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Analysis of Total Factor Productivity Among Rice Farmers in Southwestern Nigeria.

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ABSTRACT

The research work was carried out to analyze the effects of total factor productivity on rice farmers in Southwestern Nigeria, and to determine the technical efficiency of the rice farmers, using Maximum Likelihood Estimation (MLE). The findings revealed that all the selected variables (farmer's age, family labour, hired labour, quantity of herbicides and Quantity of seed planted) have significant effects on Total Factor Productivity (TFP) except for the quantity of fertilizer used (QFU) in Southwestern Nigeria. It was shown that the variables, having significant effects on TFP are the major determinants of Total Factor Productivity (TFP) on rice farmers. Based on the findings, it is therefore recommended that farmers should de-emphasize the used of fertilizer, as it does not add value to the productivity of rice in Southwestern Nigeria. Also, government should encourage more famers to involve in rice production to enjoy the technical efficiency in rice farming.

Keywords: Rice farmers, technical efficiency, maximum likelihood estimation

Introduction

Agriculture was once the main economic base of Nigerian economy before the discovery of crude oil which led to its neglect, and the resulting effect was a failure in agricultural production, leading to over-reliance on food importation to supplement the gap between domestic demand and supply (Hawksworth, 1985). Rice is the world's most important food crop. Recently, important and major changes have led to structural increases in rice consumption in West African sub-region where the regional demand has grown at an annual rate of 6%, driven by a combination of population growth and substitution away from traditional coarse grains.

Nigeria has vast and potential land areas that are suitable for different varieties of rice production and the cultivable land to rice is spread over five major ecologies - upland, inland or shallow swamp, irrigated rice, deep water or floating rice, and tidal mangrove or swamp that can be harnessed to boost rice production to meet domestic demands, and even to produce a surplus for export (William, Ukwungwu, singh, Odhidievbie and Nnabo, 1999). In rice producing areas, the enterprise provides employment for more than 60% of the inhabitants in various activities along the production or distribution chain from cultivation to consumption. There has been a steady increase in rice production due to expansion of the cultivated land to rice production and also the consumption of rice has increased tremendously in Nigeria (Izuchukwu, 2011; Singh, Fagade, Ukwungwu, Williarn, Jagtap, Oladimeji, & Okhidievbie, 1997).

Nigeria has ecosystems that are suitable for different rice varieties. As a result, successive governments have pursued and implemented various agricultural policies at the State and Federal levels towards the rice transformation agenda in order to boost Nigerian rice production since but unable to match its demand (Williams, Ukwungwu, Singh, Odhidievbie, and Nnabo, 1999). In order to address the demand/supply gap, governments have at different occasions come up with policies and programmes, which have not been consistent.

The Buhari administration had in the year 2016 set aside year 2018 as a target period to end importation of rice, in order to become self-sufficient. His government has been making substantial efforts to encourage the domestic cultivation of rice and to completely eliminate its imports using incentives such as subsidized loans, cheap fertilizers, free farm land and tax rebates (Campbell, 2017). Despite these various agricultural policies, Nigeria's rice statistics suggest there is an enormous potential to raise productivity and increase production, rice production has remained low compare to its demand. Therefore, this study aim to analyze the effect of total factor productivity on rice farmers in Southwestern Nigeria and also to determine the technical efficiency of the rice farmers.

LITERATURE REVIEW

Since the discovery of crude oil in marketable quantity in Nigeria, agriculture which was once the pillar of her economy has suffered a terrible neglect. And the subsequent effects of this action has been a sharp decline in agricultural production, leading to over-reliance on importation of food stuff to meet the domestic demand, and others. Nigeria is currently one of the largest importers of food stuff across the world, leading to annual food import bill of about $10 billion (Obayelu, 2015). The main reason why rice farmers are experiencing low productivity at this dispensation is due to static use of low technologically agricultural equipment which did not support large scale production. For instance, Fasoyiro and Taiwo (2012) observed that rice is mainly produced by small-scale farmers in Nigeria, where their production is characterized by low output, resulting from production inefficiency, aging farming population, low technological know-how, and so on.

