International Journal of Food and Agricultural Economics
ISSN 2147-8988, E-ISSN: 2149-3766
Vol. 6, No. 4, 2018, pp. 71-85

# RICE OUTPUT RESPONSE TO COMMERCIAL LOAN TO AGRICULTURE IN NIGERIA FROM 1966 TO 2015

**Abraham Emmanuel Okpe**
University of Agriculture Makurdi, Department of Agricultural Economics, Benue State, Nigeria, E-mail: linconaby2k@gmail.com

**Orefi Abu**
University of Agriculture Makurdi, Department of Agricultural Economics, Benue State, Nigeria

**Innocent Uwaegbuonu Odoemenem**
University of Agriculture Makurdi, Department of Agricultural Economics, Benue State, Nigeria

**Abstract**

*This study examined rice output response to commercial loan to agriculture (CLA) in Nigeria from 1966 to 2015. Employing the Augmented-Dickey Fuller test to analyze the level of stationarity of each of the series and applied the Autoregressive Distributed Lags (ARDL), via bounds testing to determine long-run elasticities as well as short-run elasticities of rice output. Rice output was responsive to producer price of rice with elasticity of 0.34 in the short run at 5% and elasticity of 0.66 at 1% in the long run. Producer price of maize was negative and significant in the short run with elasticity of -0.48 at 5% level of significance and elasticity of (-1.38) in the long at 1% level of significance. Rice output showed an insignificant elasticity of 0.19 in the short run but was elastic (0.3%) and significant at 5% in the long run. Furthermore, hectarage was highly significant at 1% with elasticity of 1.14 in the short run and elasticity of 1.4 in the long run in relation to the output. It was therefore concluded that CLA made intense impact on rice output in the long run. On this premise therefore, it is recommended that government should review its Land Use Act of 1978 to enable producers more access to land for rice cultivation, secondly government should increase such funds to ease producers the ability to procure all the necessary inputs and make the fund readily and promptly available.*
**Keyword:** *ARDL, Commercial Loan to Agriculture, Nigeria, Rice output,*
**Jel Codes:** *H81, Q11, Q14*

## 1. Introduction

Rice (*Oriza sativa*) remains critical to the agricultural economy of Nigeria and plays unprecedented role in the provision of food, generation of employment and income to farmers amongst others. Nigeria is noted to be the largest rice producing country in West Africa (PWC, 2017) with annual production increase of 0.3 million tonnes between 2015 and 2017 (Goronyo, 2017) and expecting to commence export to West African countries by 2018/2019 (Ahmad, 2017). However, in the face of this seemingly unsustainable improvement PWC (2017), comments that Nigerian import dependency is increasing exponentially coming third in the world and first in Africa with most of the importation coming from Thailand and India.

According to Boansi *et al.*, (2014) current policy initiative in Nigeria is aimed at sustainable agricultural production with prompt supply of inputs while discouraging imports.

The paradigm of rice policy in Nigeria is anchored on surging local output and to sustain self-sufficiency (this is on-going). The Nigerian government initiative over the years focus on closing the gap on rice output by encouraging self-sufficiency so as to meet the increasing local demand. Scholars like Oladele & Wakatsuki (2008), concede that this period recorded remarkable increase in rice output but was not sufficient enough to meet the demands of the increasing population. It is worthy of note however, that there has been intense instability, policy inconsistency and multiple challenges opposing the rice sufficiency target in Nigeria.

Rice grows virtually in all the ecological zones in Nigeria but varies in prospect from one region to another, with land currently allocated to its production standing at approximately 3.7 million hectares out of the 70 million hectares of arable land available in Nigeria (Bayou, 2009). Food and Agriculture Organization statistics (FAOSTAT) revealed that paddy rice production growth rate is not commensurate to consumption in Nigeria over the past five years. Attributing this short fall in paddy production to a couple of factors namely, lack of improved seed varieties, poor agronomic and post-harvest handling practices.

The overwhelming dependence on rice as a staple food in Nigeria necessitated the need to embark on this research. It is however pertinent to mention that the concomitant challenges confronting the sector have denied it the luxury of meeting food security target. The overarching issue underscores that most rice farmers in Nigeria, as revealed by (IFAD, 2009) and (USAID, 2015) are smallholders accounting for majority of the estimate, with primitive approach to agricultural production, characterized by dearth of input. Rice sectorial dominance by small scale farmers has been a major challenge since the sector is plagued by diverse challenges which PWC (2017) underscores as low income, defective access to financial empowerment and poor technology, describing these as impediment constraining mechanization in the sector. According to Idachaba (2013), the dominance of the agricultural sector by small-scale has saddled them with the brunt of feeding the nation in the past and this is expected to continue into the foreseeable future. The private sector has a fundamental role to play by closing this gap in order to have a sustainable agriculture.

The Federal Government of Nigeria set up commercial loan to agriculture as an intervention strategy to alleviate the financial burden confronting farmers in the advancement of the agricultural sector to attaining food sufficiency. Loan availability to farmers is of immense necessity to the sustenance of the agricultural sector in Nigeria and this alludes to Central Bank of Nigeria (CBN) (2005), paradigm that credit supply is one of the major inputs to boost the agricultural sector. Some of these agricultural credit schemes include Commercial Agricultural Credit Scheme (CACS), Nigerian Agricultural and Cooperative Bank (NACB), Agricultural Credit Guarantee Scheme Fund (ACGSF), and Nigerian Incentive-based Risk Sharing for Agricultural Lending (NIRSAL). The Central Bank of Nigeria (CBN) & Federal Ministry of Agriculture & Water Resource (FMA & WR), (2009) comment that one of the cardinal objectives of commercial loan to agriculture is to give farmers opportunity to access credit facilities to enable the procurement of inputs and to carryout farm operations with relative ease. The question to examine in this study therefore is how commercial loan to agriculture impacted the rice output over the years in Nigeria.

This study examined the effects of commercial loan to agriculture on rice output in Nigeria from 1966 to 2015, following the Federal Government commitment of huge resources through this scheme to ensure agricultural sustainability in the country.

