Output supply and yield response of rice in Nigeria: implications for future rice policy

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OUTPUT SUPPLY AND YIELD RESPONSE OF RICE IN NIGERIA: IMPLICATIONS FOR FUTURE RICE POLICY

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ABSTRACT

With the local rice industry of Nigeria been hindered by inconsistent government policies, improper methods of production, high cost and scarcity of vital inputs of production among other constraints, domestic production of rice has failed to catch up with the increasing pace of consumption. In spite of the strong agricultural and natural resource base it hauls, Nigeria spends a total of about US$11 billion annually on importation of rice, wheat, sugar and fish. Attempts by previous regimes and the current government to reverse the net rice importer status of the country has proven futile regardless of the high tariffs imposed on imports, quantitative restriction through the use of quota and outright ban between the years 1986 and 1995. To inform future rice policy decisions on the way forward, the current study analyzed the output supply and yield response of rice in Nigeria. The results show that output of rice increases with increasing harvested area of rice, increasing farm gate price of rice, increasing nominal rate of assistance and increasing labor availability. It however decreases with increasing price of maize. Yield increases with increasing farm gate price of rice, nominal rate of assistance and labor availability. It however decreases with increasing harvested area of rice and price of maize. To improve on its rice supply, it is advised that policy measures be devised to couple area expansion with intensification to help mitigate the adverse effect of area expansion on yield, reduce labor shortages through appropriate investment in development of the rural communities (to help minimize rural-urban migration), ensure continuous government support to the sector, maintain fair prices for local rice farmers, and ensure appropriate transmission in times of price increment.

Keywords: Output supply response, yield response, nominal rate of assistance, government policies
[1]

1.0 INTRODUCTION

Hindered by inconsistent government policies, improper production methods, high cost and scarcity of vital inputs of production, and post-harvest handling and marketing challenges, the local rice industry of Nigeria has failed to catch up with the increasing pace of consumption (driven by increasing per capita income, urbanization and population growth). By estimates of USDA as sourced from the World Rice Statistics of IRRI, current milled rice production of 2.85 million tonnes accounts for approximately 55percent of total supply of rice in Nigeria, with the remaining 45 percent been bridged through imports. Although blessed with a strong base of agricultural and natural resources coupled

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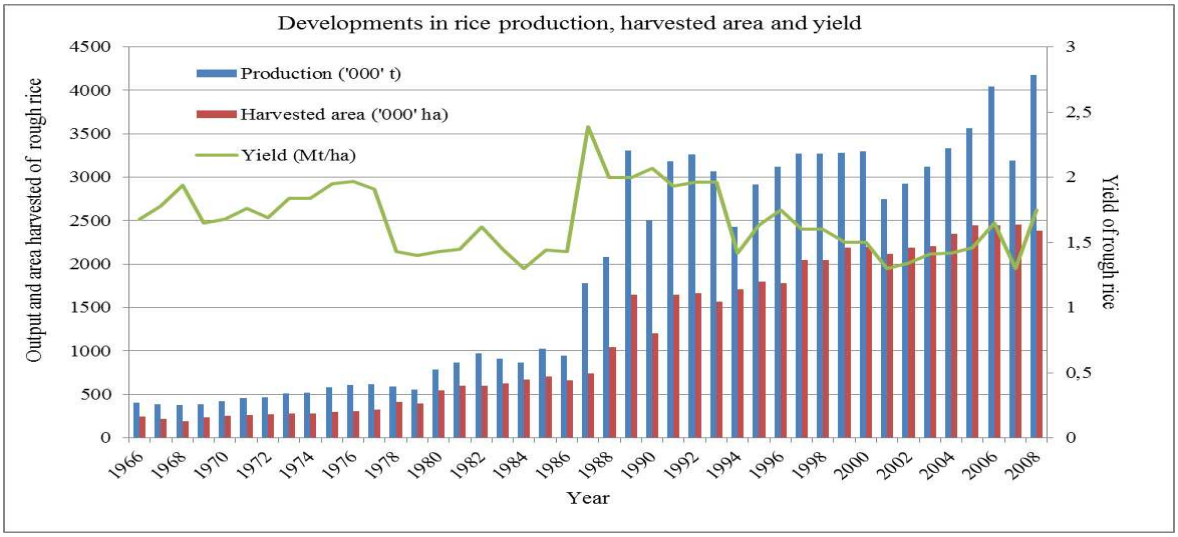
with favorable climatic conditions for agricultural production, a total amount of about US$11billion is spent annually by Nigeria on importation of rice, wheat, sugar and fish (*from a statement by the Minister of Agriculture-Dr. Akinwumi Adesina*). These are commodities which could have been easily produced in the country, but are been sourced from without due to failure of past and present policies to appropriately identify and address impediments to the development of the various sub-sectors and the agricultural sector as a whole.

