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FARM LEVEL ALLOCATIVE EFFICIENCY OF RICE PRODUCTION IN LGA'S OF NIGER STATE, NIGERIA

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Abstract

Rice is a staple food crop in Nigeria, the demand for rice has been increasing at much faster rate in Nigeria than in other West African countries since the mid- 1970s. For example, Nigeria's per-capita rice consumption level has grown significantly at 7.3% per annum, rising from 18kg in the 1980s to 22kg in 1990s but production rate is relatively low. The low productivity is mostly attributed to allocative inefficiency. Allocative efficiency (AE) considers farmers' ability to allocate resources efficiently, by producing the maximum possible output at minimum cost. Increasing AE requires an understanding of the specific sources of inefficiency that vary across farm enterprises, geographically and temporally. This research will help to discover how farmers can increase production of rice so that there will be less amount invested in importation of rice, in addition it will also be useful for policy intervention. A cross-sectional study was carried out in some selected local government in Niger state, Nigeria to assess the sources of farm-level allocative inefficiency in rice production using the Data Envelopment Approach System. Data were collected from a random sample of 120 smallholder rice farmers. Results show that the mean AE was 42.9%. Land ownership, Area cultivated, Gender, and Quantity of Fertilizer used had significant effects on AE. We recommend adoption of technologies such as the use of ox-ploughs to enable farmers plough large area of land for rice cultivation and reallocation of farm resources especially quantity of fertilizer used and gender balance.

Keywords: Allocative Inefficiency, DEA Approach, Pricing Efficiency, Production, Rice Farmers

1.0 Introduction

Rice (*Oryza sativa*) is a major staple food for millions of people in West Africa and the fastest growing commodity in Nigeria's food basket (Akande, 2003). The demand for rice in Nigeria is growing faster than for any other major staples, with consumption broadening across all socio-economic classes. Smallholder farming, predominant in Nigeria, is characterized by low productivity for most crops including rice which has gained prominence as both a food and income crop. In response to the growing demand for this staple, government at various periods actively intervened in the rice production by formulating policies one of which was the enormous (rice) imports to supplement the local production which no doubt constitute an enormous drain on the country's hard earned foreign earnings. Nigeria's rice sector has witnessed some remarkable developments particularly in the last ten years (Okoruwa ***et al***., 2006). Substitution of rice for coarse grains and traditional roots and tubers has fueled growth in demand at an annual rate of 5.6 per cent between 1961 and 1992 (Osiname, 2002). Food and Agricultural Organization (2003) projected growth in rice consumption for Nigeria beyond year 2000 remained as high as 4.5 per cent per annum. In response to the growing demand for this staple, government at various periods actively intervened in the rice production by formulating policies one of which was the enormous (rice) imports to supplement the local production which no doubt constitute an enormous drain on the country's hard earned foreign earnings (United States Department of Agriculture, 2007). The ecological nature of the Nigerian environment is aptly very much suitable for cultivation of different rice varieties. Rice is not only a key source of food but a major employer of labour and source of income (West Africa Rice Development Association, 2004). The potential land area for rice production is between 4.6million and 4.9million hectares, the world's population is expected to exceed nine billion by 2050 (United Nations, 2019).

However, only 1.7 million or 35% of this is cropped to rice, (Singh et al. 1997). Local rice production has not kept pace with domestic consumption demand (International Rice Research Institute, 1995). Presently, Nigeria is the largest producer of rice in West Africa but the second largest importer in the world, accounting for 25% of continent's imports (Muhammad ***et al***., 2018). In 2017, the nation's annual production capacity was about 5.3 million tonnes, and over 2.7 million tonnes ($600 million worth) of rice was imported into the country (Food and Agricultural Organization, 2017). Despite this production capacity, Nigeria rice sub-sector could not meet the domestic requirement. The inability of the sector to meet the demand is attributed to low productivity, inefficient use of resources and low mechanization level (Okam ***et al***., 2016). It has become a staple food in Nigeria such that every household; both the rich and the poor consume a great quantity (Godwin, 2012). A combination of various factors seems to have triggered the structural increase in rice consumption over the years with consumption broadening across all socio-economic classes, including the poor. Rising demand is as a result of increasing population growth and income level (Global Agricultural Information Network, 2012) coupled with the ease of its preparation and storage.