Uduma, Samson and Mure (2016) noted that the inability of local supply to meet up with rice demand (consumption) has given rise to the high rate of importation of rice in Nigeria, from 300 thousand tons of rice annually in recent times with an estimated average cost of 300 million naira annually on our foreign reserves. So, the rice importation has exposed our country to international market shocks with its associated risk implications on food security.

Rice is one of the crops considered under the FGN's ATA, having given its growing importance and prominent role among essential food crops in Nigeria. So, it is undertaken that Nigeria has a history of indigenous rice production and high demand which must be addressed again (Johnson, Takeshima, & Gyimah-Brempong, 2013). Thus, it is not surprising that rice has emerged as a major food crop in Nigeria.

A closely related development is the Memorandum of Understanding (MOU) between Dangote Industries Limited and the FGN worth US$1 billion investment in commercial local rice production and modern integrated rice mills, which was signed in August 2014. Reports showed that farmlands for rice plantation have been acquired in Edo, Jigawa, Kebbi, Kwara, and Niger States with acreage of about 150,000 hectares as well as the proposed establishment of two large-scale rice mills with capacity of 240,000 metric tons of rice paddy (Okodua, 2017). Anyway, all these private and government participations are expected to encourage local content and value chain development of local rice.

Technology is a must now for enhancing rice production. It is the embodiment and result of systematic, disciplined, cumulative, non-accidental and non-serendipitous research (Ellul, 1965). In this context, agricultural technology is the application of technology for the promotion and development of agriculture at all levels (Olayide, 1980). Two types of technology that may be distinguished in the literature are "appropriate" and "intermediate" technology, helping the less developed countries (LDCs) to boost or increase their level of productivity of rice. The level of technical efficiency of a particular farmer is characterized by the relationship between observed production and the ideal or potential production (Greene, 1980). The measurement of firm specific technical efficiency is based upon deviations of observed output from the best production or efficient production frontier.

There are several approaches to analyze the determinants of technical efficiency from stochastic production frontier functions. A set of authors followed a two- step procedure in which the frontier production function was first estimated to determine technical efficiency indicators while the indicators obtained were regressed against a set of explanatory variables that are usually firm-specific characteristics. Authors in this category include Pitt and Lee (1981); Ben-Belhassen (2000); Ogundele (2003). While this approach is very simple to handle, the major drawback experienced is that, it violates the assumptions of the error term.

Studies conducted either in Nigeria or elsewhere have identified several factors affecting the efficiency of resources used by crop farmers. Some of these empirical studies reviewed are; Ogunfowora, Essang and Olayide (1974) who examined resource productivity in traditional agriculture in Kwara State, Nigeria, using a Cobb–Douglas production function through a method of Ordinary Least Square (OLS) and discovered that labour and seed inputs were inefficiently utilized. Farm size (scale of operation) and the level of technology were not taken into consideration, however, making the result too generalized. Using the same Cobb–Douglas production function in Imo State, Oludimu (1987) examined the efficiency of resources used in various farm enterprises and concluded that the efficient use of resources took place only at the rational stage of production (i.e., at the decreasing but positive return to scale stage).

Seyoum, Battesse and Fleming (1998) investigated the technical efficiency and productivity of maize producers in Ethiopia. The findings showed that farmers who participated in a programme of technology demonstration were more technically efficient than farmers who do not. Townsend, Kirten and Fleming (1998) used data envelop analysis to investigate the relationships among farm size, return to scale and productivity among wine producers in South Africa. Their study established that most farmers operated under constant return to scale, with a weak inverse relationship between farm size and productivity.

Ajibefun and Abdulkadri (1999) estimated technical efficiency for food crop farmers under the National Directorate of Employment in Ondo State, Nigeria. The results of the analysis indicated wide variation in the level of technical efficiency, between 0.22 and 0.88. Mochebele and Winter-Nelson (2000) investigated the impact of labour migration on technical efficiency performance of farms in Lesotho, using the stochastic frontier production. The study found that households that sent migrant labour to South African mines were more efficient than households that do not, with mean technical efficiency of 0.36 and 0.24 respectively.

