Psi)v_i - q(x:z)u_i \qquad (8)$$

$g(x:\Psi)v_i$ is the risk function component, $q(x:z)u_i$ is the technical inefficiency component, Y_j is the quantity of rice produced by $j-th$ farmer measure in kg/ha, x1 is quantity of seed used measured in kg/ha, x2 is quantity of fertilizer used measured in kg/ha, x3 is quantity of agrochemicals used measured in lt/ha and x4 is labour used measured in man days/ha, j is j-th farmer where j = 1,2,3…….231 and i is i-th input where i = 1, 2,….4 and $\alpha_0, \alpha_i, \alpha_{ii}$ and α_{ik} are the estimated parameters of production technology. The specification is consistent with [18]. The elasticity of output with respect to the various exogenous inputs are functions of the level of inputs involved and are generally specified as:

$$\frac{\delta \ln E(p_i)}{\delta \ln x_{ji}} = \{\alpha_j + \alpha_{jj} \ln x_j + \sum_{k=1} \alpha_{jk} \ln x_j\} \qquad (9)$$

The trans-log production function is not probably going to translate elasticity directly from the coefficients of production function as applied to Cobb-Douglas production function, consequently, the elasticity of production follows [19]. The scale elasticity which is equivalent to frontier output elasticity of greater than 1 implies increasing returns to scale (IRS), less than 1 decreasing returns to scale (DRS) and equal to 1 means constant returns to scale (CRS).Relating to equation (8), the linear production risk function is specified as:

$$g(x_i : \Psi) = \Psi_0 + \sum_{w=1}^{4} \Psi_w x_{wi} \qquad (10)$$

Where $x_w^{'s}$ represent input variables as described above, $\Psi_w^{'s}$ are the unknown values of the risk parameters, that is the marginal production risks of individual inputs and when it is negative it implies that the respective input is a risk decreasing input and vice versa [16].Referring to equation (8), the linear technical inefficiency model is specified as:

$$u_i = \delta_0 + \sum_{r=1}^{9} \delta_r w_{rj} \qquad (11)$$

Where δ_r represents unknown values of the technical inefficiency model, $w_r^{'s}$ are vectors of r producer variables (Table 1).

Table 1. Description of variables in the inefficiency model

Variable	Description	Measurement
w_{1i}	Gender	Male 1, female 0
w_{2i}	Household size	Number
w_{3i}	Education	Formal 1, non-formal 0
w_{4i}	Farming experience	Years
w_{5i}	Extension contact	Had contact 1, otherwise 0
w_{6i}	Member of cooperatives	Member 1, not member 0
w_{7i}	Land cultivation method	Use machine 1, otherwise 0
w_{8i}	Planting method	Transplanting 1, broadcasting 0
w_{9i}	Harvesting method	Machine 1, manual 0

2.4 Statement of Hypothesis

The following hypotheses were formulated for investigation: $H_0 : \alpha ij = 0$, the coefficients of the second-order variable in the translog model are zero. This implies that the Cobb-Douglas function is the best fit for the model. $H_0 : \Psi_1 = \Psi_2 = \Psi_3 = \Psi_4 = 0$, the variability in the output is not explained by production risk in input factors. $H_0 : \lambda = 0$, inefficiency effects are absent from the model. That is the variance of inefficiency term are zero and deviations of observed output from the frontier output are entirely due to pure noise effect which implies Ordinary Lease Square (OLS) is more appropriate. $H_0 : \delta_1 = \delta_2 = ,.... = \delta_9 = 0$, parameters of modern farming technology have no effects on technical efficiency of rice farms. That is the coefficients of modern farming technology are zero.

2.5 Data and Sampling Technique

This study used cross sectional data from a total of 231 rice farms randomly sampled from Kebbi State. The data for the study was sourced from the survey conducted for the period of 2016 farming season. The data covered relevant variables including output and inputs variables as well as farm specific variables. Kebbi State has 21 Local Government with four agricultural zones [13]. Farmers were randomly sampled relative to the population of each agricultural zone as: zone i(Birnin Kebbi) 68, zone ii (Argungu) 44, zone iii (Suru) 95 and zone iv (Zuru) 24, totalling 231 respondents.