Declining productivity is being witnessed in many countries and Farmers need new approaches and technologies to produce more rice on existing or less land and water with limiting and or expensive inputs. The world's population is expected to exceed nine billion by 2050 (United Nations, 2019). Minimizing the yield gap between what is currently harvested by farmers and the achievable highest yield is possible through efficient resource utilization (IRRI, 1995). According to Alimi (2000), resources must be available and efficiently used in order to achieve optimum production level. Helfand (2003) emphasized that the analysis of efficiency is generally associated with the possibility of farms producing a certain optimal level of output from a given bundle of resources, or certain level of output at least cost. The productivity of farmers has remained all time low leading to massive importation and depletion of the nation's foreign reserve hence the need to examine the allocative efficiency of rice farmers in the study area.

Allocative efficiency (AE) is the ability of a firm to use inputs in optimal proportion, given their respective prices and the production technology. The use of an input is allocatively efficient if the value of marginal product is equal to its price (Mohammad, 2009). A number of studies have been carried out to determine factors that influence efficiency of farmers especially on rice. Farrel's (1957) pioneer work on production efficiency that assumed constant returns to scale has been under going further improvements to increase the power of estimation (Ogundele and Okoruwa, 2006). Allocative (Pricing) Efficiency (AE) refers to the ability of a firm to produce at a given level of output using the cost-minimizing input ratios (Ettah and Angba, 2016). Allocative efficiency is a measure of how an enterprise uses production inputs optimally in the right combination to maximize profits (Inoni, 2007). Thus, the allocatively efficient level of production is where the farm operates at the least-cost combination of inputs. Most studies have been using gains obtained by varying the input ratios based on assumptions about the future price structure of products say maize output and factor markets. This study follows Chukwuji, ***et al***., (2006) reviewed assumptions used by farmers to allocate resources for profit maximization. Such assumptions included, farmers choose the best combination (low costs) of inputs to produce profit maximizing output level; there is perfect competition in input and output markets; producers are price takers and assumed to have perfect market information; all inputs are of the same quality from all producers in the market. Over 96% of African farmers are smallholders (Kanu ***et al***., 2014). Smallholders' farming activities are majorly constrained by family labour and land size (Jayne ***et al***., 2010). For most smallholders, the main source of production labour is family labour, which is highly dependent on household size (Kamau ***et al***., 2009).

Efficiency of resource use and its predisposing factors is necessary for guiding decision-making and improve farm planning. In Vietnam, for instance, Tung (2013) observed that farmers needed to change their farm plans and 'expand their production' due to the increased efficiency of rice production. The study also analyzed the sources and causes of inefficiency for rice production in the region. The aim was to fill the gap in literature and contribute to the discussion on efficiency. Most studies on efficiency focus on technical efficiency (for example, Tung 2013; Madau ***et al***., 2017; Ahmed and Melesse 2018; Tanko and Jirgi 2008) and profit efficiency (Tanko and Aji 2014; Hyuha ***et al***., 2007). Technical efficiency looks at the ability of farmers to maximize output while profit efficiency combines both technical and allocative efficiency but does not reveal specific factors responsible for the observed technical or allocative efficiency. Instead it combines the two into profit efficiency.

However, in light of the need to promote smallholder commercialization, there is an increasing use of purchased inputs (Sheahan and Barrett 2017). This brings into perspective the other dimensions of efficiency—economic efficiency—which is the ability of farmers to use the least possible cost in production. This study focused on the allocative efficiency which looks at the ability of farmers to produce the maximum possible output (technical efficiency) at the least possible cost (economic efficiency) (Farrell 1957).