Although treated with benign neglect prior to independence by virtue of its self-sufficiency, rice has become a strategic commodity in Nigeria attracting much attention due to its increasing role in the diet of the populace and its drainage of foreign exchange through imports. Rice which use to be classified as a luxury food item prior to the country's independence, now holds the status of a staple taking the place of cassava and yam among others (Daramola, 2005). The consumption of rice in spite of increasing prices induced through high tariff imposition has been on the rise since the year 1977 when the country observed close to a tripling of per capita consumption of rice (kg/yr) over that for the immediate preceding year. Production has however failed to catch up with the increasing demand for rice, leading to widening of the gap between domestic production and demand since the mid-1990s, making Nigeria a net importer in the process.

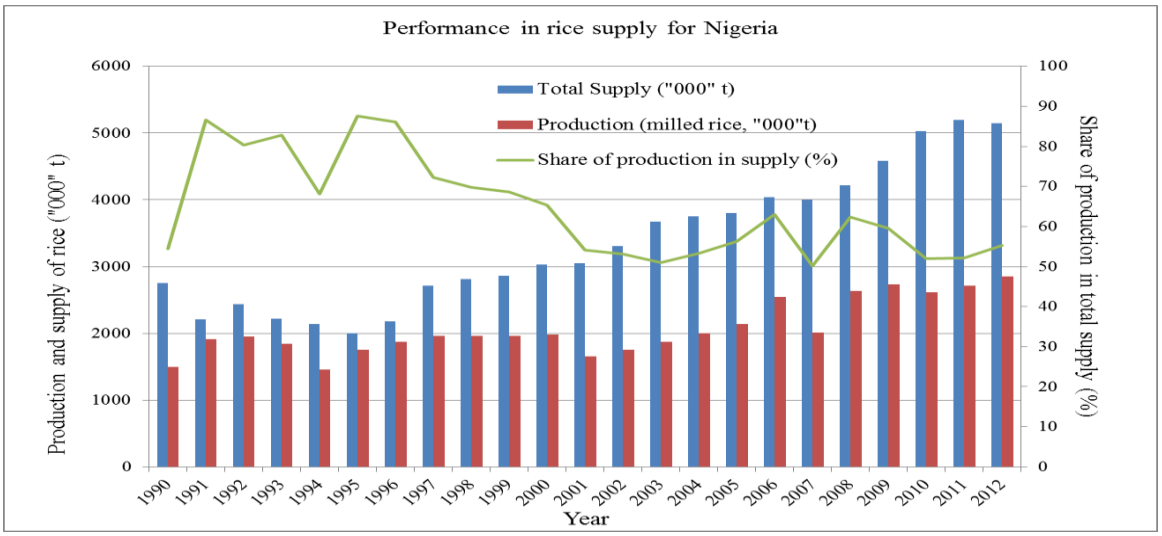
Attempts by previous regimes to reverse the situation attracted the use of various trade policy measures ranging from tariff imposition, quantitative restriction on imports through the use of quota, to outright ban on imported rice. In spite of all past and present efforts to revive the local rice industry, Nigeria is still observed as one of the leading importers of rice in the world (although the leading producer in West Africa) and the supply-demand gap continues to widen. Among the suggested impediments by various researchers to achievement of the goals of such policy measures are low productivity of farmers' fields (WARDA, 2003), scarcity of labor (due to rural-urban migration) and high cost of inputs, inconsistent government policies on rice import (ban, unban, tariff) (which have led to major drifting of farmers from the rice sub-sector) and rent-seeking attitude of government officials and their agents in the distribution/sale of fertilizer and other inputs (Daramola, 2005). With USDA data showing improvements in acreage cultivated of rice, but a declining trend for yield, as well as lagging of output behind demand, this study is purposed on identifying the long-run and short-run magnitudes and effects of key determinants of output supply and yield response of rice in Nigeria, findings of which have vital implications for future rice policy.

