# Rice Supply Response in Nigeria; whither changing Policies and Climate

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**Abstract:** Rice is a leading staple crop in Nigeria cultivated and consumed in all parts of the country. Its domestic supply therefore has a great implication for food security and self-sufficiency in the country. Against this background, this study examines the supply response of rice to price and non-price factors inclusive of policy and climate variables. The study was conducted on Nigerian national level data mined from the International Rice Research Institute (IRRI) rice statistics (1960-2008). The data was supplemented with rainfall data from International Institute of Tropical Agriculture. An Error Correction Model in a cointegration framework was employed to test the responsiveness of supply to the factors considered. The study revealed that Rice supply in Nigeria is non-responsive to price, climate, importation and trade regulation policy. However area cultivated and fertilizer consumption significantly influences rice supply in Nigeria. To this end it was recommended that a reform of the land tenure system that increases rice farmers' holdings as well as availability, affordability and adoption of improved input, such as fertilizer will go a long way in boosting rice supply in Nigeria.
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**Key Words:** Rice, Supply Response, Policies, Climate

## 1. Introduction

Rice is the leading staple food crop in Nigeria, it is cultivated in virtually all the agro-ecological zones of Nigeria, from the mangrove and swamps environment of the coastal areas, to the dry zones of the Sahel in the North (Akande, 2002). In 2007, about 1.7 Million hectares were under rice cultivation in Nigeria with an estimated national production of 3.4 million metric tons (National Food Reserve Agency, NFRA, 2008). NFRA (2008) also reported that rice yield in the same year was estimated at 2 metric tons per hectare, a negligible decrease of 0.03 percent over 2006 and 1 percent annual growth rate from 1999. About 5.3 million metric tons was produced nationally in 2008 resulting from the cultivation of about 2.3 million hectares and a yield of 2.3 metric tons per hectare (International Rice Research Institute, IRRI, 2010). On the other side, the demand for rice has been soaring over the years. Since mid-1970s, rice consumption in Nigeria has risen tremendously growing by 10.3% per annum, a result of accelerating population growth rate, increasing per capita consumption, rapid urbanization, increased income levels, and associated changes in family occupational structures (Akpokodje *et al*., 2001; Akande, 2002; UNEP, 2005). About 3 billion people eat rice everyday with Nigerians consuming over 3.5 million metric tons per annum (This day, 2009). The foregoing notwithstanding, the production increase has been unable to match the consumption increase (Okoruwa *et al*, 2006; Rahji *et al*, 2008), and domestic production capacity is below the national requirements for rice (Rahji and Adewumi, 2008).

Nigeria is the largest producer of rice in West Africa, but the country still relies on a massive rice importation (Bello, 2004). Bello (2004) further stated that Nigeria imports US$700 million worth of rice in 2003, it also accounts for 20% of sub-Saharan Africa's rice imports (Omotola and Ikechukwu, 2006). Similarly, it was reported by Workman (2008) that Nigeria imported 1.4 million tons of rice, equivalent to 4.8 percent of global rice imports and therefore tops the list of rice importers in the year 2007. In another report, Nigeria expends US$1.3 billion every year to import 2.2 billion Kg of rice in order to fulfill its domestic requirements (This day, 2009). These imports represent a substantial foreign exchange outlay for the Nigerian economy. Given the size and value of the imports, there is considerable policy interest in reducing rice imports by promoting domestic rice production (Sanusi, 2003; Omotola and Ikechukwu, 2007).

Nigeria has suitable ecologies and a potential land area for rice production, the potential of rice yield has not been fully realized (Akpokodje *et al*, 2001; Akande, 2002). The risk and uncertainty faced by agricultural firms is much higher than that faced by other standard firms, yet risk factors are often neglected in the analysis of supply response and dynamic modeling have not been employed in most cases (McKay *et al*, 1999; Muchapondwa, 2008). Similarly, Numerous general and specific agricultural research, policies and programmes in Nigeria such as, previous import bans, government's attention on varietal improvement, seed multiplication, varying tariff regimes on imported rice, special rice projects, multinational NERICA rice dissemination project, import substitution policies and the presidential initiative on rice (Akpokodje *et al*, 2001; Akande, 2002; Erenstein *et al*, 2004; NFRA, 2008; Tiamiyu, 2009; This day, 2009) have been executed in Nigeria over time, yet local rice production has not kept up with the domestic demands of the Nigerian populace and, consequently, rice is still imported (Rahji and Adewumi, 2008).