2.0 Methodology

2.1 Study Area

Niger State is located in the North Central part of Nigeria and the largest state in land mass in the country. It is located between Latitudes 6^o 30' N and 11^o 20' N and Longitudes 2^o 30' E and 10^o 30' E. The region occupies a total land area of 296,898 km^2 representing about 32% of the land area of the country. The State capital is Minna, and other major cities are Bida, Kontagora, and Suleja. It was formed in 1976 when the then North-Western State was bifurcated into Niger and Sokoto State. It was named after the River Niger. Two of Nigeria's major Hydroelectric Power stations, the Kainji Dam and the Shiroro Dam, are located in the State. Also situated in the State is Kainji National Park, the largest National Park in Nigeria, which contains Kainji Lake, the Borgu and the Zugurma Game Reserves.

The State experiences two main seasons; namely, dry and wet seasons, with the wet season beginning towards the end of March and the end of October. The dry season starts from November of each year to March. The rainfall per annum ranges from 1000 to 1500mm with the average of 187 to 220 rainy days and an average monthly temperature ranging from 21^{o}C to 37^{o}C. The vegetation of the zone consists of the forest Savannah Mosaic, Southern Guinea Savannah and the Northern Guinea Savannah. The vegetation, soil and weather patterns are favorable for the production of a wide spectrum of agricultural food, industrial and cash crops of various types. The major crops grown in the State include rice, maize, millet, sorghum, yam and cassava (Tologbonse, 2004).

Niger State, a community of 30 ethnic groupings, was created out of the defunct North Western State on 3rd February 1976. It is bounded on the West by the Republic of Benin, North by Zamfara State, North West by Kebbi, South by Kogi State, South West by Kwara State, North East by Kaduna State and South East by the Federal Capital Territory (FCT, Abuja). It is located between latitude 8^{o} 20' North to 11^{o} 30' North and longitude 3^{o} 30' East to 7^{o}20' East. With its 25 Local Government Areas (LGAs), Niger state is one of the largest states in Nigeria with a landmass of 86,000km^2 (8.6 million hectares) which represents about 9.3% of the total landmass of Nigeria. The provisional result of the 2006 National Population Census shows that Niger State has a population of 3,950,249 comprising 2,032,725 males and 1,917,524 females (NPC, 2006). This represents a percentage share of 51.5% for males and 48.5% for females. Moreover, as opposed to a national annual growth rate of 3.2%, Niger State is growing at 3.4%. The projected population of the State as at 2014 was 4,961,512.

The major economic activity is agriculture (farming, fishing and Livestock rearing). The state is blessed with numerous natural resources like solid minerals, vast arable land, good weather and water. Amongst its rich mineral resources are gold, talc, kyanite, kaolin, graphite, ball clay, feldspar, marble, manganese, lead and copper, asbestos, iron, silica, sand and granite, all of which abound in large deposits. The two major dams for electricity generation in the country are located in the State. The extensive flood plains in the southern boundary of the state, availability of large water bodies, dams and reservoirs offer great opportunity for dry season cultivation of fadama crops such as rice, sugar cane, maize and assorted vegetables. It has ideal conditions for livestock production. Its abundant grass land and fodder, favorable weather and abundant water supply as well as control of tsetse fly menace favor rearing of cattle, goats, and sheep among others.