Figure 1.0 Developments in rice production, harvested area and yield



Source: Author's construct with data from IRRI-(World Rice Statistics, USDA Data)

Figure 2.0 Performance in rice supply for Nigeria Country



Source: Author's construct with data from IRRI- (World Rice Statistics, USDA Data)

1.1 RICE POLICY AND GOVERNMENT ASSISTANCE

Rice policy of Nigeria has primarily place emphasis on increasing domestic production and achieving self-sufficiency in rice (although yet to materialize). Measures to help achieve these goals have been in the form of subsidies to producers and consumers and tariffs, quantitative restrictions (quota) and outright ban on imports. According to Akande (2002), rice policies and acts in Nigeria can be discussed under three period, namely the "Pre-ban" period (1971-1985), the "Ban" period (1986-1995) and the "Post-ban" period (1995-date).

- **Pre-ban Period (1971-1985)**

This period is sub-categorized into "Pre-crisis" period (1971-1980) and "Crisis" period (1981-1985). The "Pre-crisis" period is characterized by liberal policies on rice import with ad-hoc policies been applied in times of interim shortages. This period marked the launching of various programmes and projects aimed at developing rice production, namely the "national accelerated food production" of 1972 , "operation feed the nation in 1976", with the research station been established in 1970 and later transformed into the National Cereal Research Institute in 1974 with a primary aim of providing farmers with high yielding varieties .With increasing imports and subsequent drainage of foreign exchange due to liberalization of trade in this period, tariffs on imports were increased, but fluctuated between 66% in 1974 and 19% in 1979 due to the inconsistent nature of the then trade policy.

During the crisis period, more stringent policies (including Agricultural Input Subsidy Policy, Input Supply and Distribution Policy, Water Resources and Irrigation Policies and Agricultural Cooperatives Policy) were applied. During this period import licenses were restricted to few individuals, and a presidential task force was established to issue allocation to customers and traders. Government policies artificially lowered domestic rice and fertilizer prices relative to the world price, through massive importation of rice resulting in low price of locally produced rice (Emodi and Madukwe (2008)). In addition, government became involved in rice importation, distribution and its marketing with non-transfer of actual costs to consumers. Elite consumers were protected at the expense of farmers, leading to depressed farm gate prices. This led to a subsequent loss in competitiveness of local rice production and through disincentive effect led to drifting-out of some farmers from rice production.

- **Ban Period (1986-1995)**

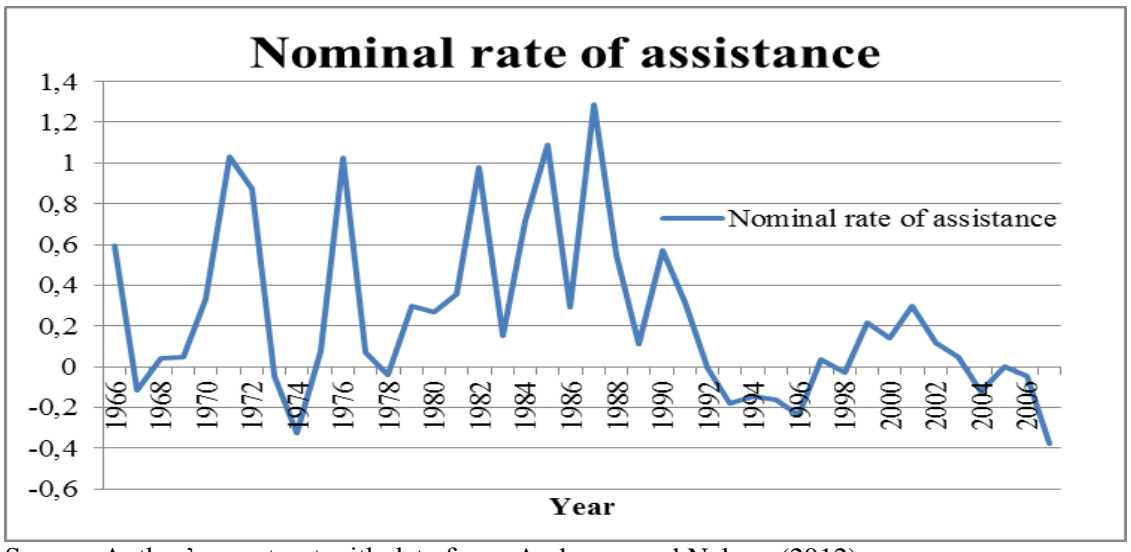
During this period, importation of rice was regarded illegal. Under the Auspices of the World Bank, State and Federal Governments, the Agricultural Development Project as one of the packages of the Structural Adjustment Program (SAP) was initiated with the aim of providing infrastructure and farm inputs in the rural areas. The Nigerian Agricultural and Corporative Bank was consequently set up to provide credit facilities. The ban on rice import was removed in 1995 and replaced with 100% tariff on rice import. This rate was however reduced by half (50%) in the following year and increased again in 2001 to 85% (Lançon and David-Benz (2007)). The tariff imposed on imports fluctuated between 100% and 110% between the years 2003 and 2006, but was relaxed to 0% in 2007 due to the global commodity crisis.