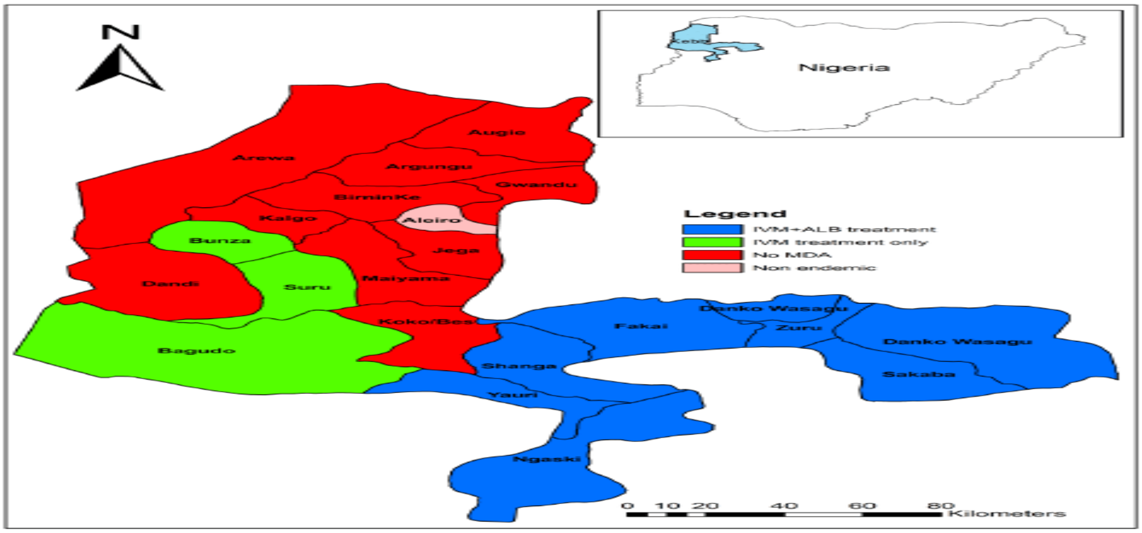

Figure 2.2: Map of Kebbi State showing the twenty one Local Government Area in the State.

3. RESULTS AND DISCUSSION

3.1 Summary Statistics of Output and Inputs Variables

The result for this study (Table 2) reveals that on the average, farmers used 127.65 kilograms per hectare of seed, 195.25 kilograms per hectare of fertilizer, 2.75 litres per hectare of agrochemicals and 32.20 man days per hectare of labour in order to produce 4.66 tons per hectare of rice. The minimum and maximum production was 2.64 tons per hectare and 5.98 tons per hectare respectively. The coefficient of variation of production was 573.17 kilograms per hectare which revealed the large variability on the rice production among the sampled farms. This might be as a result of large variation in the use of fertilizer and seed among the sampled farmers. However, considering all the inputs in the production process the frontier output is not known thus, this study seek to estimate the determinants of technical efficiency.

Table 2. Summary statistics of output and input variables

Variable	Unit	Mean	Minimum	Maximum	Standard Deviation
Output(Rice grains)	Kg/ha	4461.11	2636	5976	373.17
Seed	Kg/ha	127.65	110	185	10.45
Fertilizer	Kg/ha	195.25	175	315	55.23
Agrochemicals	Lt/ha	2.75	1.6	4.65	1.03
Labour	Man days/ha	32.20	18	45	5.36

Source: Field survey data, 2016.

3.2 Testing of Hypothesis

The result for the various test of hypotheses perform on the estimated coefficients are summarized in Table 3. The first hypothesis that Cobb-Douglas is the best fit model for the data was rejected at 5% level of significance in favour of the trans-log production function model. Further, production risk in inputs and technical inefficiency explained the variability in the output and should not be excluded from the model. The parameter λ in Table 4 is found to be significantly different from zero, indicating that inefficiency and production risk are important contributors to total output variability. The study also reject the assumption that modern farming technology (Table1) has no effect on technical efficiency of rice farmers in the study area.

