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Analysis of technical efficiency of rice production in Anambra State, Nigeria

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Abstract

Technical efficiency of rice farmers in Anambra State, Nigeria using stochastic frontier production function was studied. Multistage random sampling techniques were used to select 120 rice farmers. Structured questionnaire complimented with oral interview were used to collect data from the respondents for the study. The result showed that the estimated level of technical efficiency was ranged between 24 % - 94 %. Also, the determinants factors to technical efficiency of the rice farmers were age of the farmers, level of education and extension services. The major constraints to rice production in the study area were pest and disease (92 %), poor access to credit (83 %), high cost of labour (67 %). Policy options aimed at enhancing farmers' access to improved rice varieties, paddy, pesticides, and credit facilities and educational programs were proffered.

Keywords: Technical efficiency, production, rice, stochastic frontier, production function

Introduction

The roles of agriculture as engine room for economic prosperity of most countries in Sub-Saharan Africa, Nigeria inclusive are well documented (Ume and Nwaobiala, 2012 [24], CBN, 2018 [4], FAO, 2021) [9]. Agriculture according to Udemezue, (2019) and CBN, (2018) [4] is source of food, employment, raw materials for industries, poverty alleviation and human resource development. In Nigeria, among cereal crops produced in the crop production subsector of agriculture that had gained wide preeminence is rice (Shantha, *et al.* 2013 [18]; CBN, 2018 [4]; RIFAN, 2018 [17]). Rice is an important food security and cash crop with smallholder farmers being the dominant farming population in most developing countries of the world (Udemezue, 2014) [20]. Globally, the three top rice-producing countries are China (148,032million metric tons) followed by India (116,016 million metric tons) and Indonesia (35,612 million metric tons), (FAO, 2021) [9]. Nigeria is the highest producer of rice in Africa with total annually output of 5.8 million tons in the year 2021 (FAO, 2022) [6].

Globally, rice is consumed by half of the human population. It has fastest growing consumption rate among all staple crops for several years now. For instance, in the 2021/2022 crop year, about 509.87 million metric tons of rice was consumed worldwide, up from 437.18 million metric tons in the 2008/2009 crop year (FAO, 2022) [6]. China is the highest consumer of rice in the world with about 154.9 million metric tons consumed in 2021/2022. This is followed by India (103.5 metric tons) in same period (FAO, 2022) [6]. In Nigeria, the average rice consumption is 34 kg (Udemezue, 2019) [21]. The nation's growing population, rising income of the population especially among the urban dwellers and easy to serve in the table could be responsible for increasingly consumption of the grain in most developing countries in recent times (CBN, 2018) [4]. The other uses of rice as noted by Hossain and Rahman, (2012) [11] are for industrial uses (beverages, roofing materials, flour and starch), livestock feed, medium for growing tropical mushroom and compost.

Despite successive Nigeria government programmers and policies inform of introduction of high yielding varieties supported by fertilizers, pesticides, irrigation and mechanized cultivation in order to attain self-sufficiency in rice production in Nigeria, yet, literatures revealed that the domestic rice production is not sufficient to satisfy the consumption of the ever nation's growing population. For instance, in the year 2021 according to Rice Farmers Association of Nigeria (RIFAN), (2018) [17], Nigeria rice production was estimated at 5.8 million tons with annual consumption currently around 7.9million tons, leading to a deficit of about 2.1 million metric tons, which is either imported or smuggled into the country illegally.

The low productivity of the nation's rice production and productivity in form of low rice yield range of 1.5-3.0 t/ha vis-à-vis a potential of 3.0-6.0 t/ha, could be as result of suboptimal water management, poor weed management, low adoption of modern varieties, low mechanization, pest and disease infestation, and land tenure (Ajibefun; *et al*; 2002 [2]; Osajie, 2016 [22]; CBN, 2018) [4]. The others reasons as asserted by Udemezue, (2019) [21] and Emma-Aja *et al.* (2021) [5] are reliance on rain-fed agriculture, smallholder land holding, low fertilizer application, and a weak agricultural extension system.

The productivity of the farmers can be enhanced through fostering their efficiency in resource use, especially as relates to technical efficiency. Therefore, it becomes imperative to measure farmers' efficiency, since such intension could aid in gathering pertinent information for making a sound management decision in resource allocation to boost their productivity (Hossain and Islam, 2015) [10]. This study attempts to analyze the technical efficiency of rice farmers in the State in order to add to existing body of knowledge on farmers' resource use efficiency Specifically, the objectives of this study are to: (i) describe the respondents' socio-economic characteristics, (ii) estimate the technical inefficiency in rice production by the respondents and (iii) identify the constraints to rice production in the study area.