- **Post-ban Period (1995-date)**

Quantitative restrictions on rice imports were lifted and Nigeria adopted a more liberal trade policy on rice. The year 2004 marked the introduction of the presidential initiative on rice to address the widening demand-supply gap and aid in attainment of self-sufficiency in rice production. This was followed up with the National Rice Development Strategy in 2009 aimed at doubling rice production in Nigeria and increasing land area under rice cultivation. The Government of Nigerian , according to Rondon and Nzeka (2013) introduced a new tariff for rice (effective July 1, 2012) which brought a 30% levy on imported brown rice and a 50% levy on imported milled/polished rice with a 100% levy (effective December 31,2013) been later on applied. Import bans on rice, sugar and fertilizer, according to Rondon and Nzeka (2013) are expected by the year 2015

Nigeria's rice sub-sector has witnessed inconsistent policies, applying and revising tariffs in almost every year. The unstable nature of the country's rice tariff and trade policy structure could limit investment by farmers in their fields as well as incite inappropriate responses of them to temporal production incentives. As seen in the nominal rate of assistance figure below, it is noted that assistance given to farmers through subsidies and taxing of importers through tariffs had undergone multiple-peaked oscillations in short-time-intervals. Such observations mostly have incentive reducing effects on the part of farmers, especially when it comes to investing in their fields due to uncertainty in market for their produce. Using a more stable structure may help incite appropriate investment in producers, processors and other stakeholders in the supply chain.

Figure 3.0 Nominal rate of assistance for Nigeria



Source: Author's construct with data from Anderson and Nelgen (2012)