Figure 1: The map of Nigeria showing the Location of Niger state

Figure 2: The map of Niger state showing the different Local Government Areas

2.2 Method of Data Collection

Data for the study were elicited from primary sources. A structured questionnaire was used to collect the primary data in the study area, which was complemented with interview schedules. Data collected include the farmers' social characteristics such as age, marital status, educational level, household size, land ownership status, extension contact, credit access, and cooperative society membership. Input-output data were also collected; these include area devoted to rice cultivation, quantity of fertilizer used, labor input and capital inputs. A multistage technique was used to get a representative sample and achieve the stated objectives of the study. Firstly, four (4) Local Government Areas (LGA_s) in Niger state, namely: Wushishi, Shiroro, Lavun and Katcha purposively selected. The choice was based on the preponderance of rice farmers in these LGA_s. This was followed by a random selection of three (3) villages from each LGA as follows: Wushishi (Kanko et al.), Katcha (Jibo et al.), Shiroro (Bassa et al.), Lavun (Zanchita et al.). Lastly, ten% of respondents were chosen from the sampling frame in each village. The researcher collected data, and it lasted from May to September 2023.

2.3 Analytical Technique

The methods of data analysis adopted include descriptive statistics, the Net Farm Income model and

Data Envelopment Analysis (DEA) model. The selection of the farmers was done proportionate to size.

The formula used in drawing samples from the farmer frames is given as:

n = N/ 1 + N (e) 2 (1)

Where; N= population/frame, e = limit of tolerable error = 0.05 (or 95% confidence interval), n = Sample size, 1 = constant.

Emprical model for the Measurement of the Technical, Allocative and Economic Efficiency

The efficiency estimates were computed using the DEA model.

The technical, allocative and economic efficiency of the rice farmers will be determined using the empirical data envelopment analysis (DEA).The input-oriented DEA will be used in this study to determine how much input mix the rice farmers would have to change to achieve the output level that coincides with the best-practice frontier. DEA is a relative measure of efficiency.

The model used in the estimation of allocative efficiency is specified as follows:

$$\text{Max AE} = \frac{\sum_{r=1}^{n} \propto_r \pi_{ro}}{\sum_{j=1}^{m} \beta_i X_{io}} = \frac{\pi}{\pi^*} \qquad (1)$$

$$\text{Subject to} = \frac{\sum_{r=1}^{n} \propto_r \pi_{rj}}{\sum_{j=1}^{m} \beta_i X_{ij}} \leq 1, j = 1, 2, \dots \dots n \qquad (2)$$

And $\alpha_{r,} \beta_i \geq 0;\ r = 1, \dots, s;\ i = 1, \dots \dots, m.$

Where X_{ij} and π_{ij} are the prices of the i[th] and net profit realized by the j[th] DMU respectively; AE = Allocative efficiency.

The $X_{ij's}$ include the following:

X_1 = price of land / rent (₦)
X_2 = price of fertilizer (₦)
X_3 = price of family labour (₦)
X_4 = price of hired labour (₦)
X_5 = price of seeds and agrochemicals (₦)
X_6 = depreciation on equipment (₦)

2.4 Tobit Model

Tobit model is also called censored regression model. It is designed to estimate linear relationships between variables when there is either left- or right- censoring in the dependent variable (also known as censoring from below or above respectively). Censoring from above takes place when cases with a value at or above some threshold, all take on the value of that threshold, so that the true value might be equal to the threshold, but it might also be higher. In the case of censoring from below, those values that fall at or below some threshold are censored.

2.5 Test of Hypothesis

The hypothesis was tested by ascertaining the statistical significance of the estimated regression coefficients in the inefficient model.

3.0 RESULTS AND DISCUSSION

3.1 Measurement of the Allocative, Technical and Economic Efficiency of Rice Farmers

A summary of the results showing the number of efficient and inefficient farms, as well as Farms/Decision making unit (DMUs) operating under Constant returns to scale (CRS), Increasing returns to scale (IRS) and Decreasing returns to scale (DRS) are presented in Table 1 and 2 respectively. Results in Table 1 indicated that, 90 DMUs were inefficient while 30 were efficient. This implies that 25% of the farmers in the study area were operating at optimum level of production with mean technical, allocative and economic efficiencies of 0.815, 0.429 and 0.279 respectively. 75% of the farmers in the study area can still improve on their level of efficiency through better utilization of available resources.