Materials and Methods

Study Area

The study area was Anambra State and it is located in longitude 6°36´-7°21´E and latitude 5°38´N – 6°47´N. Anambra State consist of 21 Local Government Areas with total population figure of 3.261 million people (NPC, 2006) and land mass of 4415.54 km^2. The State is bounded in the West by Delta State, in the East by Enugu State, in the North by Kogi State and South and East by Imo and Enugu States respectively. The major crops grown in the state were rice, cocoyam, yam, cassava, vegetable, and others. More so, sheep, goat, pig and poultry are common livestock reared in the State. The off-income activities engage by the farmers are hair saloon, auto mechanics, petty trading and among others.

Method of Data Collection

Structured questionnaire was used to collect information on farmers' socio-economic characteristics, constraints to rice production, inputs and outputs prices.

Sampling Size and Sampling Technique

Multi-stage sampling techniques were used to select zones, Local Governments Areas (LGAs), towns and respondents. In the 1st stage, three out of four agricultural zones of the state were purposively selected because of their intensity of rice production in those areas. The selected zones were Anambra, Aguata, and Awka. The second stage involved the random selection of two Local Governments Areas (LGAs) out of five from each zone. This brought to a total of six LGAs. In the third stage, two towns were randomly selected from each Local Governments Areas (LGA). This brought to a total of twelve towns. Finally, ten farmers were randomly selected from each of the towns from the lists of farmers compiled by the extension agents of the Anambra State Agricultural Development Programmed (ADP). This brought to a total of one hundred and twenty farmers for detailed study.

Method of Data Analysis

The objective 1 and 4 were captured using descriptive statistics such as percentages and means and frequency distribution table. The objective 2 was assessed using Cobb-Douglas stochastic frontier production function.

Model Specification

Cobb-Douglas Stochastic Frontier Production Function.

The choice of the function is due to its advantages over the other functional forms. As well, it is widely used in frontier production study in most developing agriculture, (Okoye and Onyenweaku, 2007) [15]. The Cobb-Douglas frontier production is specified as follows:

$$\text{In } Yi = ß_0 + ß_1 \text{ Inx}_{1i} + ß_2 \text{ In } X_{2i} + ß_3 \text{ In } X_{3i} + ß_4 \text{ In } X_{4i} + ß_5 \text{ In } X_{5i} + V_1\text{-}u_i\text{-} \quad \text{-----------------------(1)}$$

Where, the subscript I indicates the ith farmers in the sample, in= natural logarithm, Y_i= output of rice (kg), X_2= Farm size (hectares), X_3= Labour (man hours), X_4 = Fertilizer (kg), X_5 = Capital input (N), V_i= random errors, U_i= technical inefficiency effects predicted by the model.

Determinants of technical inefficiency, (U_i) could be achieved using the following model which is formulated and estimated jointly with stochastic frontier model in a maximum likelihood estimated procedure using the computer software frontier version 4.1 (Ajibefun, *et al.*, 2002) [2].

$$Ui = \alpha_0+\alpha_I Z_1 = \alpha_2 Z_2+\alpha_3 Z_3+\alpha_4 Z_4+\alpha_5 Z_5+e_i \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where,

U_i = technical inefficiency effect, Z_1 = the age of the itch farmers, Z_2 = years of farming experience (Years), Z_3 education status of the farmers (Years), Z_4 = extension services (Dummy), Z_5 = Membership of Organization (Dummy). α_s= are unknown scalar parameter and e_i = error term. These were included in the model to indicate their possible influence on the technical efficiencies of the farmers. Measure of individual farm technical inefficiency was computed as:

Technical inefficiency = 1-estimated TE (technical efficiency ……………..……. (3)

Results and Discussion

Table 1: Distribution of respondent according to their socio economic characteristics

Variable	Frequency	Percentage
Age		
20- 30	20- 30	18.33
31- 40	30	25
41- 50	54	45
51- 60	14	11.67
Total	120	100
Level of Education		
No formal	4	3.3
Primary	64	53.3
Secondary	34	28.3
Tertiary	18	15
Total	120	100
Contract with Extension Agent		
Yes	30	25
N0	90	75
Total	120	100
Years of Farming Experience		
1-10	22	18
11-20	32	27
21-30	66	55
Total	120	100
Membership of Organization		
Yes	64	53.33
No	56	46.67
Total	120	100

Source: Field Survey 2021

Table 1 show that 43.33 % of the respondents were less than 41 years old, while 56.67 % were above 40 years. The implication is that most respondents are aged and may not be able to withstand the rigors and stains in rice farming. The finding of Ume and Nwaobiala, (2012) [24] concurred to above assertion. Morever, 96.7 % of the respondents had formal education, while 3.3 % did not have. FAO, (2020) [8] reported that education helps to unlock the natural talents and inherent enterprising qualities of the farmer As well, education and training are important factors that could enhance farmer's ability to evaluate, understand and accept new innovation (Ume, *et al.* 2012) [24].