Table 1.0 Nigeria's Trade Policy on Rice 1974-2003

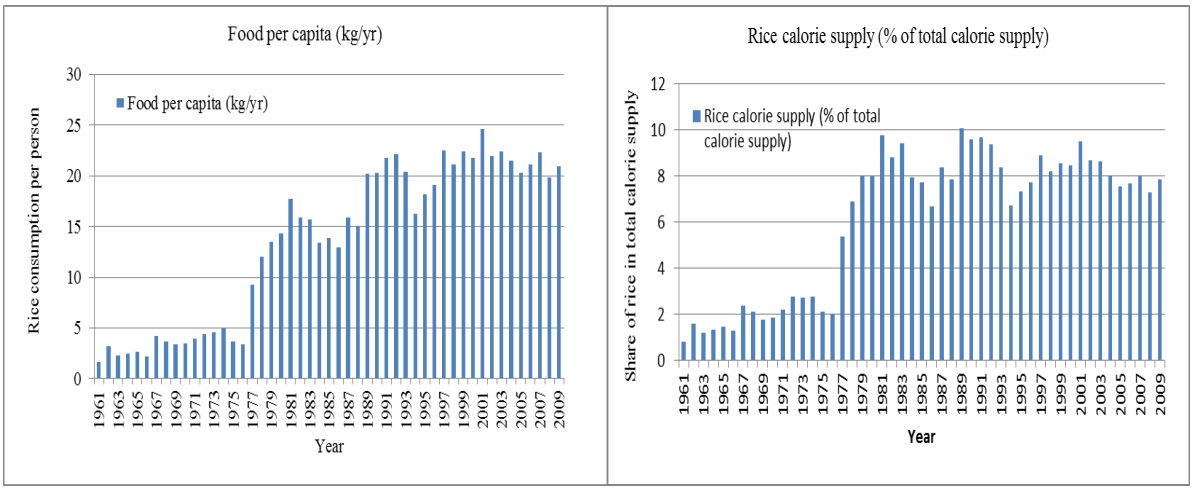
Period	Policy measures
Prior to April 1974	66.6% tariff
April 1974-April 1975	20%
April 1975-April 1978	10%
April 1978-June 1978	20%
June 1978 – October 1978	19%
October 1978-April 1979	Imports in containers under 50kg were banned
April 1979	Imports under restricted license only; Government agencies
September 1979	6 months ban on all rice imports
January 1980	Import license issued for 200,000 tonnes of rice
October 1980	Rice under general import license with no quantitative restrictions
December 1980	Presidential Task Force (PTF) on rice was created with issuing of allocations to customers and traders been done through the Nigerian National Supply Company (NNSC)
May 1982	PTF commenced issuing of allocations to customers and traders in addition to those issued by the NNSC
January 1984	PTF disbanded. Rice importation placed under general license restrictions
October 1985	Importation of rice (and maize) banned
July 1986	Introduction of SAP and the abolition of Commodity Boards to provide production incentives to farmers through increased producer prices
1995	100% Tariff
1996	50%
1998	50%
1999	50%
2000	50%
2001	85%
2003	100%

Source: Daramola (2005)

1.2 DEVELOPMENTS IN RICE CONSUMPTION

Rice held a minimal role in the diet of the average Nigerian both in terms of per capita annual consumption and in terms of contribution to total calorie intake in the 1960's and early 1970's. Per capita consumption of rice during the 1960's was 2.9kg/yr on average and 4.1kg/yr for the period 1970-1976. Consumption of rice almost tripled between the years 1976 and 1977 as consumption per capita increased from 3.4kg/yr in the former to 9.3kg/yr in the latter. Consumption of rice has since then depicted a more or less increasing trend with the year 2009 observing a figure of 20.9kg/yr (an increase of over 1200% on the figure for the year 1961(1.6kg/yr)). Likewise, the share of rice in total calorie intake in the country increased from as low as 0.84% to 10.08% in 1989, and gradually decreased to 7.86% in 2009. This shows that rice is gradually gaining grounds in dietary patterns of Nigeria and there arises the need therefore to initiate and implement appropriate measures to help meet both current and future rice needs to ensure food security for all.

Figure 4.0 Consumption of rice and share in total calorie supply



Source: Author's construct with data from IRRI – (World Rice Statistics)

