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ANALYSIS OF PRODUCTIVITY OF RICE FARMERS IN NORTH-CENTRAL NIGERIA

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Abstract
Analysis of productivity of rice farmers in North-Central Nigeria was carried out with the use of secondary data collected from 1992 to 2016 from data banks and Federal Ministry of Agriculture Nigeria. 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 the MTFPI analysis revealed that rice contributed 0.1% of technical efficiency change to productivity growth over the period studied. The mean technological change indicated 2.3% improvement in production technologies of rice to achieve the productivity growth of 2.2%. 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. These imply that increase in these factors led to increase in rice productivity over the period studied. Government policy (ATA) had significant but negative relationship with the productivity of rice at 10% probability level. 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. The study recommends training on farm practices, techniques and proper allocation of production resources to achieve productivity growth in the study area. Policies on public security and insurance of farms against risk of all kind will increase productivity.

Key Words: *Productivity trend, Malmquist Index, Capital-Labour ratio*

Introduction

Productivity is the ability to create or generate goods, services and is a measure of the physical output produced from the use of a given quantity of inputs. This varies on the basis of production technology, technical efficiency and the external environment in which the production occurs. Agricultural productivity increase can be achieved from increase in output per unit of input variables, technical progress and efficiency change. This will lead to decrease in the cost of production and the price of the output, which leads to stability and gain in the long-run for both the producers and consumers (Isonguyo and Omolehin, 2017).

The estimated 200 million Nigerians, which increases at the growth rate of about

2.7% per annum (United Nations, 2018) rely on the agricultural sector for sustenance. This sector is estimated to produce at a production growth rate of about 1.7% (Food and Agriculture Organization (FAO, 2016)). The report of National Bureau of Statistics (NBS) (2016) did estimate the Gross Domestic Product (GDP) of rice to have risen from 120.96 billion Naira in 2013 to about 129.14 billion Naira in 2015. The high imbalance between the population growth rate and food crop production growth rate indicates that there is much hunger in the country.

However, Nigeria is known to be the world's third largest producer of rice, of which the largest quantity is produced in North-Central Nigeria (Udemezue, 2018). The production has increased from 5.5 million tonnes in 2015 50 5.8 million tonnes in 2017 (Rice Farmers' Association of Nigeria - RIFAN, 2017). Although, the global agricultural output growth is known to have shifted from resource-driven to productivity-driven in recent time, the knowledge of agricultural productivity of a country, region or state is important. This perhaps, may help to bridge the gap between demand and supply for food in Nigeria. Previous studies on agricultural productivity in Nigeria (Jatto *et al.,* 2015 and Ajao, 2011a) did not link food demand and supply to total factor productivity. This study, therefore, aimed to analyse the productivity of rice farmers in North-Central Nigeria from 1992 to 2016. This was carried out to determine the evolution of efficiency and total factor productivity change in the production of rice in the study area; determine the technical change or progress observed in the production of the crop and ascertain the determinants of total factor productivity growth in rice in the study area.

Theoretical and Conceptual Framework

Contemporary empirical studies on productivity rely on economic theory of production for analytical framework. The expression of the relationship between variable inputs and fixed input at a minimum level to produce maximum output is referred to as the production function. According to Ojo (2013), this is a quantitative description of input-output relationship in the production process. Total factor productivity measurement is commonly carried out by using either of the two approaches (parametric or non-parametric). The parametric approach relies on econometric techniques, such as the simple regression analysis (SRA) and stochastic frontier analysis (SFA) (Dharmasiri, 2001). Total factor productivity index can be obtained by multiplying the technical change with efficiency change.

The non-parametric approach involves the construction of index numbers, such as, Malmquist, Fisher, Tornquist and Laspeyes index numbers (Daskovska *et al*., 2010, Ojo, *et al*., 2012). This is the most often preferred method in situations where there are price fluctuations, inaccuracy or non-existence and cost minimization or profit maximization assumptions are not necessary, since it does not require input or output prices. The non-parametric model is expressed as in equation (1), thus:

$$A_t = T_t / I_t \quad (1)$$

Where: A_t measures the TFP level; T_t is an index of output quantity, while I is the input quantity, and 't' is the time frame. Subsequent growth rate may not be the same as that of the parametric estimation. This Data Envelopment Analysis (DEA)-

based Malmquist productivity index methodology allows the evaluation of relative efficiency of combined units of multiple inputs into multiple outputs, to produce a single comprehensive measure of performance (efficiency score) for each unit (Cooper *et al*., 2011). The Malmquist productivity index, when compared to other indices could be used in situations where the objectives were unknown, differ, or were difficult to implement, as it does not require the cost minimization or profit maximization assumptions (Mohammadi and Ranaei, 2011). To accommodate the sources of productivity changes in the case of scale efficiency, Mayer and Zelenyuk (2014) generalized the Malmquist productivity index and defined it as the difference between the average growth rates of outputs and inputs.