The result also showed that 75% of the respondents had no contract with extension workers, while 25% had contract. This implies that most farmers studied had poor extension outreach, with resultant effects of being denied the necessary access to improved varieties and technical assistance associated with extension services in order to improve their production (Emma-Ajah, et al. 2021) [5]. The table further revealed that 55% of the farmers studied had number of years of farming experience of 21- 30 years, while 27 % and 18 % of the respondents had farming experience of 11-20 and 1-10 years respectively. The aftermath of wealth of farming experience as noted by Okoye and Onyenweaku, (2007) [15] is to enhance the farmer's capacity of maximizing the output and profit at minimum cost. This result collaborated with the finding of Ume, *et al;* (2016) [22], who reported that farming experience enhances farmers' efficient use of scarce resources. Also, 53.33 % of the sampled farmers were members of organization, while 46.67 were not. This result is in conformity with Ogbonna (2018) [13] finding. He reported that members of cooperative through having access to information on improved innovations and capacity building and training by cooperative, leads to their improved farm productivity through enhanced technical efficiency

Table 2: Estimation of Technical Inefficiency in Rice Production

Variable	Parameters	Coefficients	Standard Error	T-value
Constant term	ß$_0$	4.0123	96.4723	0.0415
Seed	ß$_1$	0.0801	0.0831	0.9639
Farm size	ß$_2$	0.3156	0.0508	6.2071***
Labour	ß$_3$	0.0373	0.0268	1.2075
Fertilizer	ß$_4$	0.0556	0.0085	6.4778***
Capital	ß$_5$	0.5775	0.09863	5.8559***
Inefficiency Factors				
Constant	Z_0	2.9094	96.5447	0.03016
Age	Z_1	-0.01611	0.0082	-1.9623*
Experience	Z_2	0.0855	0.03511	2.4335**
Education	Z_3	0.34884	0.0209	3.3335**
Extension Contact	Z_4	0.0627	0.1212	0.512**
House hold size	Z_5	0.0442	0.0312	2.8431
Diagnostic Statistics				
Total variance^2	α	0.2139	0.03125	6.8452***
Variance ratio	α	0.3814	0.3814	0.0396
LR test	21.6615			
Log likelihood function	-58.3127			

Sources: Computed from Field Survey Data, 2021.
*, ** and *** are significant at 10 %, 5 % and 1 % level of probability respectively.

Table 2 revealed that the estimated total variance (0) was statistically significant at 1 % level, indicating goodness of fit and the correctness of the specified distribution assumption of the composite error term. The estimated gamma (y) is a measure of the variance parameter and it ranges from 0 to 1. From the Table, the variance ratio is estimated to be 0.3814 and is statistically significant at 1% level of probability. This can be interpreted that over 38.14 % of random variation in rice production among the sampled farmer, is explained by inefficiency factors of the farmers which could be from their socio- economic and institutional characteristics and management practices. The result showed that the coefficients of farm size, fertilizer and capital inputs were positive and significant at 1 % level of probability. This implies that any increase in farm size, fertilizer and capital by 1 % would result to a 0.3156 %, 0.556 % and 0.5775 % increase in rice output in the study area.

The estimated determinant of technical efficiency in rice production is also presented in the same table. The result shows that the age (-0.01611) of the farmer is negatively related to the farmers' output and significant at 10% alpha level. This implies that as farmer is advancing in age, his/her technical inefficiency increases. This finding is in consonance with Okoye and Onyenweaku, (2007) [15] and Ume, *et al*; (2016) [22], who opined that age variable picks up the effects of physical strength as well as farming experience of the farmer. Furthermore, aged household heads according to Hossain, and Rahman, (2012) [11] could be conservative to try out new and efficient technologies/ techniques. More so, the estimated coefficient of education (0.34884) was positively signed and significant at 5 % risk level. Hasnain, Hossain, and Islam, (2015) [10] finding concurred with aforesaid assertion. They observed that farm level technical efficiency can be increased by additional investment in education including schooling, training and orientation. Additionally, education attainment boosts farmer's ability to develop, explain and appraise valuable information and in enhancing labour quality, hence improving his or her technical efficiency. The above finding disagreed with the result of Ayodele, *et al.* (2016) [3], who noted that high level of education diminishes the aspiration for farming and therefore the highly educated farmers probability devote much of their time on salaried employments instead.