## 2. Literature Review

The theoretical framework adopted for this study hinges on supply response in agricultural production. Supply response in this context reflects the disparity in output and increase following the disparity occasioned by the price (Olayide & Heady, 1982). This in essence indicates that a shift in supply curve and a simultaneous movement along the curves. This may be occasioned by the utilization of more or less resources that is generated by price increase or decrease as the case may be.

Studies (Diao *et al.,* 2010; Brooks & Secretariat, 2010; Sarris, 2001) have acknowledged that supply response is strategic in agricultural development economics. This is because of its effect on aggregate responsiveness of agricultural output of agriculture's terms of trade. This alludes to Rao (1989), who admits that aggregate data is a major underpinning in measuring supply response which forms a basis for policy formulation.

The empirical determination of the ARDL analysis involves three successive processes: (i) testing for unit root to ascertain the integration order of the variables (ii) testing for the presence of co-integration by adopting the bounds testing process and (iii) determination of the short-run and long-run coefficients by the application of ARDL. According to Pesaran and Shin (1998), co-integrating procedure can be computed as ARDL model, occasioned by the advantage that the co-integrating variables have the combination of levels I(0) and first difference I(1), without necessarily specifying the order of integration, adding that it is contrary to other methods administered to estimate co-integrating relationships. Additionally, the ARDL takes into consideration acceptable number of lags to rejig the process of data generation from a broader to a more specific order.

ARDL function is described as a least square regression technique involving lags of exogenous and endogenous variables, expressed as $(p, q_1 \ldots \ldots \ldots \ldots . q_k)$,

Where
$p$ refers to number of lags present in the dependent variable,
$q$ refers to number of lags present in the first explanatory variable, and
$q_k$ refers to the number of lags present in the k-th explanatory variable.

Boansi (2013) carried out a study on output supply and yield response of rice in Nigeria: implications for future rice policy. Results reveal a significant increase in rice output with corresponding increase in others variables, viz hectarage, price, nominal rate of assistance and labour, however, it shows an inverse relationship with maize price. Furthermore, rice yield surged with increase in the following variables, price of rice, nominal rate of assistance as well as labour. However, it shows an obverse effect with hectarage of rice and maize price.

Conteh *et al,* (2014), estimated rice output response in Sierra Leone from 1980 - 2010 applying the Nerlovian model. Results reveal high level of significance (1%) effect on the following variables, output, yield and hectarage within the period under review. Furthermore, results showed that rice output increases with increase in hectarage. Government policy intervention was insignificant to each of the variables. Price in the short and long run were negative for each of the variables as well.

Rhaji & Adewunmi (2008) modeled the relationship between market supply response and demand for local rice in the Nigerian context, looking critically at the policy implication by OLS analytical techniques. Results show that hectarage was statistically significant to the variables of expected price of rice output and wage rate. The price demand for rice is positive with elasticity of 0.841. Demand for local rice revealed elasticity of 0.3378.

Tanko & Alidu (2016), examined the relationship between domestic rice response and associated price risk in northern Ghana from 1970-2015 applying the autoregressive distributed lag (ARDL), error correction models and double logarithmic model of the Cobb Douglas linear model employing documentary analyses survey. Results revealed that rice producers showed a significant relationship to price, exchange rate as well associated price risk. Recommendation stipulates reduction in price risk to stimulate rice output.

Ayanwale *et al*. (2011) applied the Error Correction Model to analyze rice supply response in Nigeria; by critically assessing the policy initiatives and other exogenous factor. Results show that variables such as price of rice, climate, importation and policy issue were not significant to rice supply; hectarage and fertilizer consumed were responsive to dependent variable.

Ogazi (2009) modeled the response interplay of rice output and changes in price in the Nigerian context from 1974 to 2006 following the Error Correction version of autoregressive distributed lag (ARDL) model procedure to co-integration. The estimated regressors are combinations of I (0) and I (1). Results show that price of rice was inelastic in the long run with coefficient of 0.271, while it is positive in the short run but not significant. The long run estimate reveals that the farmers encountered structural challenges. The estimated variables of whether and hectarage show a 1% level of significance, trend shows statistical significance at 5%, maize price was inelastic and insignificant.

Ayinde *et al.* (2014), examined the response of rice to price risk factor in Nigeria. Results revealed positive elasticity and significance during the period of restriction in the importation of rice with a positive impact on output. Hectarage also was elastic and significant, implying that increase in hectarage translated to increase in output of rice. Result also showed that rice farmers' relationship to price risk was elastic and significant. It was therefore concluded that restriction of rice importation will engender the production of rice locally at a good price and land availability is fundamental to generate a robust output.

## 3. Methodology

### 3.1. Study Area

Nigeria is located along latitude 4˚and 14˚North of the equator and longitudes 3˚and 14˚ East of the Greenwich Meridian. The country is predominant in the tropical zone. It occupies about 923 773 km2 (made up of 909,890 square kilometers of land area and 13,879 square kilometers of water area) (National Bureau of Statistics (NBS), 2011). According to National Population Commission (NPC) (2016), Nigeria's population was currently 182 million. It comprises six notable agro-ecological zones, with rainfall decreasing from the coastal area to the savanna region (Adedipe *et al*., 1996). The savannah ecology is the major cereal production area in Nigeria. It accounts for about 665,600 square kilometers (about 67 million hectares), which also represent about 70 percent of the geographical area of Nigeria (Idem & Showemimo, 2004). Ogungubile & Olukosi (1991), assert that 85 percent of country's land mass lies within the savannah region. Rainfall is primary source of agricultural water for cereal crop production in Nigeria.

### 3.2. Method of Data Collection

Data for this study relied on secondary data covering the period 1966 to 2015. Time series data in respect of yields (tons/hectare), producer price of rice (expressed in Naira), producer price of wheat ( expressed in Naira), producer price of maize (expressed in Naira) were sourced from Food & Agriculture Organisation (FAO) , weather variable (that is, rainfall (mm) were obtained from the World Bank, fertilizer consumption (kg), available labor (agricultural labor force was used as proxy, ("000") persons, were sourced from International Rice Research Institute (IRRI) and Commercial Loans to Agriculture was garnered from the bulletin of Central Bank of Nigeria (CBN).