### 1.1 Objective of the Study

In line with the aforementioned, this study estimates a supply response model for rice in Nigeria inclusive of price and non-price factors.

### 1.2 Hypothesis

Price and non-price factors do not determine the supply of rice in Nigeria.

## 2. Research Methodology

### 2.1 Data

For the purpose of analysis of supply response, Nigerian national level data on rice output, area, yield, price, and import were obtained from the International Rice Research Institute (IRRI); the United State Development Agency (USDA) version was chosen over the Food and Agricultural Organization (FAO) version contained in the IRRI statistics because it was better updated, comprehensive and consistent for the targeted time interval (1960-2008). The need to incorporate input consumption factor results in the supplementation of the above data with fertilizer consumption data from Food and Agricultural Organization (FAO) statistics with minimal interpolation. Supplementary data on rainfall was also obtained from the International Institute of Tropical Agriculture to account for the effect of climate on supply. Price was deflated with official exchange rate.

### 2.2 Analytical Techniques

**Test of stationerity**

The development in time series modelling points to the need to exercise some caution, by first examining the statistical properties of the series and incorporating these in the final model specification where necessary, as to guarantee non-spurious regression (Granger and Newbold,1974). The first step in the analysis was to identify the order of integration of the variables. In this study the Augmented Dickey Fuller test was estimated to check for the presence of unit root in the variable in case variables do not follow AR(1) process. Variables were differenced further and until stationarity was attained in the variables.

**Engle-Granger Error Correction Procedure**

The Engle and Granger (1987) approach to ECM employed in this study consists of three steps:

i. Estimation of the cointegrating regression $Y_t = \alpha + \gamma X_t + e_t$
ii. From these estimate, the residual term $\hat{e}_t = Yt - \hat{\alpha} - \hat{\gamma} X_t$ are generated; and
iii. The residual term is included in the short-term equation $\Delta Y_t = \beta \Delta X_{t-1} + \rho \hat{e}_{t-1}$ as an "error correction term".

The coefficients $\hat{\beta}$, $\hat{\alpha}$, $\hat{\gamma}$ and $\hat{\rho}$ obtained in this process are then interpreted and used as earlier illustrated with the simplified ECM representation in (2). The Engle and Granger (1987) approach to testing for co-integration is to test for stationarity of the stochastic residuals generated in the second stage of the three stage ECM procedure (Gujarati, 2007; Ogundele, 2007). Equation (2) was estimated using the least square regression; a parsimonious error correction model was equally estimated.

**Model Specification**

Outp = f (Pric, Area, Rain, Impt, FCon, Poly, ECT, $\varepsilon_t$ )
Variables are defined as follows:
Outp= Rice Supply in year t, Proxied by Rice Output (tons)
Pric = Price of Rice in year t (₦/tons)
Area = Area of rice cultivated in year t (Ha)
Fcon = Fertilizer consumption in year t (tons)
Rain = Amount of Rainfall in year t (mm) as climate element
Impt = Rice Import in year t (tons) as a proxy for importation policy
Poly = Policy Variable (1-Policy intervention era, 0-Non- policy intervention era)
ECT is the error correction term
$\varepsilon_t$ is the stochastic disturbance.
B, $\rho, \alpha, \gamma$ in (2) are parameters to be estimated.

**Note:** Introduction of SAP and the abolition of Commodity Boards to provide production incentives to farmers through increased producer prices started from 1986, period from 1986 are thus referred to as policy era on rice (Ogundele, 2007; Rahji *et al*, 2008).