Malmquist TFP index distance functions, from output is defined as expressed in equation (2)

$$d_0(x,y) = \min\{\theta : (y/\theta) \in P(x)\} \qquad (2)$$

Where:

$P_{(x)}$ = Output set for all output vector, y, which can be produced using the input vector x. and following Brümmer *et al.* (2002), the MI TFP change between a base period (t) and a period (t+1) can be expressed as:

$$M_0 = (y_s x_s y_t x_t) = -\left[\frac{d^s{}_0(y_t, x_t)}{d^s{}_0(y_s, x_s)} \times \frac{d^s{}_0(y_t, x_t)}{d^t{}_0(y_t, x_t)}\right]^{1/2} \qquad (3)$$

Where:

$d^s{}_0(y_t x_t)$ = distance from period t observation to the period t+1 technology; y is the output and x is the input variable. When M >1 indicates positive TFP growth from period t to period t+1 or otherwise, if M<1. Equation (2) is the geometric mean of two TFP indices. The first index is evaluated with respect to period t technology, while the second is in respect to period t_{+1} technology. In equation (3), the term outside the square brackets measures the Farrell technical efficiency change in the output-oriented measure between period t and t+1; while the term inside measures technical change. This is the geometric mean of the shift in the technology between the two periods, which means that the efficiency change is equivalent to the ratio of the technical efficiency in period t to technical efficiency in period t+1. The Malmquist productivity indexes, when decomposed gives the technical change and the efficiency change and the two terms in equation (3) are as expressed in equations (4) and (5):

Efficiency Change (Technical Efficiency Change)

$$= \frac{d^s{}_0(y_t, x_t)}{d^s{}_0(y_s, x_s)} \qquad (4)$$

Technical Change (Technological Change)

$$= \frac{d^{s}{}_{0}(y_t, x_t\ )}{d_{s0}(y_t, x_t\ )}\left[\frac{d^{s}{}_{0}(y_t, x_t\ )}{d^{s}{}_{0}(y_s, x_s\ )}\times\frac{d^{s}{}_{0}(y_t, x_t\ )}{d^{t}{}_{0}(y_t, x_t\ )}\right]^{1/2} \qquad (5)$$

Where:

$d^{s}{}_{0}(y_t x_t\ )$ = distance from period t observation to the period t+1 technology. The efficiency change (technical efficiency change ($TEFFCH_{crs}$)) component is equivalent to the ratio of the Farrell technical efficiency in period t to the Farrell technical efficiency in period t+1, under the constant return to scale. Pure technical change measures the shift in the reference production frontier curve, while the efficiency change measures the catch-up attempt. Jatto *et al.* (2015) and Ajao (2011b) attempted the DEA approach for determinants of agricultural productivity in Nigeria but concentrated mainly on identifying socio-economic factors as the major determinants of agricultural productivity, without assessing total factor productivity of agricultural output.

Methodology

The Study Area

This study was conducted in North-Central Nigeria. The zone is made up of Benue, Kogi, Kwara, Niger, Nasarawa, Plateau States and the Federal Capital Territory (FCT), Abuja as shown in Figure 1. The zone occupies a total land area of about 296,898 km^2, which represents about 32% of the land area of the country, with a population of about 22,887,250 people as at 2016 (National Bureau of Statistics (NBS), 2016). It is located between Longitudes 2^o 30′ to 10^o 30′ East and Latitudes 6^o 30′ to 11^o 20′ North. More than 77% of the people in this zone are rural dwellers, who are mostly engaged in one form of agricultural activity or the other (Aregbeore, 2009). The zone has two main seasons, namely dry and wet seasons. The wet season occurs from the ending of March till the end of October, while the dry season begins from November and ends towards March. The annual rainfall ranges from 1,000 to 1,500 mm at the average of about 187 to 220 rainy days, with average monthly temperature ranges of 21^{o}C to 37^{o}C.

The zone has vegetation that consists of the Forest Savannah Mosaic, Southern Guinea Savannah and the Northern Guinea Savannah. Geographically, the zone is characterized by varying topographical landforms, such as, the extensive and swampy features found around the lowland areas, along the valleys of rivers Niger and Benue; while large hills, mountains, plateaus and deep valleys make up the remaining parts of the land areas. The vegetation, soil and weather patterns of the zone favour the cultivation and production of wide spectrum of agricultural foods, industrial and cash crops of various types. The available rivers and dam enable irrigation farming and vegetables gardening during dry seasons. The zone consists of more than 40 ethnic groups. The people in the zone are mainly farmers, hunters, fishermen and artisans. The major crops grown in the zone include rice, maize, millet, sorghum, yam, potatoes, cassava, cowpea, soybean and vegetables.