### 3.3. Estimation Procedure

Autoregressive Distributed Lags (ARDL) analytical tool was applied as inferential statistics in the data analysis for this study. The methodology involves three steps: (i) analyze the order of integration of variables via the unit root tests by employing Augmented Dickey Fuller (ADF) to determine whether or not the variables are stationary; (ii) testing for the existence of co-integration using the bounds testing outcome; and (iii) estimation of the ARDL to obtain the short-run and long-run coefficients.

The bounds testing approach follows the Pesaran *et al*., (2001) model. This involves a VAR in the order of p, as in equation 1.

$$Q_t = \propto + \beta_t + \sum_{i=1}^{p} \prod Q_{t-1} + e \quad (1)$$

Where,

$t$ denotes time = 1,2,3,4…..T;

$Q$denotes the dependent variable;

A refers to the vector of intercept;

$\beta$ denotes the coefficient of the trend;

$\prod$ denotes the coefficient of the lagged form of the dependent variable $Q$

VECM is based on the assumption that there is existence of co-integration relationship amidst the variables; invariably, VECM is modeled as in equation 2.

$$\Delta Q_t = \propto + \beta_t + \prod Q_{t-1} + \delta X_{t-1} + \sum_{i=1}^{p} \varphi \Delta Q_{t-1} + \sum_{i=1}^{p-1} + \lozenge \Delta X_{t-1} + e_t \quad (2)$$

Where

δ and ◊ are the coefficients of lagged and differenced lag for of the explanatory variables $X_i$ respectively and all the other parameters are previously defined. Drawing from the above, the conditional VECM as specified for this study is

$$\Delta LnRO_t = \alpha + \omega_1 LnRO_t + \omega_2 LnRHA_t + \omega_3 LnPPR_t + \omega_4 LnPPW_t + \omega_5 LnPPM_t + \omega_6 + LnRF_t + \omega_7 LnCLA_t + \omega_8 LnFcons_t + \omega_9 LnLAGR_t + \sum_{i=1}^{q} . \lozenge \Delta LnRO_{t-i} + \sum_{i=1}^{q} . \lozenge_2 \Delta LnRHA_{t-1} + \sum_{i=1}^{q} \lozenge_3 \Delta LnPPR_{t-1} + \sum_{i=1}^{q} . \lozenge_4 \Delta LnPPW_{t-1} + \sum_{i=1}^{q} . \lozenge_5 \Delta LnPPM_{t-1} + \sum_{i=1}^{q} . \lozenge_6 \Delta LnRF_{t-1} + \sum_{i=1}^{q} . \lozenge_7 \Delta LnCLA_{t-1} + \sum_{i=1}^{q} . \lozenge_8 \Delta LnFcons_{t-1} + \sum_{i=1}^{q} \lozenge_9 \Delta LnLAGR_{t-1} + \sum_{i=1}^{q} \quad (3)$$

$\Delta$ and ◊ are vectors of the long run multipliers and the short run dynamics coefficients respectively and $Ln$ connotes natural logarithm. PPR represents producer price of rice, PPW represents producer price of wheat, PPM represents producer price of maize, RO is rice output, RHA is rice hectarage, RF is rainfall, CLA is commercial loan to agriculture, Fcons is fertilizer consumed.

In order to sufficiently delineate the relationship between domestic rice output to its price and other concomitant endogenous variables, it is hypothesized that there is no co-integration, via a test of significance of the coefficient of the dependent variable. The null hypothesis explicitly is

$Ho = \omega_1 = \omega_2 = \omega_3 = \omega_4 = \omega_5 = \omega_6$and the alternative hypothesis is

$$H_0 = \omega_1 \neq \omega_2 \neq \omega_3 \neq \omega_4 \neq \omega_5 \neq 0$$

This was followed by conducting a bound test to initiate co-integration equation. The asymptotic derivation of F-statistic generated via bound test is non-standard irrespective of whether the integration order is I (0) or I (1). F ratio estimate in the hypothesis test was set as a standard and compared against the critical values tabulated on C111 of Paseran Shin & Smith (2001) for a case of intercept without trend, that is K= 8, Where K= number of regressors +1. The rule of thumb is that if the F Ratio value falls below the lower bounds, we fail to reject the null hypothesis of no c-integration. Similarly, if the F Ratio exceeds the upper bounds, we reject the null hypothesis of no co-integration. But when the F Ratio comes in between the upper and the lower bounds, it then implies there is no relationship.

The co-integration and long run form was adopted to produce an ADRL framework. Finally, the shot-run elasticities associated with the long-run estimate were obtained by including the error term in an ECM from the co-integration and long run form of ARDL (1, 2, 2, 3, 3, 2, 2, 3, 3) framework to estimate the short-run elasticities, the lag length in the ARDL was selected based on the lowest AIC.

$$\Delta LnRO_t = \alpha + \omega_1 LnRO_t + \omega_2 LnRHA_t + \omega_3 LnPPR_t + \omega_4 LnPPW_t + \omega_5 LnPPM_t + \omega_6 + LnRF_t + \omega_7 LnCLA_t + \omega_8 LnFcons_t + \omega_9 LnLAGR_t + \sum_{i=1}^{q} .\lozenge\ \Delta LnRO_{t-i} + \sum_{i=1}^{q} .\lozenge_2\ \Delta LnRHA_{t-1} + \sum_{i=1}^{q} \lozenge_3\ \Delta LnPPR_{t-1} + \sum_{i=1}^{q} .\lozenge_4\ \Delta LnPPW_{t-1} + \sum_{i=1}^{q} .\lozenge_5\ \Delta LnPPM_{t-1} + \sum_{i=1}^{q} .\lozenge_6\ \Delta LnRF_{t-1} + \sum_{i=1}^{q} .\lozenge_7\ \Delta LnCLA_{t-1} + \sum_{i=1}^{q} .\lozenge_8\ \Delta LnFcons_{t-1} + \sum_{i=1}^{q} \lozenge_9\ \Delta LnLAGR_{t-1} + \sum_{i=1}^{q} + \lambda ECT_{t-1\ldots} \quad (4)$$

In a situation where the coefficients are the short-run or long-run dynamics elasticities of the model convergence to long run equilibrium, $ECT_{t-1}$ is a one period lagged error correction term and λ is the speed of adjustment to attain equilibrium in the event of shock to the system. This study adopted the Co-integration and long run form in the selection of the preferred ECM. The outcome is now subjected to diverse diagnostic test, such as serial correlation LM test, Breuche-Pagan-Godfrey heteroskedasticity test, normality test and structural stability (sensitivity analysis).