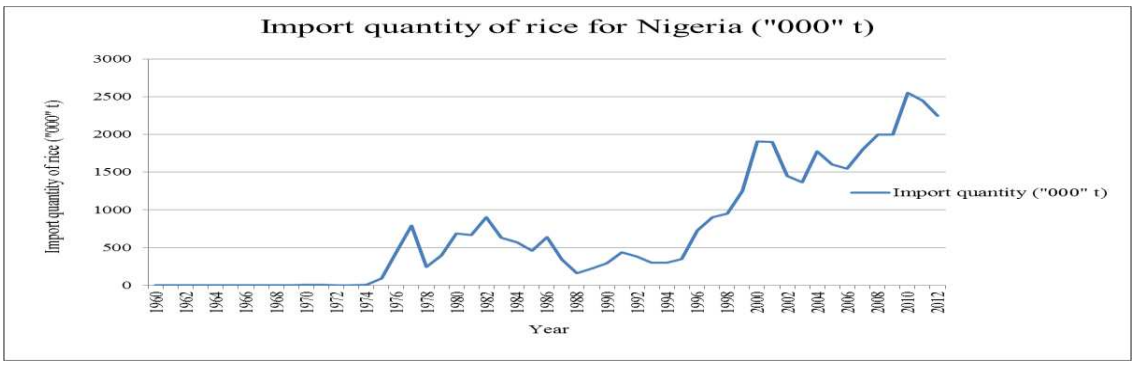
1.3 SOCIO-DEMOGRAPHIC CHARACTERISITCS OF NIGERIA

Located in Coastal West Africa, Nigeria has observed an increase in its population from approximately 47 million people in 1961 to about 167 million people in 2012. This figure by projection of the FAO is expected to reach approximately 204 million by the year 2020. Currently, a total of about 51% of the total population live in urban areas, with this ratio anticipated to increase to 56.85% by the year 2020. Annual population growth in the country is 2.48% on average for the period 1962-2011. Per capita income as measured by GDP per capita (in current US$) has increased form US$102.42 in 1962 to US$1501.72 (World Bank: Development indicators). With these four indicators been confirmed in past studies as being major drivers of rice consumption, increases observed in them and projections on them signal likely increases in future rice consumption and the necessity to be on alert.

1.4 DEVELOPMENTS IN IMPORTATION OF RICE

With Nigeria being virtually self-sufficient in rice in the 1960's and early 1970's (1970-1974), imported rice did play an insignificant role in total rice supply and consumption in the country. The quantity imported was on average 1100 Mt for the 1960s and 5800 tonnes for the period 1970-1974. Import of rice however picked a pace from the year 1976 with an import quantity of 446,000 Mt.

Figure 5.0 Developments in rice imports



Source: Author's construct with data from IRRI – (World Rice Statistics, USDA data)

The quantities of rice imported into the country between then and the ban period were shaped by the level of tariff and quantitative restrictions imposed. It however has since the post-ban period depicted an increasing trend, increasing from 350,000 Mt in 1995 to 2,250,000Mt in the year 2012

1.5 DEVELOPMENT IN RICE YIELDS

With land area for crop production in major agricultural food crop producing countries been gradually exhausted, concerted efforts are been put in place to increase productivity of current fields to enhance sustainability. A challenge faced by most countries in Africa, especially West African countries, is low productivity of farmers' fields. Although blessed with vast land area, the production of most food crops lags well behind demand as a result of low productivity of current fields. In as much as some major countries noted in world trade have observed improvements in yield of paddy rice, Nigeria on the contrary has not witnessed any significant improvement in rice yield. With yields in countries like Egypt increasing from an average of 5.143 for the period 1960-1969 to 9.809 for the period 2000-2009, yields in Nigeria decreased from 1.820 to 1.519 for the respective periods. As is observed from the table below, almost all the countries (except Egypt, Indonesia and Vietnam) have observed yields below the average for the world. This signals that the problem of low productivity is more or less a general one and needs addressing to ensure continuous supply of adequate amounts of rice in the near future

Table 2.0 Global rough rice yields (Mt/ha)

	1960-1669	1970-1979	1980-1989	1990-1999	2000-2009
World	2.057	2.474	3.144	3.692	4.016
Nigeria	1.820	1.747	1.651	1.742	1.519
Côte d'Ivoire	0.985	1.172	1.162	1.202	1.838
Ghana	1.171	1.009	1.037	1.913	2.165
Egypt	5.143	5.324	5.803	8.010	9.809
Indonesia	2.076	2.652	3.965	4.346	4.617
Pakistan	1.562	2.318	2.466	2.658	3.165
Thailand	1.749	1.851	2.009	2.282	2.683
Vietnam	1.925	2.115	2.732	3.675	4.709

Source: Calculated by Author with data from IRRI- (World Rice Statistics, USDA data)

1.6. CONSTRAINTS TO THE DEVELOPMENT OF RICE PRODUCTION

Development of the local rice production industry in Nigeria is been reported by Daramola (2005) to be inhibited by several factors including high cost of inputs like credit, imported equipment and agrochemicals due to taxes, high transportation costs, absence of extension advice, low mechanization of rice farms, scarcity of labor due to alternative (and more remunerative) off-farm employment opportunities and due to rural-urban migration, land tenure system (which mostly limit size of holdings and investment in land improvement), high cost of land preparation and the broad use of genetically inferior (unimproved) varieties that exhibit low productivity. Due to the high cost of fertilizer and other vital inputs of production in the country, most farmers do not use them in their cropping and those who use them use inadequate amounts resulting in sub-optimal yields and retarded outputs.