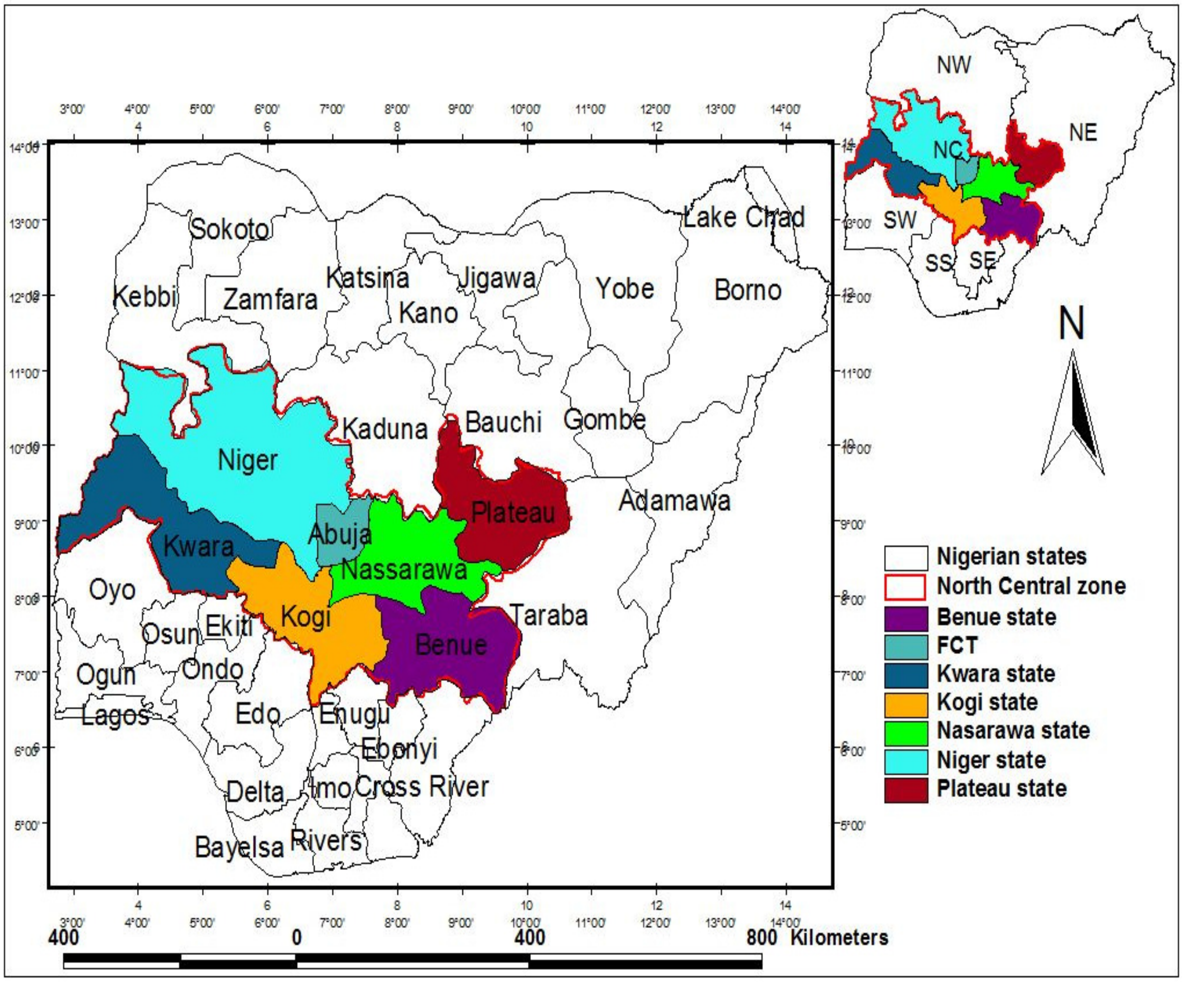

Fig. 1: Map of Nigeria showing the six geo-political zones with North-Central Nigeria at the centre

Method of Data Collection

Secondary data on rice production from 1992 to 2016 was collected for each of the selected State in the zone from National Bureau of Statistics (NBS), States' Agricultural Development Programmes (ADPs), States and Federal Ministry of Agriculture Abuja. Data on rice importation by Nigeria was gotten from Food and Agricultural Organization Statistical Data Bank (FAOSTAT). The secondary data collected from these establishments for the States studied included rice annual outputs measured in tonnes, the production inputs, such as farm size cultivated (in hectares), seed (in tonnes), labour (in man-days) and fertilizer (in tonnes) and capital (measured in Naira and Kobo).