## 4. Results and Discussion

### 4.1. Unit Root Test of Variables Used in the Analysis

Table 1 shows the result of unit root test. It shows that Rainfall (RF) is stable at level I(0). Producer Price of Rice (PPR), Producer Price of Wheat (PPW), Producer Price of Maize (PPM), Rice Hectarage (RHA), Rice Yield (RY), Commercial Loan to Agriculture (CLA), Fertilizer Consumed (FCONS) and Labour (LAGR)are stable at first difference I(1). This implies that the variables is a combination of I(0) and I(1) variables. Based on this combination, the ARDL analytical technique was applied via the bounds testing approach to examine the short and long run impact.

### 4.2. The Bounds Testing Result for Co-Integration of Variables

This study applied the bounds testing as a precursor to the application of the ADRL analytical technique following the outcome of integration order of the variables. Different lags were selected for the exogenous and endogenous variables for the analysis, with focus on values having the lowest AIC. This selection process was considered an advantage in carrying out analysis for ARDL as it underscores the flexibility of choosing the number of lags used during analysis (Ogazi, 2009). Pesaran, Smith & Shin (2001) have proposed critical values as a bench mark to delineate the upper and lower boundaries. As a rule if the F Ratio value falls below the lower bounds, we fail to reject the null hypothesis of no co-integration. Similarly, if the F Ratio exceeds the upper bounds, we reject the null hypothesis of no co-integration. But when the F Ratio comes in between the upper and the lower bounds, it then implies there is no relationship.

**Table 1. Result for Unit Root Test of Variables**

| Variable | ADF in Levels | ADF in First Difference | Integration Order |
|---|---|---|---|
| RO | -1.253729 | -8.941832*** | I(1) |
| PPR | -2.976775 | -9.337294*** | I(1) |
| RY | -1.713355 | -11.06756*** | I(1) |
| PPW | -2.526088 | -6.620830*** | I(1) |
| PPM | -1.988887 | -10.88379*** | I(1) |
| RHA | -1.093405 | -9.915511*** | I(1) |
| CLA | -1.254203 | -10.40131*** | I(1) |
| FCONS | -2.393449 | -6.307241*** | I(1) |
| RF | -6.006146*** | -6.594163 | I(0) |
| LAGR | -1.129439 | -6.786790*** | I(1) |

**Source:** Author's computation

**Notes:** *** P<.01, **P<.05, *P<.10 indicates significance at 1%, 5% and 10% respectively. Where- Rice output is (RO), Rice Hectarage is (RHA), Producer Price of Rice is (PPR),Producer Price of Wheat is (PPW), Producer Price of Maize is (PPM), Rainfall is (RF), Commercial Loan to Agriculture is (CLA), Fertilizer Consumed is (FCONS), Rice Yield is (RY) and Labour is (LAGR)

Critical values for the intercept and trend when k=8 at 1% delineates the lower region, I (0) = 2.79 and upper region, I (1) = 4.1. A lag of 1 for the dependent variable and a lag of 3 for the independent variables were selected. The F-Statistics of 8.84 when output is used as dependent variable falls above the upper bound and significant at 5% level, thus revealing the rejection of the null (no co-integration). Conclusion is subsequently drawn indicating the existence of co-integration. Therefore we cannot reject the existence of relationship among variables.

**Table 2. Bounds Testing Results for Co-integration of Variables**

| Dependent variable | Output |
|---|---|
| F-statistic | 8.836214** |
| I0 Bound | 2.79 |
| I1 Bound | 4.1 |

**Source:** Authors' Computation

**Note:** ** is significant at 5%

### 4.3. Effects of Commercial Loan to Agriculture on Rice Output

Effects of Commercial Loan to Agriculture on rice output in Nigeria is presented in Table 3. Producer price of rice shows that the estimated coefficient was elastic (0.34) and significant at 10%. This shows that an increase in producer price of rice by 10% will increase rice output by 3.4% in the short run implying that as rice output increases; lagged producer price of rice also increases in the short run. This is an indication that producer price of rice is responsive to price changes in the short run. This result resonates with Mkpado (2010) where a 10% increase of price of rice led to 24% increase of rice output. This is contrary to Ogazi (2009) that lagged producer price of rice was inelastic in the short run. Kuwornu *et al.* (2011), in a similar study in Ghana obtained an elasticity of 2.01 and significant at 5%. This emphasizes that the speed of adjustment of lagged producer price of rice to output in the short run is faster in Nigeria than Ghana, which reemphasizes the view that rice output has appreciated significantly over the years in the short run in Nigeria. This is also in consonance with the cobweb model which typically explains the rationale behind periodic price fluctuation in prices of agricultural crop in a certain period that stimulates production in subsequent periods.

Lagged producer price of maize was found to be negative in the short run at 5% level of significance, and also inelastic (-0.48), displaying same tendency as in the long run. The result shows that a unit increase in the price of maize reduces rice output by 0.5% in the short run, thus implying that maize is a close substitute to rice in Nigeria; as such it can sufficiently compete with rice both in the long and short run. This is consistent with the premise that an increase in producer price of maize will divert resources from rice production and channel them into maize production. This is in consonance to Ogazi (2009) with elasticity of real price of maize estimated at -0.066 for rice output in Nigeria. This result is similar to Kuwornu *et al*. (2011) who found a negative coefficient of -0.011 of price of maize at 10% level of significance.