## 3. Results and Discussion

### 3.1 Unit Root Test

The summary of the results of Augmented Dickey Fuller (ADF) unit root analysis as presented in table 3 reveals that yield and rainfall were stationery at their levels, the unit root null hypotheses (ρ=1) was therefore rejected at their levels at one percent and five percent probability level respectively. Output, area cultivated, price, import and fertilizer consumption has a unit root. The null hypotheses of the presence of unit root in the variables (ρ=1) were accepted at one percent (P≤ 0.01). The variables however becomes stationery at first difference implying that they are all integrated of the order of 1- I(1).

**4.2 Test for Cointegration**

Table 4 shows that the linear estimation of the relationship between supply (output) and other explanatory I (1) variables results in a stationery process (i.e. the residual has no unit root). The null hypothesis was rejected at 1 percent level of significance. Hence, it could be inferred that Output of rice could exhibit long run equilibrium with area cultivated, domestic producer price, quantity of imported rice and fertilizer consumption.

**4.3: The Long Run Model (Engle-Granger Approach)**

The estimates from the long run models as presented in table 5 shows that the output model is fit with Log likelihood value of -334.955 and F-Statistics of 365.101 significant at P≤ 0.01. The low values of Akaike information and Schwarz criterion, 14.165 and 14.360 respectively confirms further the fitness of the model. The R-Square value implies that the explanatory factors so considered jointly explain about 97 percent of the variation in rice output. This high R-square value is a further attestation of the fitness of the model employed.

In the long run, two major factors were found to significantly influence the output (supply) of local rice, these are the area cultivated which was significant at 1 percent and fertilizer consumption significant at 10 percent probability level. Some authors such as Begum *et al* (2002) Rahji and Adewumi (2008) had aforetime found rice supply to respond to area cultivated in the long run. The coefficient of output is greater than unity (2.167), hence supply is area elastic. Domestic Rice supply does not respond to price factor importation and trade regulation policy for the time considered in the long run. The non-responsiveness of rice supply to imported quantity here confirms the assertion that there appears to be a segregation of market between local and imported rice in the long run, hence they are not perfect substitute (Ogundele, 2007). The non-responsiveness of price to rice supply corroborates the findings of Rahji *et al* (2008) and Muchapondwa (2008) among several authors.

**4.4 Short Run Equilibrium Model (Engle-Granger Approach)**

The result of the short run equilibrium model further confirms area as the most critical factor determining rice supply in Nigeria. The coefficient of the lagged area was found to be significant at 1 percent (P≤0.01), the coefficient of adjustment was significantly large (2.02) which is over 200 percent. The speed of adjustment of output to shocks due to area is thus very fast. When the model was parsimoniously estimated, the coefficient of fertilizer consumption equally became significant at 5 percent (P≤0.05) level. A direct relationship was equally observed, an increase in fertilizer consumption results in output increase. Output re equilibrates to shocks caused by fertilizer in 12/1.364 months (about 9 months). The log likelihood value of -307.137 and the F-value was found to be significant at 1 percent probability level, the explanatory variables jointly explain close to 70 percent of variation in output in both the general and the parsimonious estimates. Furthermore the Akaike information and Schwarz criterion were low enough to confirm the fitness of the error correction model. For both the general and the parsimonious model the error correction term was found to be significant at 1 percent level (P≤0.01) and carries the expected negative sign implying that the error has been corrected in the short run.

**5. Summary, Conclusion and Recommendations**

**5.1 Summary of Findings**

1. The result of the ADF unit root test revealed that output, area, price, import and fertilizer consumption are integrated of the order of 1 while yield and rainfall are stationary at their levels.
2. Supply response estimates shows that two major factors were found to significantly influence the output (supply) response of rice in Nigeria, these are: the area cultivated which was significant at 1 percent and fertilizer consumption significant at 5 percent and 10 percent probability level in the short run and long run model respectively.
3. Local rice output was not found to be price, import or trade regulation policy responsive in the Long run and short run.
4. The explanatory factors considered jointly accounted for about 97 and 70 percent variation in rice output in the long run and short run model respectively.