Analytical Techniques

The productivity of rice in the study area was estimated with the use of a non-parametric approach (Data Envelopment Analysis (DEA)), based on Malmquist Total Factor Productivity Index (MTFPI). The results of the analysis were compared across the selected States in the study area. The evolution of different estimated efficiencies (technical, pure and scale efficiency changes) and productivity growth over time were presented using Tables or graphs. Tobit regression analysis, was used to ascertain the determinants of total factor productivity change.

Model Specification: Malmquist Total Factor Productivity Index (MTFPI)

Malmquist TFP index (MTFPI), based on distance functions were calculated for the TFP change between the two periods (t and t+1). Linear Programming (LP) problems solved, with the use of constant return to scale (CRS) helped to maintain uniformity of the variables. This is defined as inverse of Farrell's ratio between an output quantity change index and input quantity change index (Farrell, 1957) The required LPs are as expressed in equations (6) and (7):

$[D_0(X^{k*}, Y^{ky})]^{-1} Z^k, \theta^k$ = Max θ^{k*} (6)

Subject to:

$\sum_{k=1}^{N} Z^k Y_j^k \geq Y_j^k, \theta^{k*}$ j=1..., j

$\sum_{k=1}^{N} Z^k X_h^k \geq X_h^{k*}$ h=1..., H

$Z^k \geq 0$ k=1...N

$[D_0^{t+1}(X_{t+1}^{k*}, Y_{t+1}^{k*})]^{-1}$ = Max θ^{k*} (7)

Subject to:

$\sum_{k=1}^{N} Z^{k*} X_{t+1}^{k*} \geq Y^{kh} \theta^{k*}$ j=1..., J

$\sum_{k=1}^{N} Z^k X_h^k \geq X_h^{k*}$ h=1..., H

$Z^k \geq 0$ k=1..., N

Where:

D_0 is the output distance function; t is the initial period ; t+1 is the proceeding period; Y is the output quantity; X is the input quantity; N is the total population of farmers studied; k is the number of the States studied; k* is the particular State whose efficiency is being measured; j is the set of outputs; h is the set of inputs; Z^k is the weight of the k^{th} State's data and θ is the efficiency index, which is equal to 1 if k* State is efficient in producing the output vector. A less than one efficiency index indicates inefficiency in production. Linear programmes LP (6) and (7), therefore, are the point at which production points were compared to technologies from different time periods, which θ parameter is between 0 and 1. (Daskovska *et al.,* 2010 and Ludena, 2010). Equations (6) and (7) can be expressed as in equation (8):

Maximize: $Y^k = Y_1Z_1 + Y_2Z_2 + Y_3Z_3 + Y_4Z_4 + Y_5Z_5$

Subject to:

$$\begin{aligned} &A_{11}X_1 + A_{12}X_2 + A_{13}X_3 + A_{14}Z_4 + A_{15}Z_5 \leq H \\ &A_{21}X_1 + A_{22}X_2 + A_{23}X_3 + A_{24}Z_4 + A_{25}Z_5 \leq L \\ &A_{31}X_1 + A_{32}X_2 + A_{33}X_3 + A_{34}Z_4 + A_{35}Z_5 \leq C \qquad (8) \\ &A_{41}X_1 + A_{42}X_2 + A_{43}X_3 + A_{44}Z_4 + A_{45}Z_5 \leq S \\ &A_{51}X_1 + A_{52}X_2 + A_{53}X_3 + A_{54}Z_4 + A_{55}Z_5 \leq F \\ &Y^kZ^k \geq 0 \end{aligned}$$

Where:
Y^k denotes selected food crop output (in tonnes); X_1, X_2, X_3, X_4, X_5, denotes decision variables; Y_1, Y_2 Y_3, Y_4 and Y_5 denote output coefficients maximized; A_{ij} denotes Input-Output coefficients; H = Farm size cultivated (hectares); L = Labour used for the period of t activity (man-day); C = Working capital used at period t (Naira and Kobo); S = Quantity of seeds planted during period t (tonnes); F = Quantity of fertilizer used at period t (tonnes); Z^k = Weight of the k^{th} state's data (tonnes), while Y_5 denotes rice import;. In using these models, the technical efficiency change (TEFFCH), technological change (TECHCH) and total factor productivity (TFP) growth over the years obtained were presented with the use of graphs and Tables to show their evolution.