Table 3. Hypothesis test for model specification and statistical assumptions of Stochastic frontier model with flexible risk properties

Null Hypothesis	log Likelihood Of H_0	log Likelihood Of H_a	Test Statistic (λ)	Degree Of Freedom	Critical Value $(\lambda)^2$	Decision
$H_0 : \alpha_{ij} = 0$	575.405	586.355	21.901	10	17.7	Reject H_0
$H_{\alpha:} : \Psi_1 = \Psi_2 .. = . \Psi_4 = 0$	570.420	586.355	31.870	4	8.8	Reject H_0
$H_0 : \lambda = 0$	570.420	586.355	31.870	1	2.7	Reject H_0
$H_0 : \delta_1 = \delta_2 = ... \delta_9 = 0$	570.420	586.355	31.870	3	7.0	Reject H_0

Source: Field survey data, 2016. **Note:** Taken from table 1 of [20] using 5% level of significance.

3.3 Elasticity of Production and Returns to Scale

The estimates of elasticity of output with respect to inputs of production is presented in Table 5. The parameters of the stochastic frontier model showed that all the output elasticity are positive. The positive sign implies that as the variable input increased output increased and vice versa. The output elasticity for seed, fertilizer, agrochemicals and labour are 0.3781 percent, 0.3907 percent, 0.2078 percent and 0.1465 percent respectively. This means that, one percent increase in the quantity of seed used per hectare results in output increase by 0.3781 percent. Similarly, a percentage increase in fertilizer employed per hectare will increase yield by 0.3907 percent. Also, a percentage increase in agrochemicals utilized will increase yield by 0.2078 percent.Table 5 further shows that a percentage increase in labour used will increase output by 0.1894 percent. The estimated returns to scale value of 1.123 implies that if all inputs are jointly increase by one percent, rice output will increase by 1.123 percent. Thus, rice production in the study area is characterized as increasing returns to scale. This agrees with [21].

Table 4. Maximum likelihood estimates of translog mean output function

Variable	Parameters	Estimates	Standard Error	P-Value
Constant	α_0	3.009***	1.019	0.003
Seed	α_1	0.392***	0.147	0.008
Fertilizer	α_2	0.278**	0.111	0.012
Agrochemical	α_3	0.562**	0.229	0.014
Labour	α_4	0.065	0.124	0.600
$\frac{1}{2}*(Seed)^2$	α_{11}	0.651	0.998	0.514
$\frac{1}{2}*(Fert.)^2$	α_{22}	0.248**	0.126	0.049
$\frac{1}{2}*(Agrochemicals.)^2$	α_{33}	0.185**	0.085	0.029
$\frac{1}{2}*(Labour)^2$	α_{44}	-0.343*	0.184	0.062
(Seed)(Fertilizer)	α_{12}	0.466	0.388	0.229
(Seed)(Agrochemicals.)	α_{13}	0.363**	0.155	0.020
(Seed)(Labour)	α_{14}	-0.731***	0.255	0.004
(Fertilizer)(Agrochemicals.)	α_{23}	0.251**	0.128	0.049
(Fertilizer)(Labour)	α_{24}	-0.061	0.178	0.731
(Agroch.)(Labour)	α_{34}	-0.011**	0.006	0.042
Variance Parameters				
Sigma-Square(u)		0.0379		
Sigma-Square(v)		0.0194		
Lambda $(\lambda = \delta_u / \delta_v)$		1.9589		
Sigma^2 $(\delta^2 = \delta v^2 + \delta u^2)$		0.0018		
Gamma $(\gamma = \lambda^2 / (1+\lambda^2))$		0.7933		

Source: Field survey data, 2016: **Note:** *, ** and *** correspond with 10%, 5% and 1% level Of significance respectively.

Table 5. Elasticity of production and returns to scale

Variable	Elasticity
Seed	0.3781
Fertilizer	0.3907
Agrochemicals	0.2078
Labour	0.1465
Returns to Scale (RTS)	1.123

Source: Field survey data, 2016.

3.4. Production Risk

Production risk in inputs is significant in the production process. Result (Table 6) of the study shows that fertilizer and agrochemicals significantly decrease production risk. But seed and labour increase production risk though not significant. Fertilizer and agrochemicals being risk decreasing inputs is consistent with [21]. Seed and labour as risk increasing inputs was also reported by [22]. This study entails that effective use and proper management of fertilizer and agrochemicals can be used to reduce output variance, and stabilize yield with the existing technology.