**5.2 Conclusion**

Against the background of rising importation bills and consequent drains on foreign exchange reserve necessitated by ever increasing demand and shortage in supply of domestically produced rice, this study estimate a supply response model for rice in Nigeria. The analysis isolated area cultivated as the most critical factor affecting supply response of rice in Nigeria in addition to fertilizer consumption. To this end, in order to improve rice supply in Nigeria, the following recommendations are made:

**5.3 Policy Implication and Recommendations**

1. Pricing, importation and trade policy is rather a blunt instrument in driving supply of rice in Nigeria.
2. Increase in farm size through redesigning favourable land tenure system and Land transfer to farmers will go a long way in improving rice supply in Nigeria.
3. Also, increased use of improved input (such as fertilizer) through effective extension delivery, availability and affordability by farmers is a veritable means of increasing rice production in Nigeria.

**Table 1: Trend of Rice Production and Import in Nigeria: 1995 – 2007**

| Year | Productn ('000) | Area ('000ha) | Yield (tonne / ha) | Import ('000tons) | Rice calorie % |
|---|---|---|---|---|---|
| 1995 | 2920 | 1796 | 1.63 | 350 | 7 |
| 1996 | 3122 | 1784 | 1.75 | 731 | 8 |
| 1997 | 3268 | 2048 | 1.60 | 900 | 8 |
| 1998 | 3275 | 2044 | 1.60 | 750 | 8 |
| 1999 | 3277 | 2191 | 1.50 | 1250 | 9 |
| 2000 | 3298 | 2199 | 1.50 | 1906 | 9 |
| 2001 | 2752 | 2117 | 1.30 | 1897 | 9 |
| 2002 | 2928 | 2185 | 1.34 | 1448 | 9 |
| 2003 | 3116 | 2210 | 1.41 | 1369 | 10 |
| 2004 | 3334 | 2348 | 1.42 | 1777 | 10 |
| 2005 | 3567 | 2494 | 1.43 | 1600 | 9 |
| 2006 | 4042 | 2725 | 1.48 | 1600 | NA |
| 2007 | 4677 | 3000 | 1.56 | 1600 | NA |

**Source: FAOSTAT Database, 2010. Available at: http://www.beta.irri.org/statistics**

**Table 2: Share of Rice in Nigerian Diet**

| Percentage Share | Frequency | Valid Percent | Cumulative Percent | |
|---|---|---|---|---|
| 1-10% | 3926 | 20.8 | 28.3 | 28.3 |
| 11-20% | 3810 | 20.2 | 27.5 | 55.9 |
| 21-30% | 2458 | 13.0 | 17.7 | 73.6 |
| 31-40% | 1571 | 8.3 | 11.3 | 85.0 |
| 41-50% | 963 | 5.1 | 7.0 | 91.9 |
| 51-60% | 671 | 3.6 | 4.8 | 96.8 |
| 61-70% | 450 | 2.4 | 3.2 | 100.0 |
| Total | 13849 | 73.4 | 100.0 | |
| 0% | 5012 | 26.6 | | |
| Total | 18861 | 100.0 | | |

**Table 3: Result of ADF Unit Root Test of Variables**

| Variables | Level | | First Difference | | Order of Integration |
|---|---|---|---|---|---|
| | Untrended | Trended | Untrended | Trended | |
| Outp | 0.672 | -2.043 | -8.437 | 8.883* | I(1) |
| Area | 0.742 | -2.540 | -9.450* | 9.649* | I(1) |
| Yield | -3.059** | 3.742** | | | I(0) |
| Pric | -2.433 | 3.865** | -7.947* | 7.856* | I(1) |
| FCon | -1.398 | -1.383 | -5.997* | -5.968* | 1(1) |
| Impt | -0.790 | -2.297 | -6.398* | -6.392* | 1(1) |
| Rain | -5.959* | 5.943* | | | I(0) |

***Values significant at 1%; **Values significant at 5%; *Values significant at 10%

**Table 4: Residual Test**

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -3.681 | 0.008 |
| Test critical values: | 1% level | -3.578 | |
| | 5% level | -2.925 | |
| | 10% level | -2.601 | |