Tobit Regression Model

Tobit regression model is a censoring model and was used to ascertain the determinants of TFP change of the production of rice, as expressed in equation (9). Following Tobin's definition in 1958, the model is defined as;

$$Y_i^* = X_i\beta + \mathcal{E}_i^* \qquad (9)$$

$$Y_i^* = \begin{cases} Y_i^* \; if \; Y_i^* > 0 \\ 0_i \; if \; Y_i^* \le 0 \end{cases}$$

Where:
Y_i* is a latent (unobservable) variable; > 0 = greater than zero ; ≤ 0 = less than /equal to zero.; Y_i is the observed dependent variable , observed 0's on the dependent variables could mean real 0 or censored data. The explicit form of the Tobit model is as expressed in equation (10).

$$Y_i^* = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 \qquad (10)$$

Where:
Y_i^* = Total Factor Productivity Change (TFPCH); β_0 = Intercept; $\beta_{1\text{-}6}$ = Parameter to be estimated, which determines the relationship between TFP and X_1-X_6 (Independent variables); X_1 = Climatic Factor: Rainfall (Millimetre); X_2 = Institutional Factor: Amount of Credit (Naira and Kobo); X_3 = Government Policy: Agricultural Transformation Agenda (0 = period before the programme, and 1= during the programme) and X_4 = Capital-Labour ratio. In using Tobit regression model, β is not interpreted as the effect of X on TFP, but the estimation of relationships for limited dependent variables. The change in TFP of those above the limit, weighted by the probability of being the limit or the expected value of TFP change if above. A value of 1, indicates TFP change (efficiency) and 0 indicates no-change (inefficiency).

Results and Discussion

Evolution of Efficiency and Total Factor Productivity Change in the Production of Rice in North-Central Nigeria

The evolution of efficiency and total factor productivity changes in rice production in North-Central Nigeria is as shown in Table 1. The results reveal that, although, rice production was technically efficient slightly for more than half of the period studied, the mean pure and technical efficiency changes were both less than one, which did not have any adverse effect on the crop's productivity growth. The mean technical efficiency change of 0.999, implied a 0.1% reduction in its contribution to the overall total factor productivity change. Technical efficiency change fluctuated throughout the period of study but greater technological changes were recorded in the technique of the rice production over the years studied.

Table 1: Efficiencies and total factor productivity (TFP) changes in rice production in North-Central, Nigeria

Year	Pure Efficiency Change PECH	Scale Efficiency Change SECH	Technical Efficiency Change TEFFCH	Technological Change TECHCH	Total Factor Productivity Change TFPCH
1992					
1993	1.000	1.020	1.020	0.889	0.907
1994	0.865	0.876	0.716	0.832	0.848
1995	1.000	0.977	0.977	0.902	0.881
1996	1.000	1.049	1.049	1.150	1.080
1997	1.000	0.916	0.916	1.047	0.959
1998	1.000	0.996	0.996	1.183	1.080
1999	1.000	1.064	1.064	0.899	0.956
2000	1.000	0.985	0.985	1.156	1.110
2001	1.000	1.044	1.044	0.989	1.020
2002	1.000	0.986	0.986	1.029	1.014
2003	0.978	0.907	0.887	1.114	0.988
2004	1.023	0.829	0.848	0.874	0.880
2005	1.000	1.090	1.110	0.917	1.149
2006	0.947	0.942	0.892	1.192	1.010
2007	1.056	0.941	0.993	1.059	1.052
2008	1.000	1.053	1.053	1.034	1.089
2009	1.000	1.058	1.058	0.896	0.874
2010	1.000	0.910	1.091	1.092	1.059
2011	0.835	0.948	0.892	1.104	0.945
2012	1.076	1.039	1.117	1.109	1.140
2013	1.029	1.119	1.131	1.112	1.135
2014	1.025	0.936	0.960	1.093	1.088
2015	1.005	1.070	1.076	1.051	1.021
2016	1.164	1.123	1.137	1.182	1.158
Mean	0.999	1.000	0.999	1.023	1.022

The highest growth of 1.158 in total factor productivity of rice was recorded in 2016. This implied that TFP grew to about 15.8% in 2016, which was towards the ending of the period of Agricultural Transformation Agenda (ATA), just after 2015. The ATA was when agriculture was introduced on business-like attitude, to be managed by key stakeholders from the private sector to achieve self-sustained economy through improved funding. The effect of the ATA could still be felt, while the Agricultural Promotion Policy (APP) was introduced for the period of 2016-2020. This was the period when successes of the ATA were to be re-enforced through more direct funding.

The mean technological change of rice production was 1.023, which suggested a 2.3% improvement in the production technique used. This is greater than that of the technical efficiency change, which implied that technological change contributed more to the rice productivity than technical efficiency change. This enabled the total factor productivity to remain positive at 1.022, which indicated a 2.2% growth in the rice productivity over the period studied. This finding is in agreement with the findings of Adedeji *et al.* (2016) and Wakili and Md-Isa (2015) where rice production was found to be technically efficient in Nigeria.