Rice hectarage was elastic (1.14) and significant at 1% in the short run, implying that increase in hectarage by 10%, will increase rice output by 11.4%. The more hectarage allocated to rice, the higher the output. This result agrees with Mkpado (2013) with a view that a 10% increase in hectarage, resulted in 33% increase in rice output, implying that price was the major determinant of hectarage allocation. The outcome is similar to the estimate obtained by (Boansi, 2013) in Cote d ' Ivoire where a unit increase in rice hectarage resulted to an increase of 0.340 in rice output at 5% level of significance. In comparative terms, adoption to equilibrium is faster in Nigeria than Cote d 'Ivoire arising from a better policy to access hectarage.

Commercial loan to agriculture was positive and insignificant in the short run with elasticity of 0.19, implying that farmers actually benefited from the scheme in rice production in Nigeria. However, it could be stated that many producers did not have access to such funds in the short run as at when due or there was delay in getting access to it due to administrative bottlenecks. Mkpado (2010), obtained a positive coefficient on the impact of credit agricultural production, implying that increase in volume of such fund would aid hectarage expansion and output of grains. Arene (1996) demonstrated that fund or micro credit was essential for increasing the level of operation of small-scale farmers in Nigeria. The null hypothesis, indicating absence of relationship between commercial loan to agriculture and rice output in the short run in Nigeria is not rejected because it was not significant.

Rainfall was positive and insignificant to output in the short run. This impact of rainfall is explained with a view that the large output of rice was produced under irrigation facilities across the country. This therefore suggests that positive effect in output will make resources available for the farmers so as to boost subsequent years rice output. This study is in line with Mkpado (2010) in a similar study in Nigeria, result showed that rainfall was positively related to output, with a coefficient of 0.7225, the estimates is also similar to a study in Ghana by Tanko (2016) which revealed a significant and positive elasticity, implying that a unit increase in rainfall resulted in increase in rice output by 0.753. This result also resonates with Ogazi (2009) with estimates revealing that rainfall plays a salient role in the short run.

Labour shows insignificant and positive coefficient, implying that the farmers do not need to cut cost in order to sustain rice production. The benefit obtained from commercial loan to agriculture was able to augment for labour payment, as the farmers where not constrained financially to foot their labour bills in the short run. Boansi (2013), obtained coefficient of 1.708 in short run in Cote d' ivoire with a significant outcome, attributing this to labour intensive nature of rice production in the country. This outcome refutes the study by Ahmed (2007), which emphasized that in Pakistan farmers have the challenge of budget constraint to purchase input like labour.

The result in table 3 shows that the rice output response is sensitive to the producer price of rice in the long run. It is elastic and highly significant (1%) in the long run. The estimate shows that increase in producer price of rice by 10% will increase rice output by 6.6% in the long run. This implies that producer price of rice is responsive to price changes and it is adaptive. This further emphasizes farmer's receptiveness to adaptive expectation which lend credence to the Nerlove model of (Ogazi, 2009). The result agrees with the previous study of Ayinde *et al.* (2014), who obtained a value of 6.3% in Nigeria. Kuwornu *et al*. (2011) had a lower value of 0.242 at 1% level of significance in a similar study in Ghana. This is also in consonance with Askari (1976) who analysed a couple of comprehensive studies, by modeling expected price on supply response through the application of adaptive model. Adaptive expectation model has also gained a wide range of popularity based on its frequent application in studies relating to agricultural supply response. The importance of the adaptive expectation model according to Mlay (1981), is that producers review current price which serves a bench mark for production in the year after taking into consideration all the shortcomings encountered in making the predictions. This further underscores the Cob web theory which emphasizes a time lag about producer's expectations that prices are determined based on certainty of previous prices. This outcome is at variance to a study by (Ogazi (2009) where rice domestic price is inelastic in the long. The study also alludes to (Kwanashie *et al*. (1998) that if the preceding year's price of rice fell below expectation, farmers will prefer engaging the land in maize cultivation with expectation to raise more income. The scholarly contribution of Muchapondwa (2009), Obeyelu & Salau (2010) & Oni (2008) lend credence to farmer's rationality with the intention to maximize profit. Their assertion hinges on farmers responsiveness to price stimulus but constrained by issues bothering on finances. The study is in tandem with this perception, since the farmers were able to optimize their resources and plough profit into subsequent years to boost rice production in the long run. However, Muchapondwa (2009) obtained a long run responsiveness to change in prices in agricultural production in Zimbabwe.

This study qualifies the responsiveness of producer prices of wheat and producer price of maize as close substitute to rice. The estimated coefficient of wheat was not significant in the long. The coefficient is positive, implying tendency to act as a substitute in the event that the price of rice is bad. Meanwhile, the producer price of maize unveiled an inelastic and significant long run relationship, with elasticity of -1.38 at 1% level of significance; the implication is that as producers' price of maize increase by 10% it diminishes rice output by 14%. It further implied that maize is close substitute rice with the ability to compete with rice both in the long run and short run; following the analogy that increase in producer price of maize will divert resources away from rice and channel it into maize production. The result is similar to Kuwornu *et al*. (2011) with a value of -0.01. This outcome also agrees with (Begum *et al*., 2002) who estimates the responsiveness of producers of wheat, barley and corn to incentives in Iran and concluded that price incentive does not respond positively in the long run.

The elasticity estimates showed that, on average, rice hectarage is responsive to rice output in the long run. It is statistically elastic and significant at 1%. The long run elasticity estimates show that a unit increase in rice hectarage will increase rice output by 1.4%, indicating that farmers need to have access to more hectarage in order to increase rice output subsequently. The outcome resonates with Ogazi (2009) where long run estimate of hectarage was positive and statistically significant to rice output. Kuwornu *et al.* (2011), obtained a lower value of 0.218.This indicates that the speed by which farmers adjust their farm sizes in the long run is faster in Nigeria than Ghana. This unveils better tenancy structures in Nigeria than in Ghana.