Also, in line to *a priori* expectation, the coefficient of extension service (0.0627) was significant and positively correlated with technical efficiency in rice production. This result is consistent with those of Ume, *et al.* (2016) [22] in Nigeria; Hasnain; *et al.* (2015) [10] in Bangladesh, and Shantha, Ali and Bandara, (2013) [18] in Sri Lanka. However, this result differs from that of Hossain and Rahman, (2012) [11] whose result showed a negative relationship between extension services and technical efficiency in rice production in India. Extension services aids in enhancing farmer's resource use efficiency, adoption of improved technology and providing technical assistance on the new technologies to the farmers (Shantha, *et al.* 2013) [18]. Additional so, farming experience (0.0855) was positive and significantly related to technical efficiency. The more experienced a farmer is, the more proficient his decision making processes and the more he or she will be inclined to taking risks as relates to use of modern innovations. This result concurred with several studies (Okoye and Onyenweaku, 2007 [15]; Shantho, *et al;* 2013, Ume, *et al.* 2018) [23], however, differs with numerous literatures (Ajibefun and Aderinola, 2004 [1], Osage, 2016; Emma-Aja, *et al.* 2021) [5].

Table 3 showed that the mean technical efficiency level among rice farmers was 0.56 %. This implies that on the average about 44 % of potential output is lost due to inefficiency in resource utilization.

Table 3: Frequency distribution of technical inefficiency index

Technical Efficiency Index	Frequency	Percentage
021- 0.20	3	
0.31-0.40	10	8.3%
0.41-0.50	12	
0.51-60	22	
0.61-0.70	23	
0.71-0.80	40	33.3
0.81-0.90	10	8.3%
Maximum technical efficiency	0.95	
Minimum technical efficiency	0.24	
Mean technical efficiency	0.56	
Mean of best	10	
Mean of worst	10	

Sources: Computed from Field Survey, 2021

In the short-run, there is scope for increasing rice production by 44 % by adopting the technology and technique in resource utilization by efficient rice farmers. The wide technical efficiency indices differential among farmers is an indication of the need for efficiency improvement in order to become the most efficient farmer. An average rice farmer requires, 49.52 % cost saving to attain the status of the most efficient rice farmer among the sampled best 10 category, while the least performing farmer would need 52.41 % to become the most efficient rice farmer among the worst sampled farmer

Table 4 showed the production elasticity's and return to scale.

Table 4: Elasticity of Production and Return to Scale

Input	Elasticity
Seed	0.0801
Farm size	0.3156
Labour	0.0373
Fertilizer	0.0556
Capital	0.5775
Return to Scale	1.0711

Source: Field Survey, 2021

The regression coefficients in the Cobb Douglas stochastic production frontier function are the elasticity and their sums indicate the return to scale (Ajibefun, *et al;* 2002) [2]. The sum production elasticity (return to scale) have a co efficiency of 1.0711, implying that the rice farmers are in stage III of production phase. This is necessitated by high and positive coefficient of capital. The farmers in the study area over utilized their resources, since their elasticity were less than 1. This means that rice framers in Anambra State had not optimally utilized and allocated most of their inputs.

The constraints to rice production is presented and discussed in table 5.

Table 5: Distribution of Farmer according to Constraints to Rice Production

Problems	Frequency	Percentage
Poor access to credit	100	83
High cost of improved rice variety	110	92
High cost of labour	80	66.67
Pest and disease infestation	75	62.5
Scarcity of paddy	54	45
Poor extension services	14	12
Poor germination	28	23

*Multiple responses

Source: Survey Data 2021

Table 5 shows that most (92 %) of the respondents encountered the problem of high cost of improved inputs. High cost of improved inputs has negative implication to agricultural development as substantial number of farmers resorted to the use of local varieties which has genetically broken down, resulting in poor yield (Onyenweaku, *et al*; 2010; Ume, *et al*, 2018) [23]. This was followed by poor access to credit, which accounted for 83% of the total sampled population in the study area. The poor farmers' access to credit is a negative sign to agricultural development. Credit is a vital catalyst in farming, as it helps to procure production inputs and in payment of hired labour (Ume and Nwaobiala, 2012) [24]. The least of the respondents (12 %) complained about poor access to extension services. The poor motivation of the change agents by government affects their effectiveness and efficiency in performing their duties (Ogbonna and Osondu, 2018) [13].

Conclusion and Recommendations

The results of this study show that the technical inefficiency of the rice farmers in study area were affected by their age, educational level and extension services. More so, the production rice in the study were affected by poor access to credit, high labour cost, poor access to improve rice varieties among others. The policy options by concerned government agencies and non-Governmental Organization (NGO) aimed at enhancing farmers' access to educational programmers, extension services, credit facilities, improved rice varieties and labour saving devices were proffered.

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