Efficiency and Total Factor Productivity Change in the Production of Rice on States Basis in North-Central Nigeria

The results of the technical efficiency, with its components, technological and total factor productivity changes in the production of rice in the selected States in North-Central Nigeria as shown in Figure 2. The result shows all the States to be technically efficient, except Benue State, which recorded a 0.5% decrease in technical efficiency. The mean technical efficiency change for the states, suggested a 0.1% reduction in technical efficiency change over the period studied. Technological change for rice production was positive for all the states and the mean technological change was 1.023, which suggested a 2.3% improvement in production technique used. Kogi and Plateau States had lower technological changes at 2.3% and 1.7% respectively, which led to the regress in their total factor productivities by the same values respectively. This meant that the two states were inefficient, on the average in the method of production over the years studied as they recorded regress in productivities. However, the overall mean total factor productivity for rice production in the study area was 1.022. This indicated 2.2% productivity growth in the crop's production over the period studied. Benue, Kwara and Niger States achieved positive total factor productivity changes at 1.030, 1.054 and 1.071, indicating 3.0%, 5.4% and 7.1% productivity growth in rice production, respectively. This result is in agreement with the findings of Shabu (2013), Oladimeji and Abdulsalam (2013), and Matanmi *et al.* (2011), where rice production was found to be efficient in Nigeria. 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 (Shabu, 2013). This result also agreed with the findings of Dauda *et al.* (2013), where average total revenue of low land rice production in Katcha Local Government Area of Niger State, Nigeria was found to be greater than the total cost of its production, thus indicating high profitability and productivity. This result was further presented in a bar chart in Figure 2.

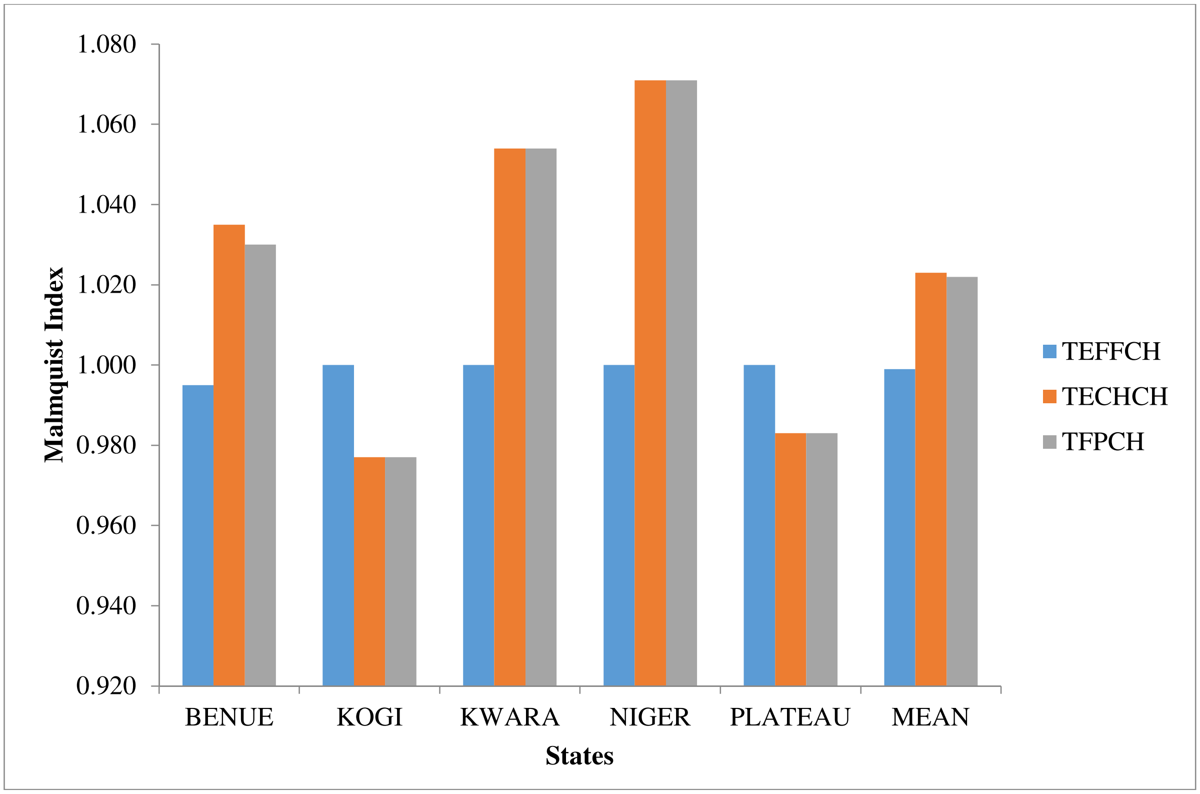

Fig. 2: Efficiency and productivity changes in rice production in North-Central Nigeria

Technical Progress in the Production of Rice in North-Central Nigeria

The mean technological change, technical progress and total factor productivity change in rice production in the study area are as presented in Table 2. Technical progress is often derived from technological change and is calculated as a difference between maximum efficiency score, which is 1.000 and technological change, thus, the need to mention technological change in the discussion. The highest technological change was recorded in 2016 at about 1.182 index, indicating 18.2% rise in the technology employed for the rice production in area that year. This was the ending period of Agricultural Transformation Agenda (ATA) (2011-2015), when sustainable agriculture based on business-like attitude through the private sector was emphasized to boost agricultural productivity in Nigeria.