**Table 3.Rice Output Response to Commercial Loan to Agriculture in Nigeria, 1966-2016**

| Variable | Coefficient | Std. Error | t-Statistic |
|---|---|---|---|
| D(LOGPPR) | 0.342* | 0.117 | 2.918 |
| D(LOGPPR(-1)) | -0.312 | 0.151 | -2.068 |
| D(LOGPPW) | 0.114 | 0.066 | 1.722 |
| D(LOGRPPW(-1)) | -0.076 | 0.060 | -1.265 |
| D(LOGPPM) | -0.480** | 0.143 | -3.367 |
| D(LOGPPM(-1)) | 0.512** | 0.152 | 3.371 |
| D(LOGPPM(-2)) | 0.308* | 0.099 | 3.096 |
| D(LOGRHA) | 1.145*** | 0.147 | 7.769 |
| D(LOGRHA(-1)) | -0.471* | 0.154 | -3.067 |
| D(LOGRHA(-2)) | 0.151 | 0.110 | 1.364 |
| D(LOGFCONS) | 0.064 | 0.081 | 0.785 |
| D(LOGFCONS(-1)) | 0.305 | 0.113 | 2.711 |
| D(LOGCLA) | 0.190 | 0.093 | 2.055 |
| D(LOGCLA(-1)) | -0.244 | 0.106 | -2.310 |
| D(LOGRF) | 0.213 | 0.240 | 0.891 |
| D(LOGRF(-1)) | 0.205 | 0.223 | 0.919 |
| D(LOGRF(-2)) | 0.460 | 0.254 | 1.809 |
| D(LOGLAGR) | 1.136 | 1.016 | 1.118 |
| D(LOGLAGR(-1)) | 0.534 | 0.972 | 0.550 |
| D(LOGLAGR(-2)) | -1.298 | 0.710 | -1.828 |
| CointEq(-1) | -1.364*** | 0.170 | -8.038 |
| Long Run Coefficients | | | |
| Variable | Coefficient | Std. Error | t-Statistic |
| LOGPPR | 0.662** | 0.150 | 4.418 |
| LOGPPW | 0.142 | 0.075 | 1.901 |
| LOGPPM | -1.384*** | 0.229 | -6.055 |
| LOGRHA | 1.387*** | 0.103 | 13.473 |
| LOGFCONS | -0.200* | 0.068 | -2.936 |
| LOGCLA | 0.288** | 0.074 | 3.907 |
| LOGRF | -0.600 | 0.314 | -1.910 |
| LOGLAGR | 1.861 | 0.805 | 2.312 |
| C | -17.442 | 8.571 | -2.035 |
| R-squared | 0.932 | Mean dependent var | 0.061 |
| Adjusted R-squared | 0.817 | S.D. dependent var | 0.224 |
| S.E. of regression | 0.096 | Akaike info criterion | -1.591 |
| Sum squared resid | 0.156 | Schwarz criterion | -0.410 |
| Log likelihood | 67.393 | Hannan-Quinn criter. | -1.147 |
| F-statistic | 8.080 | Durbin-Watson stat | 2.283 |
| Prob(F-statistic) | 0.000 | | |

**Note: All** variables are lagged. The dependent variable is also lagged. Dependent variable is rice output; the estimates are significant at 10% = *, 5% = ** and 1% = ***. Where- Rice output is (RO), Rice Hectarage is (RHA), Producer Price of Rice is (PPR), Producer Price of Wheat is (PPW), Producer Price of Maize is (PPM), Rainfall is (RF), Commercial Loan to Agriculture is (CLA), and Fertilizer Consumed is (FCONS), As shown in table 3, there is a long run significant (5%) relationship with elasticity of 0.3 between commercial loan to agriculture and rice output. This suggests that increasing commercial loan to agriculture by 10% will increase rice output by 3%. The result has the right sign since increase in commercial loan to agriculture would mean increase rice output. This phenomenon explains the fact that rice farmers do have access to such funds as at when due in the long run; as such commercial loan to agriculture could not be regarded as mere budgetary allocations to credit which has translated into actual expenditure in practice. This outcome lends credence to the work of Anetor *et al.* (2016) with emphasis that commercial loan to agriculture has contributed to agricultural production in Nigeria. The result also resonates with Olubode *et al.* (2006) with a view that if there is a significant increase in price and there is deficiency in machinery and credit needed to arrive at a reasonable price, then price will be discouraging. Similarly, Idachaba (2011) unveils that Farm input subsidies have engendered prominent roles in the past in providing appropriate price incentives for accelerated transformation of agricultural output in recognition of the future potential of farm input subsidies in attempt to attain national self-sufficiency in basic food staples. At 5% level of significance, the null hypothesis indicating there is no relationship between commercial loan to agriculture and rice output suffer rejection, because of its non-significance.