**Table 5: Long Run Model for Rice Supply in Nigeria**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| Area | 2.167 | 0.127 | 17.0440 | 0.000 |
| Pric | -0.079 | 0.199 | -0.397 | 0.693 |
| FCon | 0.800 | 0.457 | 1.748 | 0.088 |
| Impt | 0.171 | 0.108 | 1.585 | 0.120 |
| C | -134.232 | 79.940 | -1.679152 | 0.100 |

| | | | |
|---|---|---|---|
| R-squared | 0.971 | Mean dependent var | 1872.396 |
| Adjusted R-squared | 0.969 | S.D. dependent var | 1551.483 |
| S.E. of regression | 274.320 | Akaike info criterion | 14.165 |
| Sum squared resid | 3235823. | Schwarz criterion | 14.360 |
| Log likelihood | -334.955 | F-statistic | 365.101 |
| Durbin-Watson stat | 0.992 | Prob(F-statistic) | 0.000 |

**Table 6: Short Run Equilibrium Model for Rice Supply in Nigeria**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(Outp (-1)) | 0.113 | 0.123 | 0.921 | 0.363 |
| D(Area) | 2.022 | 0.276 | 7.340 | 0.000 |
| D(Pric) | -0.017 | 0.175 | -0.099 | 0.922 |
| D(Pric(-1)) | -0.042 | 0.164 | -0.256 | 0.800 |
| D(Fcon) | 1.364 | 0.847 | 1.610 | 0.116 |
| D(Impt) | -0.095 | 0.160 | -0.590 | 0.559 |
| D(Poly) | -163.189 | 228.207 | -0.715 | 0.479 |
| D(Rain) | -0.230 | 0.255 | -0.901 | 0.374 |
| ECM(-1) | -0.650 | 0.151 | -4.297 | 0.000 |
| C | -5.155 | 38.485 | -0.134 | 0.894 |

| | | | |
|---|---|---|---|
| R-squared | 0.685 | Mean dependent var | 107.891 |
| Adjusted R-squared | 0.606 | S.D. dependent var | 341.562 |
| S.E. of regression | 214.422 | Akaike info criterion | 13.763 |
| Sum squared resid | 1655162. | Schwarz criterion | 14.161 |
| Log likelihood | -306.559 | F-statistic | 8.687 |
| Durbin-Watson stat | 1.957 | Prob(F-statistic) | 0.000 |

**Table 7: Short run Parsimonious Model for Rice Supply In Nigeria**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(AREA) | 1.888 | 0.222 | 8.510 | 0.000 |
| D(FCON) | 1.640 | 0.725 | 2.264 | 0.029 |
| ECM(-1) | -0.590 | 0.127 | -4.655 | 0.000 |
| C | 7.299 | 31.648 | 0.231 | 0.819 |

| | | | |
|---|---|---|---|
| R-squared | 0.660 | Mean dependent var | 106.149 |
| Adjusted R-squared | 0.637 | S.D. dependent var | 338.040 |
| S.E. of regression | 203.745 | Akaike info criterion | 13.553 |
| Sum squared resid | 1785024. | Schwarz criterion | 13.710 |
| Log likelihood | -314.493 | F-statistic | 27.875 |
| Durbin-Watson stat | 1.965 | Prob(F-statistic) | 0.000 |