Table 6. Maximum likelihood estimate of the linear production risk function

Variable	Parameter	Estimates	Std.Error
Constant	Ψ_0	-11.528***	1.590
Seed	Ψ_1	0.488	0.677
Fertilizer	Ψ_2	-0.975**	0.467
Agrochemicals	Ψ_3	-0.0547*	0.028
Labour	Ψ_4	1.897	5.632

Source: Field survey data, 2016. **Note:** *, ** and *** denotes 10%, 5% and 1% significance levels

3.5 Determination of Technical Inefficiency

The result (Table 7) for this study reveals that education significantly decrease technical inefficiency of the farmers. This might be as a result of the participation of more educated farmers in ABP in the study area. Similarly,farming experience significantly decrease technical inefficiency of the rice farmers in the study area. Farmer who is growing rice for a long time is probably going to be more knowledgeable about the pattern of rainfall, incidence of pest and disease and other agronomic practice than a farmer who is just coming into the business. Also, extension visit was found to be significantly decreasing technical inefficiency of the farmers. Extension visit to farmers enable them to utilize recommended practices in production to enhance upon their efficiency level. Result further shows that land cultivation technique (use of machine) and planting technique (transplanting) employed significantly decrease technical inefficiency of the farmers in the study area.

Table 7. Maximum likelihood estimates of technical inefficiency model

Variable	Parameters	Estimates	Std.Error
Constant	δ_0	-7.549***	1.631
Gender	δ_1	-0.066	0.065
Household Size	δ_2	0.025	0.111
Education	δ_3	-0.904***	0.299
Years of farming	δ_4	-0.357*	0.201
Extension Visit	δ_5	-0.350**	0.159
Member of RFA	δ_6	-1.038	1.147
Land cultivation Tech	δ_7	-0.227*	0.124
Planting Tech.	δ_8	-2.604**	1.318
Harvesting Tech.	δ_9	3.627	3.538

Source; Field survey data, 2016**. Note:** *, ** and *** denotes 10%, 5% and 1% significance levels.

3.5 Technical Efficiency Estimates

The result (Table 8) for this study reveals that majority (100) of the farmers' technical efficiency score is greater than 90% but less than 100%. Few (5) farmers had technical efficiency score greater than 40% but less than or equal to 50%. The mean technical efficiency is approximately 0.853. This implies that farmers farms produced only 85.3% of the maximum attainable output for a given inputs levels for the period of production under analysis, thus, they are 14.7% below the frontier at a given technology. There is therefore the possibility of increasing the output of the farmers in the study area in the short run by adopting a technology of the best practice of the best farm. Table8 also reveals that the maximum technical efficiency score of the farmers is 0.998 and minimum is 0.402 with standard deviation of 0.130.

Table 8. Technical efficiency distribution

Efficiency Scores	Frequency	Percentage
1.00	0	0.00
>0.90<1	100	45.05
>0.80≤0.90	64	28.83
>0.70≤0.80	28	12.61
>0.60≤0.70	16	7.21
>0.50≤0.60	9	4.05
>0.40≤0.50	5	2.25
>0.10≤0.40	0	0.00
Total	**222**	**100**
Mean	0.853	
Minimum	0.402	
Maximum	0.998	
Standard Deviation	0.130	

Source: Field survey data, 2016.

4. CONCLUSIONS AND POLICY RECOMMENDATIONS

The study employed the use of stochastic frontier model with flexible risk specifications to a sample of 231 rice farms under Anchor Borrowers Programme in Kebbi State, Nigeria. Result of the frontier mean output function indicates that the estimated output elasticity of seed, fertilizer, agrochemicals and labour are positively related to rice output. Rice production in the study area exhibits increasing returns to scale. However, on the average, production has been technically inefficient and it's dependent upon application of best farm practices. The finding further revealed that technical efficiency estimates might be compromised when the production technology is modelled without the flexible risk part and the inputs used are non-neutral in risk. Policy options should encourage the application of best farm practice and include production risk in technical efficiency analysis if the inputs are non-neutral in risk. This study is limited to the used of cross-sectional data for a single period thus, further study should consider time series data to see the yearly fluctuations of agricultural outputs/inputs and their prices. Finally, the estimation of production technology, production risk and production inefficiency does not capture the influence of some factors like soil fertility and weather factors. There is therefore, the need to incorporate these factors in future studies.

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COMPETING INTEREST

We have declared that no competing interest exist.

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