Results in Table 2 show that the number of DMUs operating under CRS, IRS and DRS were 30, 83 and 7 respectively. The result suggested that most of the DMUs were in the early expansion stage and hence, a lot of scope was there to improve efficiency through proper reallocation of existing resources. Out of all the rice farmers operating under CRS, 30 were working under most productive Scale Size (MPSS), that is, they were fully efficient both under CRS and VRS mode. Results of DMUs and their counts appearing as peers are presented in Table 3. Farms appearing more frequently as a peer for other farms are termed robustly efficient. They are robustly efficient because their production practices are such that these farms were frequently used to form the efficient frontier for the inefficient farms in the data. Out of all those DMUs operating under CRS, the DMU 68 was treated as the most frequently peer (33 times), followed by 69 (32 time) and 42 and 109 (29 times each). Other farms in the study area could go and learn better production practices from these best-practice farms.

Table 1: DEA Output summary showing efficient farms

Efficiency	Total Sample	No of inefficient farms	No of efficient farms	Mean
TE	120	90	30	0.815
AE	120	90	30	0.429
EE	120	90	30	0.279

Source: Data Analysis, 2023

Table 2: DEA output Summary showing Farms operating under Constant Returns to Scale (CRS), Increasing Returns to Scale (IRS) and decreasing Returns to Scale (CRS)

Scale efficiency	CRS	IRS	DRS
TOTAL	30	83	7

Source: Data Analysis, 2023

Table 3: DMUs and Their Counts Appearing as Peers

Farm	Peer count	Farm	Peer count
2	6	58	6
6	11	60	12
14	1	66	3
20	4	68	33
27	10	69	32
29	4	70	4
30	4	71	10
31	18	72	3
35	10	74	2
39	1	79	2
40	13	80	1
41	14	81	1
42	29	82	3
43	21	95	1
52	2	103	5
54	2	109	29
55	4	115	2
56	9	116	7

Source: DEA Output, 2023

3.2 Frequency distributions of technical, allocative and economic efficiencies scores

Table 4. Shows the TE, AE and EE of the rice farmers. The mean TE, AE and EE were 0.815, 0.429 and 0.279 respectively. A total of 30 DMUs were operating on the efficient frontier. It means that these DMUs were fully technically efficient, but the performance of the DMUs could change drastically whenever the price information is used in estimating the cost efficiency and AE scores. Results in Table 4.7 show that 35 farms had capital in excess

representing 23.05%, with mean slack of 1,033.533 and mean input use of 4483.57. This was followed by fertilizer input which 38 farms had in excess with 16.41% excess usage, 0.733 mean slack and 4.71 mean input usage. Other costs such as cost of seeds, agrochemicals etc had excess input percent of 14.12% that the farms could still make use of but failed to.

Table 4: Frequency distributions of technical, allocative and economic efficiencies scores

Class of TE	Number of DMUs	Class of AE	Number of DMUs	Class of EE	Number of DMUs
0 – 0.10	2	0 – 0.10	1	0 – 0.05	9
0.10 – 0.20	7	0.10 – 0.20	36	0.05 – 0.10	20
0.20 – 0.30	6	0.20 – 0.30	37	1.00 – 0. 15	35
0.30 – 0.40	11	0.30 – 0.40	8	0.15 – 0.20	12
0.40 – 0.50	9	0.40 – 0.50	13	0.20 – 0.30	17
0.50 – 0.60	19	0.50 – 0.60	11	0.30 – 0.40	7
0.60 – 0.70	14	0.60 – 0.70	2	0.40 – 0.50	9
0.70 – 0.80	14	0.70 – 0.80	8	0.50 – 0.60	3
0.80 – 0.90	9	0.80 – 0.90	3	0.60 – 0.70	1
0.90 – 0.99	12	0.90 – 0.99	1	0.70 – 0.80	6
Up to 1	17	Up to 1	0	0.80 – 0.90	1
				0.90 – 0.99	0
				Up to 1	0
Total	120	Total	120	Total	120
Mean	0.815	Mean	0.429	Mean	0.279
Standard Dev	0.710	Standard Dev	0.373	Standard Dev	0.243
Minimum	0.07	Minimum	0.04	Minimum	0.02
Maximum	1.00	Maximum	1.00	Maximum	1.00