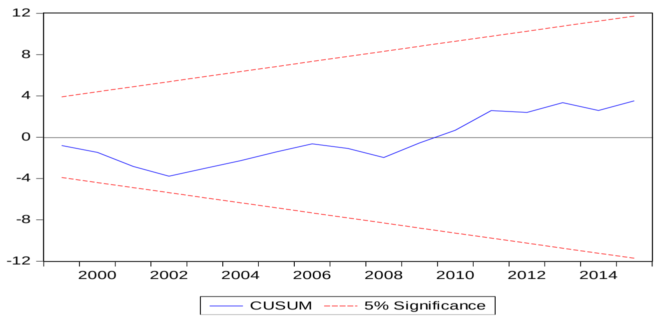


**Figure 2. CUSUM Test for Short and Long Run Elasticities of Rice Output**

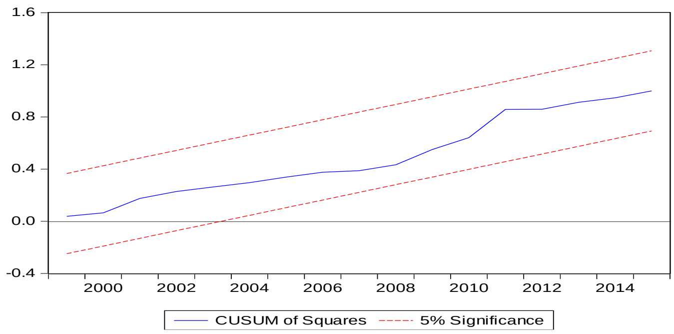


**Figure 3.CUSUMSQ Test for Short and Long Run Elasticities of Rice Output**

Furthermore, result revealed that fertilizer consumed was inelastic and significant at 10% in the long run. The result shows negative coefficient of -0.2002, indicating that a unit increase in fertilizer consumed, adversely affected rice output by 0.2%. Thus implying that the rice farmers did not have access to the required quantity of fertilizer as they were constrained by the high cost of the input, as such most of them resorted to the use of inorganic fertilizer to enhance output. This outcome is in consonance to Boansi (2013) with a view that rice production at the local industry is constrained by exorbitant inputs cost, policy issues and defective structure to aid ethical distribution and sales of inputs. In a similar view Rhaji & Adewunmi (2008) comment that one of the key factors impeding sustainable rice availability in Nigeria hinges on placing embargo on importation of rice without providing sufficient inputs to meet the production gap.

Rainfall was inelastic and statistically insignificant to rice output in the long run, implying that rice producers intensified the use of irrigation to increase output because the rainfall was not sufficient enough or there was delay in rainfall that necessitated reliance on irrigation. Boansi (2013) admits that during the crisis period in Nigeria, stringent policies including Water Resources and Irrigation Policies among others were applied to increase agricultural production. This result is different from Ogazi (2009) who found a significant outcome of rainfall to output in the long run.

An ARDL (1, 2, 2, 3, 3, 2, 2, 3, 3) was generated based on the co-integrated relationship confirmed by the bounds test. Diagnostic tests for serial correlation, Breuche-Pagan-Godfrey heteroskedasticity, normality and structural stability (sensitivity analysis) were considered in this study and the results show that the model passed all the diagnostic tests. $R^2$ value of 0.93 indicated that 93% of the changes in output were captured in the explanatory variables included in the model. Adjusted $R^2$ of 0.816964 or 82% suggested that the explanatory variable were robust in explaining the variation in agricultural production and was a good fit. F ratio was statistical significance at 1% level of error. Serial correlation LM Test shows no significance, implying the variables are not serially correlated. The test shows absence of heteroskedasticity and it is a normal distribution. The short and long run stability were tested using the cumulative sum (CUSUM) (fig. 2) and the cumulative sum of square (CUSUMQ) plots (fig. 3). The result showed clearly that the model was stable with the residuals within 5%.

The coefficient of the error correction term is negative and highly significant (1%). According to Bannerjee *et al.* (1998), this scenario further buttresses the stability and existence of a long run relationship in the model

## 5. Conclusion and Recommendations

The empirical results demonstrate the responsiveness of rice output to producer price of rice in the short run as well as in the long run. Following the short run elasticity and long-run elasticity, rice farmers have high tendency to optimize their profit in rice production. The strategy however, is to improve on rice production technology as well as adequately addressing the issue bordering on rice importation and smuggling. Commercial loan to agriculture as an incentive to boost rice output was elastic and not significant in the short run but positive and significant in the long run. Increasing it therefore, will certainly boost rice output premised on farmer's ability to increase hectarage that will subsequently increase output. Producer price of maize was negative and significant in the short run as well as in long run. This unveils that farmers tend to adjust their hectarage more to output in the long run compares to the short run, implying that maize can easily substitute rice in Nigeria; as such it can sufficiently compete with rice in the short run and long run. Hectarage was highly significant to output in the short run as well as long run, implying that the more hectarage allocated to rice, the higher the output. Rainfall was positive and insignificant in the short run but became negative and insignificant in the long run. Implying that rice producers resorted to other alternative like irrigation as a means to enhance production.

It is therefore recommended that government inconsistency in the implementation and discontinuation of rice ban should be revisited, such that policy of this nature should be uninterrupted and not interplayed with politics, this will stimulate local rice production at a reasonable global competitive price. Thus, the government should formulate reasonable policy that will create a robust market to enable Nigeria rice farmers compete favorable with their foreign counterpart in the global market. The policy should ensure that the provision of improved processing technology at the farm level to enable high quality output. The amount of money made available to the farmers was certainly not enough to increase hectarage. It is recommended that the government should as matters of urgency increase its support to farmers (increasing the amount) as there are obvious indications that the farmers suffered setback resulting from insufficient hectarage. It is also recommended that government should setup more irrigation schemes in the six geo-political zones of Nigeria to engender an all year round production.

**References**

Adedipe, J. S., Bakshi, O. A., Odegbaro, O. A., & Aliyu, A. (1996).Evolving the Nigerian agricultural research strategy plan: agro-ecological inputs. *National Agricultural Research Project.*

Ahmed, M. (2007). The effects of AKRSP's micro-credit programme on agriculture and enterprise development in district AstoreNorthen areas implication for poverty alleviation. M.Sc (Hons) Thesis, Dept.of Agric. Econ. Agric. Univ. Peshawar, Pakistan.

Anetor, F., Ogbechie, C., Kelikume, I., & Ikpesu, F. (2016). Credit Supply and Agricultural Production in Nigeria: A Vector Autoregressive (VAR) Approach. *Journal of Economics and Sustainable Development 2(7), 2016*

Arene, C. J. (1996) "Population Pressure, Agricultural Intensification and the Sustainability of Cropping Systems in Anambra State of Nigeria" *Rivista di Agricoltura Subtropicale e Tropicale Vol. 90, 75-84.*

Askari, H. & T.J. Cummings.(1976). Estimating agricultural supply response with the Nerlove model: A survey. *International Economic Review 18(2), 257–92.*

Ayanwale, A. O. S., Akinyosoye, V. O., Yusuf, S. A., & Oni, A. O. (2011). Rice supply response in Nigeria; whither changing policies and climate. *World Rural Observations, 3*(4), 78–84.