Obwona (2000) estimated a trans-log production function to determine technical efficiency differentials between small and medium-scale tobacco farmers in Uganda, using a stochastic frontier approach. The results showed that credit accessibility extension services and farm assets contribute positively towards the improvement of efficiency of production.

Recent studies like Isonguyo, R.G., Ojo, M.A., Jirgi, A.J. and Yisa, E.S. (2021) analyzed productivity of rice farmers in North-Central Nigeria using secondary data collected from 1992 to 2016. Malmquist Total Factor Productivity Index (MTFPI) using Data Envelopment Analysis (DEA), was used to empirically analyse efficiency change, technical progress and total factor productivity growth of the rice production, while Tobit regression was used to analyse the determinants of the productivity in the study area. The results of their MTFPI analysis revealed that rice contributed 0.1% of technical efficiency change to productivity growth. Tobit regression showed rainfall, amount of credit borrowed and capital-labour ratio had significant and positive relationship with the crop's productivity at 10%, 1% and 5% level of significance, respectively. They concluded that increase in their selected factors led to increase in rice productivity and that government policy (ATA) had significant but negative relationship with the productivity of rice at 10% probability level. Also, rice import had significant but negative relationship at about (5%) with rice productivity in the study area. Thus, increase in rice importation led to reduction in rice productivities. They recommended that training on farm practices, techniques and proper allocation of production resources to achieve productivity growth. Policies on public security and insurance of farms against risk of all kind will increase productivity.

In the same view, Oyita and Otuisi (2023) examined the effects of Total Factor Productivity on rice output in Nigeria. They collected data such as land area, labour, capital and rice output from 1961 to 2020 were collected from various sources such as World Bank online statistical depository, United States Department of Agriculture Economic Research Service. Their Data were analysed using descriptive such as mean and graph and inferential statistics such as Ordinary Least Square Regression model. Result from their study showed that although there is a positive trend in rice TFP in Nigeria over the years, the average rice TFP is regressive (i.e., less than 1). They recommended that promoting the adoption of modern technologies and improving management practices, policymakers can help enhance TFP and increase rice output, thereby improving food security and promoting economic development.

In another development, Buragohain, Hazarika and Deka (2022) estimated the total factor productivity (TFP) growth of rice and its contribution to rice production in Assam and examined the determinants of TFP. Their study was carried from 1991-92 to 2010-11, using secondary data, estimated us the Tornqvist Theil index. Their study revealed that TFP growth for rice at a constant price was found to be positive in both per hectare area and total area for the study period. Determinants like investment in agriculture and allied activities, expenditure in agricultural research and education, HYV area, rural literacy, irrigation, and cropping intensity were found to have a positive impact on TFP. Most of the earlier studies cited concentrated on aggregate data and are few works carried out in southwestern Nigeria, hence, the need of this study.

Methodology

This study was conducted in the Southwestern Nigeria, which involved Lagos, Oyo, Osun, Ogun, Ondo and Ekiti. Four States were selected for this study, including Osun, Ogun, Ondo and Ekiti. The primary data used was collected with the use of structured questionnaires from some the farmers in the chosen areas of the study. This study adopted a multi-stage random sampling technique. The first stage was the purposive selection of the four states mentioned above. The second stage involve selection of two rice producing local governments in each state. From each local government, two rice producing towns/villages was randomly selected. The fourth and final stage was random selection of 25 farmers from each town/village, making a total of 400 farmers for the study.

Model specification

The stochastic frontier model used in this study is a variant of that of Khumbhakar and Heshmati (1995), Yao and Liu (1998), and Ogundele (2003). The empirical model of the stochastic production frontier is specified as:

$$\boldsymbol{ln}\mathrm{OUPT}_i = \propto_0 + \boldsymbol{\beta_1 ln}\mathrm{AGE}_i + \boldsymbol{\beta_2 ln}\mathrm{FLB}_i + \boldsymbol{\beta_3 ln}\mathrm{HLB}_i + \boldsymbol{\beta_4 ln}\mathrm{LS}_i + \boldsymbol{\beta_5 ln}\mathrm{QFU}_i + \boldsymbol{\beta_6 ln}\mathrm{QHU}_i + \boldsymbol{\beta_7 ln}\mathrm{QSD}_i + \boldsymbol{V_i} - \boldsymbol{U_i}$$