The lowest technological change was at 0.832, recorded in 1994, which suggested a 16.8% decrease in the production technique used that year. The overall mean technological change of the crop's production was positive at about 1.023 index, implying a 2.3% increment in production technology overt the period studied. The highest technical progress recorded, therefore, was 0.182 in 2016, while the lowest technical progress recorded for the rice production was -0.168 in 1994, which indicated a 83.2% reduction in the technology used for the rice production in that year. Average technical progress recorded for the period studied was 0.023, implying a 97.7% technical requirement of improvement in the technique of the crop's production over the years studied in the study area.

The regressive values of technical progress observed from 1993, 1995, 1999, 2001, 2004-2005, and 2009 implied that despite the various policies and regimes, such as SAP (1986-1994), policy of liberalization (1995-2010) and Agricultural Transformation Agency (ATA) (2011-2015), much progress was not recorded in terms of technology improvement in the production of rice in the study area, thus the regress signs.

Table 2: Technical progress in rice production in North-Central Nigeria

Year	Technological Change TECHCH	Technical Progress TECHPR	Total Factor Productivity Change TFPCH
1992			
1993	0.889	-0.111	0.907
1994	0.832	-0.168	0.848
1995	0.902	-0.108	0.881
1996	1.150	0.150	1.080
1997	1.047	0.047	0.959
1998	1.183	0.183	1.080
1999	0.899	-0.101	0.956
2000	1.156	0.156	1.110
2001	0.839	-0.161	1.020
2002	1.029	0.029	1.014
2003	1.114	0.114	0.988
2004	0.874	-0.126	0.880
2005	0.917	-0.083	1.149
2006	1.109	0.109	1.010
2007	1.059	0.059	1.052
2008	1.034	0.034	1.089
2009	0.896	-0.104	0.874
2010	1.092	0.092	1.059
2011	1.104	0.104	1.095
2012	1.109	0.109	1.140
2013	1.162	0.162	1.155
2014	1.093	0.093	1.088
2015	1.051	0.051	1.021
2016	1.182	0.182	1.158
Mean	1.023	0.023	1.022

Total factor productivity changes of rice production over the years studied, in relation to technical progress, fluctuated with the highest increment observed in 2016 and lowest in 1994. The lowest total factor productivity change stood at 0.848, observed in 1994, which implied a 15.2% reduction from the possible output quantity. This result indicates that total factor productivity change seems to be positively related with the technological change or technical progress, as both contributed directly to the growth. This result agrees with the findings of Shabu (2013) and Bwala *et al.* (2015), where rice production in Northern Nigeria was found to be technically efficient. This result is also in agreement with the findings of Adedeji and Owolabi (2016), where total factor productivity of rice production in Nigeria was found to fluctuate between growth and regress after the comprehensive reform of 2003-2007, when National Economic Empowerment Development Strategy (NEEDS) was initiated (International Monetary Fund, 2005). However, the zone also achieved higher total factor productivity in post 2000 due to improvement in technical change and technical progress. This meant that over the years, several techniques were applied to recast rice production situation, which resulted to the various increase or decrease in the rice productivities.

Rice was produced with the lowest technical regress of -0.16 in 2001, which suggested the need for 84% improvement in the production technology in that year. Technical progress got to its maximum at 0.27 in 2010, which meant that about 73% innovation was required in the production technology of the crop in that year to achieve productivity growth. This result agreed with the findings of Afolabi, (2013), who estimated the value of the cultivated rice farm that had been washed away in Lafia in North-Central region to amount to about $90 million.

Technical Progress of Rice Production on State Basis

Technical progress of rice production was also carried out on the basis of individual state studied. The result is as presented in Table 3, where disparities were observed in the crop's production performance among the states. The positive technical progress did affect the total factor productivities of the crop productions of the states, as both technological change and technical progress contributed positively to the productivity growth of the crop.