Ayinde, O. E., Bessler, D. A., & Oni, F. E. (2014). Analysis of Supply Response and Price Risk on Rice Production in Nigeria: *In 2014 Annual Meeting, July 27-29, 2014, Minneapolis, Minnesota (No. 170347). Agricultural and Applied Economics Association*

Banerjee, A. Dolado, J. J. & Mestre, R. (1998). Error Correction Model Tests for cointegration in a single-equation framework. *Journal of Time Series Analysis 19(3), 267–83.*

Bayou Farms & Industries Limited (2009). Rice Value Chain Development Plan, Kaduna Rice Industry Supply Chain Development Programme, submitted to MSME Nigeria

Ahmad, M. (2017). Rice production in Nigeria hits 15 million tonnes Premium Times, August 15, 2017. www.premiumtimesng.com/agriculture/agricv-news/240287-rice-production-nigeria-hits-15-million-tonnes-official.html

Boansi, D., Lokonon, B. O. K., & Appah, J. (2014). Co-integration analysis of the determinants of cotton lint exports from Mali. *Asian J. Agricultural Extension. Economics & Sociology, 3*(6), 544-561.

Central Bank of Nigeria (CBN) & Federal Ministry of Agriculture & Water Resource (FMA & WR), (2009).Guidelines for Commercial Agriculture Credit Scheme (CACS). Project Management Committee, Federal Ministry of Agriculture & Water Resources

Conteh, A. M., Yan, X., Fofana, I., Gegbe, B., & Isaac, T. I. (2014). An Estimation of Rice Output Supply Response in Sierra Leone: A Nerlovian Model Approach. *International Journal of Biological, Biomolecular, Agricultural, Food & Biotechnological Engineering, 8*(3), 225-231.

Diao, X., Hazell, P., & Thurlow, J. (2010).The role of agriculture in African development. *World Development, 38(10), 1375–1383.*

Goronyo, A. (2017). Rice production in Nigeria increases to 5.8m tonnes in 2017. The Punch newspaper. www.punchng.com/rice-production-in-nigeria-increases-to-5-8m-tonnes-in-2017-rifan/

Idachaba, F. S. (2011). Agricultural Economist as Preacher. Essay in Policy Advocacy on Nigerian Agriculture, *Rural Development & Food Security 1, p13.*

Idem, N. U. A. & showemimu, F. S. (2004). Cereal crop of Nigeria. *Journal for Social Scientists. 14*(2), 123– 130.

International Fund for Agricultural Development (IFAD). (2009). Country Programme Evaluation. *Federal Republic of Nigeria, 2009*.

International Rice Research Institute (IRRI). (2004). World Rice Statistics. *International Rice Research Institute, Manila, Philippines.*

Kuwornu, J.K.M., Iziden, M.P.M., & Osei-Asare, Y. B. (2011). Supply Response of Rice in Ghana: A Co-integration Analysis.

Kwanashie, M., Ajima, I. & Garba, A. (1998). The Nigerian economy: Response of agriculture to adjustment policies. *AERC Research Paper 78 African Economic Research Consortium, Nairobi, Kenya*.

Longtau, S. R. (2003). Multi-agency Partnership for Technical change in West Africa Agriculture: Nigeria Case Study Report on Rice Production.

Mkpado, M. (2010) Hectarage and output responses of major crops to market liberation and price risk in Nigeria. *Unpublished Ph.D thesis at Department of agricultural economics, faculty of agricultural economics, University of Nigeria, Nsukka December, 2010*

Muchapondwa, E. (2009). Supply response of Zimbabwean agriculture: 1970-1999. *African Journal of Agricultural & Resource Economics,3*(1), 28–42.

National Bureau of Sta. (NBS).(2010). National Bureau of Statistics (NBS). 2010.

Ogazi, C. G. (2009). Rice output supply response to the changes in real prices in Nigeria: An autoregressive distributed lag model approach. *Journal of Sustainable Development in Africa,11(4), 83–100*.

Ogundele, O.O., & Okoruwa, O. V. (2006).Technical Efficiency Differentials in Rice Production Technologies in Nigeria. *AERC Research Paper 154.*

Ogungbile, A. O, & Olukosi, J. O. (1991). An overview of the problem of the resource poor farmers in Nigeria agriculture.*Pp 21-34. In: N.U.A. Idem & F.A Showemimu: Cereal Crop of Nigeria.*

Oladele O. I. & Wakatsuki, T. (2008). Social factors affecting wetlands utilization for agriculture in Nigeria: A case study of sawah rice production. *Rice Science*, *15*(2), 150–152.

Olayide, S. O., & Heady, E. O. (1982). Introduction to Agricultural Production Economics. *Ibadan University Press, Ibadan, Nigeria,* 89.

Olubode-Awosola, O. O., Oyewumi, O. A., & Jooste, A. (2006).Vector error correction modelling of Nigerian agricultural supply response.*Agrekon,45*(4), 421–436.

Pesaran, M. H., & Shin, Y. (1998).An autoregressive distributed-lag modelling approach to cointegration analysis. *Econometric Society Monographs,31*, 371–413.

Pesaran, M.H., Shin, Y. & Smith, R. J. (2001).“Bounds testing approaches to the analysis of level relationship.”*Journal of Applied Economics, 16*, 289 – 326.

Rahji M. A. Y & Adewumi, M.O. (2008). Market supply response and demand for local rice in Nigeria: Implications for self-sufficiency. *Journal of Central European Agriculture. 9 (3), 567-574*

Rao, J. M. (1989). Agricultural supply response: A survey. *Agricultural Economics, 3*(1), 1–22.

Tanko, M. & Alidu (2016). Supply Response of Domestic Rice and Price Risk in Northern
` Ghana. *American International Journal of Social Science 5 (4) 2325- 4149*

United States Agency for International Development (USAID) (2015). Cost-Benefit Analysis of USAID/Nigeria's Markets II Program. *Kristen Schubert, Economist, USAID/E3, Washington DC Jerrod Mason, Economist, USAID/E3, Washington DC March 5, 2015*.