The subscripts *i* observation, while,

OUPT = total farm output of rice (kg)

AGE = age of farmers

FLB = sum of family-labour (person days)

HLB = sum of hired labour (person days)

LS = cultivated land area for rice (ha)

QFU = quantity of fertilizer used (kg)

QHU = quantity of herbicides used (litres

QSD = quantity of seed planted (kg)

V_{it} = a random error term with normal distribution N(0, d^2)

U_{ij} = a non-negative random variable called technical inefficiency effects associated with the technical inefficiency of production of farmers involved ln = the natural logarithm.

Estimation Technique

The model of the study would be estimated using maximum likelihood estimation (MLE) technique, and to be accomplished through a joint estimation of the technical efficiency model as specified in Coelli (1996).

Result and Findings

Testing the Normality in the Distribution of the Data Set in the Study.

Table 1: Descriptive Statistics

	AGE	FLB	HLB	LS	OUPT	QFU	QHU	QSD
Mean	46.85750	4.225000	10.50750	10.69500	37.11000	17.70750	14.45250	17.90000
Median	47.00000	4.000000	11.00000	11.00000	38.00000	19.00000	15.00000	20.00000
Maximum	62.00000	6.000000	18.00000	19.00000	72.00000	26.00000	31.00000	30.00000
Minimum	32.00000	2.000000	3.000000	4.000000	12.00000	5.000000	0.000000	8.000000
Std. Dev.	7.017143	1.242269	3.849284	3.647635	15.04023	4.553436	7.700389	5.969429
Skewness	0.407584	-0.110197	0.026387	-0.087440	0.279659	-0.644446	0.245964	-0.229454
Kurtosis	3.220145	1.881808	2.801221	2.522580	2.158418	3.616975	2.907412	1.873915
Jarque-Bera	11.88268	21.64879	0.704971	4.308538	17.01826	34.03166	4.176096	24.64442
Probability	0.002628	0.000020	0.702939	0.115988	0.000202	0.000000	0.123929	0.000004
Sum	18743.00	1690.000	4203.000	4278.000	14844.00	7083.000	5781.000	7160.000
Sum Sq. Dev.	19646.88	615.7500	5911.977	5308.790	90257.16	8272.778	23659.10	14218.00
Observations	400	400	400	400	400	400	400	400

Source: Authors' Computation (2023)

Table 1 revealed the Descriptive statistics which showed that only family labour (FLB) is symmetrical while age of farmer (AGE), hire labour (HLB), land size (LS), output (OUPT), quantity of fertilizer used (QFU), quantity of herbicides used (QHU) and quantity of seed (QSD) are asymmetrical in their distribution. Skewness result revealed that AGE, HLB, OUPT and QHU are positively skewed, while FLB, LS, QFU and QSD are negatively skewed. It also revealed that AGE and QFU are leptokurtic which depicts a peak curve while FLB, HLB, LS, OUPT, QHU and QSD are platokurtic which depicts a flatted curve. Jarque-Bera statistics indicated that HLB, LS, and QHU are normally distributed while AGE, FLB, OUPT, QFU and SD are not normally distributed. The sample size used is fairly large and the issue of normality in data will not pose a problem.

Table 2: Regression Result

Maximum likelihood estimation (MLE) technique

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.678588	0.118679	-5.717825	0.0000
AGE	0.273906	0.047848	5.724459	0.0000
FLB	0.179989	0.030487	5.903750	0.0000
HLB	0.092165	0.032561	2.830580	0.0049
LS	0.053606	0.013874	3.863701	0.0001
QFU	0.010461	0.008388	1.247151	0.2131
QHU	0.061334	0.013547	4.527519	0.0000
QSD	0.056745	0.008523	6.657712	0.0000
R-squared	0.931014	Mean dependent var		37.11000
Adjusted R-squared	0.929960	S.D. dependent var		15.04023
S.E. of regression	3.980395	Sum squared resid		6226.512
Durbin-Watson stat	1.438647	eigenvalue		1.000000