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**References**

1. **Akande, S.O (2002):** An Overview of the Nigerian Rice Economy, NISER, Ibadan.
2. **Akpokodje, G., F. Lançon, and O. Erenstein (2001):** Nigeria's Rice Economy: State of the Art. Project Report - The Nigerian Rice Economy in A Competitive World: Constraints, Opportunities And Strategic Choices. Bouake: WARDA. ii-55 pp.
3. **Begum M.A.A; S.M. Fakhrul Islam; M. Kamruzzaman; M, Jahangir Kabir and S. M.A.**
4. **Shiblee (2002):** Supply Response of Wheat in Bangladesh; An Application of Partial Adjustment Model, *Pakistan Journal of Biological Science,*5 (2): 225–9
5. **Bello, A (2004):** Nigeria Imported $US700 million rice in 2003: Federal Minister of Agric. and Rural Development, Tribune Newspaper, July 7, 2004.
6. **Engle, R.F. and C.W.J. Granger (1987):** Co-integration and Error Correction: Representation, Estimation, and Testing," *Econometrica* 55
7. **Erenstein, O., F. Lançon, O. Osiname, and M. Kebbeh (2004):** Operationalising the Strategic Framework for Rice Sector Revitalisation in Nigeria. Project Report - The Nigerian Rice Economy in a Competitive World: Constraints, Opportunities and Strategic Choices. Abidjan: WARDA -The Africa Rice Centre. ii-38 pp.
8. **Granger, C.W.J. and P. Newbold (1974):** Spurious regressions in econometrics, *Journal of Econometrics*, 2.
9. **Granger, C.W.J. and P. Newbold (1986):** *Forecasting Economic Time Series*, 2ed. Academic Press.
10. **International Rice Research Institute (IRRI) (2010):** *World Rice Statistics*, Available at: http://beta.irri.org/solutions/index.php?
11. **McKay A, Morrisey O, and Vaillant C. (1999):** Aggregate supply response in Tanzanian Agriculture. *The Journal of International Trade and Economic Development*, 8(1):107-23
12. **Muchapondwa Edwin (2008):** Estimation of the Aggregate Agricultural Supply Response in Zimbabwe: The ARDL Approach to Cointegration, Working Paper Number 90, School of Economics, University of Cape Town , August 20, 2000
13. **National Bureau of statistics (NBS) (2004):** A Report on Expenditure on Food Items, National Living Standard Survey (NLSS)
14. **Nerlove, M. (1958):** The Dynamics of Supply: Estimation of Farmers Response to Price. Baltimore, Johns Hopkins Press.
15. **National Food Reserve Agency-NFRA (2008):** Report of 2007Agricultural Production Survey (APS), Federal Ministry of Agriculture and Water Resources, October 2008
16. **Nickell S. (1985):** Error Correction, Partial Adjustment, and all that: An Expository Note. *Oxford Bulletin of Economics and Statistics*, 47(2): 119-29

17. **Ogundele, F. (2007):** Trade Liberalization and Import Demand for Rice in Nigeria: A Dynamic Modelling, Journal of Rural economic and Development, 16(1), 35-46
18. **Okoruwa, V.O, O.O. Ogundele and S.O. Oyewusi (2006):** Efficiency and Productivity of Farmers in Nigeria: A Study of Rice Farmers in North Central Nigeria. Poster Paper Prepared for Presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12-18, 2006.
19. **Omotola and Ikechukwu (2006):** Rice Milling in Nigeria, a report on Development of Agriculture in sub-Saharan Africa, Jan, 2006, www.ricenigeria.com
20. **Rahji, M.A.Y., O.O Ilemobayo and S.B. Fakayode (2008):** Rice supply response in Nigeria; an Application of the Nerlovian Model, *Medwell Agricultural Journal* 3(3):229-234
21. **Rahji, M.A.Y and Adewumi, M.O.(2008):** Market Supply Response and Demand for Local Rice in Nigeria: Implications for Self Sufficiency, Central European Agriculture Journal, 9(3): 567-574
22. **Sanusi J. O. (2003):** Special Remarks delivered at the Seminar on "Sustainable Rice Production in Nigeria", Held at the Hamdala Hotel, Kaduna, 14th & 15th, January 2003.
23. **This Day (2009):** Rice Demand Pushes Up Global Price, Reported by Abimbola Akosile 26th Jan 2009, Available at: All Africa.Com, retrieved 05/03/2009
24. **Tiamiyu (2009):** Efficiency and Technology Use among Growers of NERICA Rice Varieties in the Savanna Zone of Nigeria, Unpublished PhD Thesis, Department of Agricultural Economics, University of Ibadan, Ibadan
25. **Workman, D:** Rice Import Dependent Countries, Available at: http://internationaltradecommodities.suite101.com/article.cfm/rice_import_dependent_countries, accessed January, 2010

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