Table 3: Technical progress of rice production by the selected states in North-Central Nigeria

STATE	Technological Change TECHCH	Technical Progress TECHPR	Total Factor Productivity Change TFPCH
BENUE	1.001	0.001	1.0332
KOGI	1.014	0.014	1.025
KWARA	1.1445	0.145	1.272
NIGER	1.112	0.112	1.121
PLATEAU	1.116	0.116	1.167

Technical progress of rice production by the states revealed that Kwara State scored the highest technical progress in rice production among the states studied, and this contributed positively to the mean total factor productivities of the crop by the states. The overall total factor productivity change, therefore, was positive for the whole states, which is in agreement with the findings of Longtan (2003), where rice production in Plateau State was found to be technically efficient.

Comparison between Technical Efficiency Change and Technological Change in Rice Production in the Study Area

Productivity growth is often determined by two major factors: either the input, which could be improved or non-improved and technology, which could be improved seed or the technique of production. The comparison of the rice performance in such terms was done as shown in Table 4, This is because the use of data envelopment analysis (DEA) model based on Malmquist index is less data demanding and allows the index to be decomposed into technical efficiency and technological changes, thus, the need for the multilateral comparison. Benue and Kogi States recorded greater technical efficiency change over technological change, while the other States recorded the reverse case. The mean technological change was greater than the mean technical efficiency change over the period studied in rice production. This indicated that much investment in the technique of the crop's production resulted to rice productivity growth recorded, over the years. Therefore, the mean technological change was the main contributor to the productivity growth of rice over the period studied.

Table 4: Comparison between mean technical efficiency change (TEFFCH) and mean technological change (TECHCH) for rice production by all the States studied in North-Central Nigeria

STATE	TEFFCH	TECHCH	TEFFCH > TECHCH	TECHCH >TEFFCH
BENUE	1.000	0.9833	*	
KOGI	1.000	0.977	*	
KWARA	0.995	1.035		*
NIGER	1.000	1.054		*
PLATEAU	1.000	1.071		*
MEAN	0.999	1.023		

TEFFCH = Technical Efficiency change; TECHCH = Technological change; > = Greater than.
* = Yes, the change is greater or contributes more to productivity growth (growth in total factor productivity-TFP) than the other one

Determinants of Productivity in the Production of Rice in North-Central Nigeria

The results of the factors that determined productivity of rice in the study area is as presented in Table 5. The results indicated that both climatic factor (rainfall) and institutional factor (amount of credit borrowed) were statistically significant and positively related to rice production at $P \leq 0.01$. This indicates that increase in both rainfall and farmers' utilization of the credit borrowed led to increase in productivity growth of the crop during the period of the study.

Table 5: Tobit model of the determinants of total factor productivity change in the selected food crops in North-Central Nigeria

Variables	Coefficient
Rainfall (mm^3)	0.067*** (2.78)
Amount of Credit (₦/K)	4.00e-07*** (2.63)
Government Policy	0.07* (0.61)
Capital (₦/K)	0.07* (0.67)
Labour (Manday)	0.08 (1.44)
Capital-labour (Ratio)	2.80e-10** (0.32)
Rice imports (Tonnes)	-0.06** (-1.93)
Constant	1.92 (1.94)
Chi2	5.70***
PseudoR^2	-3.25
Log Likelihood	3.72

*= significant at 0.10; ** = significant at 0.05; *** = significant at 0.01.
Figures in parenthesis are the values of the t-ratio

Government policy (ATA) and capital used had positive and significant relationships with the productivity of rice at 10% probability levels. This indicates that improvement in government policy and increase in the amount of capital used in the crop's production led to increase in the productivity growth. The result further reveals that capital-labour ratio had positive and significant relationships with rice productivity growth at 0.05 level of probability during the period of the study. The farmers' utilization of capital in a greater magnitude than labour led to increase in rice productivity growth. On the other hand, the utilization of labour in a greater proportion than capital would lead to reduction or regress in rice productivity growth. Rice import was statistically significant, but negatively related to rice production at 5%. This implied that increase in the rice imports into the study area led to reduction in productivity growth of the crop, as the rice import had negative and significant relationship with rice productivity growth at $P \leq 0.05$ during the period studied.

Conclusion and Recommendations

Analysis of productivity of rice production in North-Central Nigeria was carried out with the use of secondary data, gotten from the field survey. Generally, productivity growth was observed in rice produced in North-Central Nigeria over the period studied. Technical efficiency change, technological change and technical progress were the major drivers of the crop's productivity growth. Technical efficiency change favoured the productivity growth of rice. Benue and Kogi States were efficient in rice production but inefficient in the technology used. Productivity growth, was influenced more by technological change than other efficiencies in rice production in the study area. The study therefore recommends that policies on agricultural implement acquisition for improved production should be formulated, since both technical efficiency change and technological changes were found to be the contributors to rice productivity growth in the study area. Information on resource allocation of rice should be conveyed to farmers by agricultural extension officers and they should be assisted in improving the production technology to achieve greater technical progress than the existing one.

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