Source: DEA Output, 2023

4.CONCLUSION AND RECOMMENDATIONS

It was concluded from findings of this study that land ownership and quantity of fertilizer had an inverse relationship with allocative efficiency i.e. the farmers who owned their land are less allocative efficient that those who pay rent on the land and the more the fertilizer used, the less efficient the rice farmers are. Out of all the rice farmers operating under constant return to scale (CRS), 28 are working under most productive Scale Size (MPSS), i.e they are fully efficient both under CRS and VRS mode known as CCR (Charnes, Cooper and Rhode) model and BCC (Banker, Charnes and Cooper) model respectively. Out of all those DMUs operating under CRS, the DMU 68 was treated as the most frequently peer (33 times), followed by 69 (32 time) and 42 and 109 (29 times each).

Based on the findings of the study, the following recommendations are hereby made to promote increased rice production in the study area:
We recommend adoption of technologies such as the use of ox-ploughs to enable farmers plough large area of land for rice cultivation and reallocation of farm resources especially quantity of fertilizer used and gender balance.

REFERENCES

Ahmed, M., and Melesse, K (2018). Impact of off-farm activities on technical efficiency: evidence from Maize producers of Eastern Ethiopian. *Journal of Agricultural and Food Economics* vol, 6(3): pp 34-36

Akande, T. (2003). The rice sector in Nigeria. United Nation Crop Project (UNCP) Country Agricultural Project on trade liberalization in Agricultural sector and the environment, Geneva. pp 10.

Alimi, T. (2000) “Resource Use Efficiency in Food Crop Production in Oyo State of Nigeria”, *Journal of Agriculture and Environment*, 1(1):1-7.

Bamiro, O.M., Adedeji, I.A., Otunnaiya, A.O., Soluade, W. and Ogunjobi, J.O. (2015). Enterprise combination in the livestock sector in South-Western Nigeria. *Journal of World Economic Research*, 4(2): 38-44

Chukwuji, C.O., Odjuvwuederhie, E.I., O’raye D.O. and William, J.O. (2006). A Quantitative Determination of Allocative Efficiency in Broiler Production in Delta State, Nigeria. Department of Agricultural Economics and Extension, Delta State University, Asaba Campus, Asaba. Delta State, Nigeria. *Agriculturae Conspectus Scientifi cus*,71(1):21-26.

Ettah, O.I. and Angba, A.O. (2016). Analysis of cost and Returns among cassava farmers in Cross River State, Nigeria. *International Journal of Science and Research*, vol. 6.3,pp; 111-114.

Farrell, M.J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society*, 120:252-290.

Food and Agricultural Organization FAO (2003): FAOSTAT database http//www.fao.org/accessed June, 2007

Global Agricultural Information Network. (2012). Nigeria Grain and Feed Annual Report. GAIN Report Number: NI1204, U.S. Consulate, Lagos.

Helfand, S.M. (2003). Farm size and the determinant of Productive Efficiency in the Brazilian Centre-West Processing. Conference of Agricultural Economist. Durban. South Africa (16th – 22nd August, 2003) Pp. 605-606

Inoni, O.E. (2007). Allocative Efficiency in Pond Fish Production in Delta State, Nigeria: A Production Function Approach Agricultura Tropica Et Subtropica vol. 40 (4).

Hyuaha, T., Bashaasha, B., Nkonya, E. and Kraybil, D. (2007). Analysis of profit inefficiency in rice production in Eastern and Northern Uganda. *Africa Crop Science Journal* 15(4): 243-253

International Rice Research Institute (I.R.R.I) 1995. World Rice Statistics, pp. 34-42.