Source: Authors' Computation (2023)

The result in table 2 indicated that all the selected variables have significant effects on Total Factor Productivity (TFP) except for the quantity of fertilizer used (QFU). The coefficient of farmer's age was positively significant. This indicates that 1% increase in farmer's age will cause TFP to rise by about 0.27%. The coefficient of farmers' family labour was significant even at 1% level of significant. This implies that an increase in family labour by 1% will increase the TFP of rice farmer by about 0.18%. The coefficient or hired labour was positively significant. An increase of 10% in hired labour will result to 0.92% increase in TFP of rice farmer. The size of Farm land has a significant impact on TFP even at 1% level of significant.

The coefficient of fertilizer used was positive but it is insignificant. This implies that application of fertilizer does not influence the output nor TFP in Southwestern Nigeria. The coefficients of quantity of herbicides and quantity of seeds planted were positively significant. This implies that 10% increase in quantity of herbicides and seeds planted will increase TFP by about 0.61%, and 0.57% respectively. The R^2 value of 0.93 implies that 93% of the variations in total factor productively of rice farmers were explained by the selected variables. The value of eigenvalue indicated that there is technical efficiency of production by rice farmers in Southwest Nigeria.

Table 3: Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	13.21646	Prob. F(6,393)	0.0000
Obs*R-squared	67.15982	Prob. Chi-Square(6)	0.0000
Scaled explained SS	71.40370	Prob. Chi-Square(6)	0.0000

Source: Authors' Computation (2023)

Table 3 shows that there is no problem of heteroskedasticity. Therefore, the result obtained can be used for effective prediction.

Testing for Structural Stability

The cumulative sum of the recursive residuals (CUSUM) and the cumulative sum of squares are applied to test for the stability of the model used in this study. The test shows parameters instability if the plots of the cumulative sum of the recursive residuals (CUSUM) and the cumulative sum of squares go outside the area between the two critical lines. The plots are shown in figures 1 and 2 below:

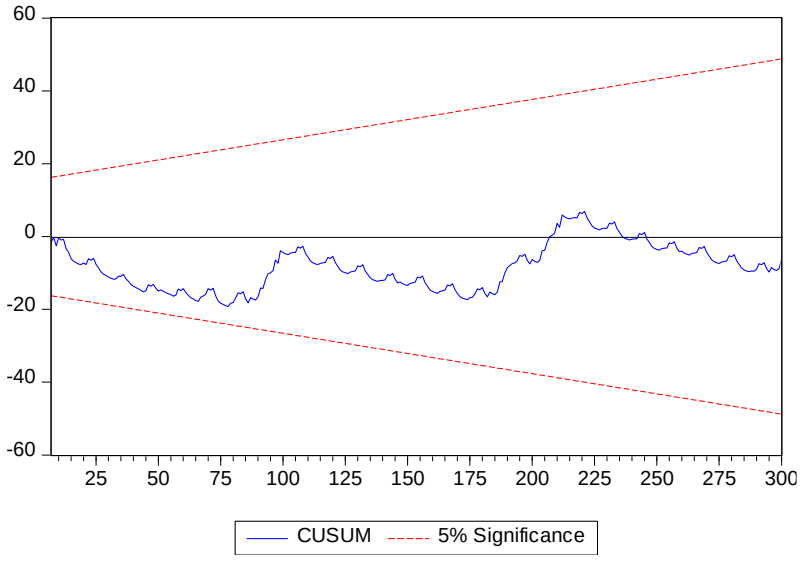

Fig. 1: CUSUM Test for Structural Stability of the Parameters

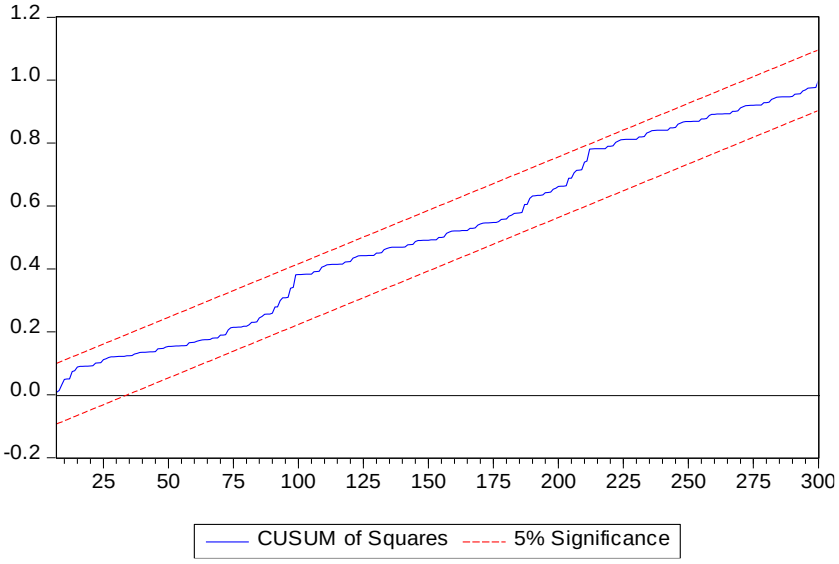

Fig. 2: CUSUM of Squares Test for Structural Stability of the Parameters

Figure 1 and Figure 2 indicated that the coefficients were stable. The existence of coefficient stability over the sample periods indicates the tendency for further coefficient stability.

Discussion

The study revealed that the farmer's age has a positive significant impact on TFP. This shows that as farmer**s** advance in age, they gain more experience which will help them improve their production or productivity. This contradicts the findings of Okoye, Onyenweaku, Ukoha, Asumugha and Aniedu (2008) and Masterson (2005). They postulated that old age might pose a disadvantage to agriculture but aged farmers most times are more experienced.

Also, it was discovered that family-labour has a positive significant impact on rice farmers of TFP. Farmers with large size of households tend to have more advantages of labour resources than their counterparts with small size of household. But the finding is contrary to that of Ukoha, Okoye and Emetu (2010) who found that farmers with large size of households tend to dissipate most of their resources on the upbringing and education of their children at the detriment of the production or productivity.

Furthermore, it was revealed that hired labour has a positive significant effect on TFP. In addition, land size also has a positive significant effect on TFP. The implication is that more hired labour is needed to match the available land resources to bring about the desired productivity in rice production in Southwestern Nigeria.

Moreover, quantity of fertilizer revealed an insignificant impact on TFP. This means that the application of fertilizer does not improve the output and productivity of rice production in Southwestern Nigeria, which might be due to availability of virgin and fertile land in Southwestern Nigeria. This also is at variance with the findings of Okoye, Onyenweaku and Asumugha (2007), as they opined that fertilizer is an important and improved technology which shifted the frontier upwards, leading to higher productivity.

In addition, it was revealed that quantity of herbicides has a positive significant effect on TFP. Application of herbicides compliments the effort of labour to improve production and productivity of rice farming in Southwestern Nigeria. Quantity of seed planted also has a positive significant effect on TFP of rice farming in Southwestern Nigeria. The use of improved seeds is an important predictor of agricultural. This result also agreed with the findings of (Shabu, 2013) where he discovered that the use of improved seeds and farm hectares were found to be the most significant predictors of rice productivity in Kaambe District of Guma Local Government Area of Benue State, Nigeria.

Finally, the study revealed that all the selected variables (farmer's age, family labour, hired labour, quantity of herbicides and Quantity of seed planted) have significant effects on Total Factor Productivity (TFP) except for the Quantity of fertilizer used (QFU) in Southwestern Nigeria. The study however concluded that the major determinants of Total Factor Productivity (TFP) in Southwest Nigeria during the study period are farmer's age, family labour, hired labour, quantity of herbicides and quantity of seed planted. It was also confirmed that there is technical efficiency of production by rice farmers in Southwest Nigeria. Based on these findings, the study therefore recommended that farmers should de-emphasize the used of fertilizer, which does not add value to their productivity. Also, government should encourage more famers to involve in rice production to enjoy the technical efficiency in rice farming.

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