Jayne, T., Mather, D. and Mghenyi, E. (2010). Principal Challenges confronting Smallholder Agriculture in Sub-Saharan Africa. *World Dev* 38(10): 1384-1398

Kamau, M., Burger, K., Giller, K. and Kuyvenhoven, A., (2009). Labor markets and labor allocative efficiency among farm households in Western Kenya. *African Journal of Agriculture and Resource Economics* vol 3(2): 144-158

Kanu, B., Salami, A.O. and Numasawa, K (2014). Inclusive growth: an imperative for African Development Bank. Tunis-Belvedere, Tunisia

Madau, F., Furesi, R. and Pulina, P. (2017). Technical efficiency and total factor productivity changes in European dairy farm sector. *Agricultural and Food Economist* 5(17)

Mohammad I.J. (2009). Efficiency Analysis of Cotton-Wheat and Rice-Wheat Systems in Punjab. Pakistan.

Muhammad, W., Abba Sidi, S.U., Ibrahim, A. and Mohammed, Z. (2018). Energy-use efficiency of rice production under irrigation in Jere Bowl Borno State, Nigeria. *American Journal of Environmental and Resource Economics*. 2018;3(1):6-11. Available:http://www.sciencepublishinggroup.com/j/ajere DOI:10.11648/j.ajere.20180301.12

Okoruwa, V.O, Ogundele, O.O., and Oyewusi, B.O. (2006). Efficiency and Productivity of Farmers in Nigeria: A Case study of rice farmers in North Central Nigeria. Paper Presented at the International Association of Agricultural Economists Conference, Gold Coast, Australia. August, 12-18

Okoruwa, V.O. and Ogundele, O.O. (2006). Technical Efficiency Differentials in Rice Production Technologies in Nigeria. Nigerian Institute for Social and Economic Research (NISER), Ibadan, Nigeria.

Osiname, O.A. (2002). Review of Current Status, Policy and Prospects of Rice production in Nigeria: Paper Presented at the Rice Stakeholders Workshop. Nigerian Institute of Social and Economic Research (NISER). 19th-20th November

Sheanan, M. and Barret, C. (2017). Ten striking facts about Agricultural input use in Sub-Saharan Africa. *Food Policy* 67:12-25

Singh, B.N., Fagade, S., Ukwungwu, M.N., William, C., Jagtap, S.S., Oladimeji, O., Effisue, A. and Okhidievbie, O. (1997). Rice growing environments and biophysical constraints in different agro-ecological zones of Nigeria. *Meteorology Journal*, 2 (1): 35-44.

Tanko, L. and Aji, D.A. (2014). Comparative Analysis of Economic Efficiency of Broiler and Egg production Enterprise in Niger State, Nigeria. Proceeding of the 15th Annual National Conference of the Nigerian Association of Agricultural Economist (NAAE), 24 th -27 th February, 2014, Federal University of Technology Akure, Nigeria. Pp. 170-180

Tanko, L. and Jirgi, A.J. (2008). Economic Efficiency among Small holder Arable Crop Farmers in Kebbi State, Nigeria. Scholarly *Journal of Agro Science*. Vol. 3(10): 454-457.

Tologbonse, E.B. (2004). Adoption of improved rice technology by farmers in the inland valley swamps of the Middle-Belt zone in Nigeria. Unpublished PhD Thesis, Department of Agricultural Extension and Rural Development, University of Ibadan.

Tug, D. (2013). Changes in the technical and scale efficiency of rice production activeness in the Mekong Delta, Vietnam. *Agricultural and Food Economics* 1(16).

West Africa Rice Development Association (WARDA) (2004) “Combining the better of two rice species. NERICA – A Technology from Africa”, O1 BP 4029, Abdijan O1, Cote d’Ivoire.