In addition, inconsistent government policies (ban, unban, tariff) by virtue of the trade policy structure of the country (on rice) makes decision-making and planning quite uncertain and limits investment towards the development of rice fields due to the associated risk in doing so. There have

been extreme oscillations in government support since the year 1974. The country and most importantly farmers have observed government support ranging from over 100% tariff imposition on rice imports to complete abandonment of levies (eg. in 2007), with some years recording complete bans on imports. Any of such decisions have incenting and depressing effects on farmers and influences their production decisions. For example, the engagement of the government in importation of rice in the crisis phase of the "Pre-ban" period of 1971-1985 coupled with the artificially low induced farm gate prices led to drifting-out of most farmers from the rice production sub-sector. Measures to ensure development and sustainable production of rice in the country could do well to ensure a more stable policy on rice in order to incite appropriate investment and ensure appropriate response of farmers to production incentives.

2.0 MODEL SPECIFICATION AND DATA

The current study analyzes the response of two dimensions of supply, namely output and yield in order to inform future policy decisions in Nigeria. Output and yield responses of rice for Nigeria are estimated based on the following equation:

Output response:

$PROD_t = f(HA_t, PPR_t, PPM_t, (WPR_t/PPR_t), (WPCORN_t/PPM_t), WPU_t, NRA_t, AL_t, IRA_t, u_t)$

Yield response:

$YLD_t = f(HA_t, PPR_t, PPM_t, (WPR_t/PPR_t), (WPCORN_t/PPM_t), WPU_t, NRA_t, AL_t, IRA_t, u_t)$

Where

$PROD_t$	- Output of rough rice ("000" tonnes)
YLD_t	- Yield of rough rice (Mt/ha)
HA_t	-Harvested area of rough rice ("000" ha)
PPR_t	- Producer price of rice (LCU –Naira)
PPM_t	-Producer price of maize (LCU –Naira)
(WPR_t/PPR_t)	-World price of rice to local producer price of rice ratio
$(WPCORN_t/PPM_t)$	-World price of corn to local producer price of maize ratio
WPU_t	-Price of urea (World price as proxy, US$/t fob)
NRA_t	-Nominal Rate of Assistance (%)
AL_t	-Availability of labor (agricultural labor force as proxy, ("000") persons
IRA_t	-Irrigated area (irrigated agricultural area as proxy ("000")
u_t	-Stochastic error term assumed to be $iidN(0\Sigma)$

Data (1966-2008) on all the variables were collected from the IRRI website (World Rice Statistics) and the agricultural production database of the FAO (FAOSTAT). Prior to estimation of the long- and short-run output and yield responses to changes in the explanatory variables, the entire data set (with variables in log except nominal rate of assistance) was verified using the Phillips-Perron unit root test (Intercept and trend at level, intercept at first difference). Verification of the data set is done to ascertain the order of integration of the individual series as this is a vital step in the data generation process and in the choice of estimator. Below are the results on the unit root test and on the estimates.

3.0 RESULTS

Table 3.0 Unit root test of variables (Phillips-Perron test)

Variables	PP-statistic at level	B-Width	PP-statistic at first diff	B-Width
PROD	-1.881835	1	-7.709820***	3
YLD	-3.454784	2	-8.821129***	4
HA	-1.906702	3	-7.933040***	1
PPR	-1.918424	3	-5.737274***	3
PPM	-2.476937	0	-7.302607***	3
(WPR_t/PPR_t)	-1.784237	1	-4.345723***	5
$(WPCORN_t/PPM_t)$	-2.002283	0	-6.415429***	0
WPU	-2.074537	3	-4.827174***	12
NRA	-4.518657***	2	15.24227***	16
AL	-2.057741	2	-6.278252***	2
IRA	-1.522528	1	-4.822190***	1
Critical value	-3.520787		-2.935001	

NB: 95 percent confidence level for critical value, ***1%, **5%

Result of the test shows that all the variables excluding the nominal rate of assistance (NRA) are non-stationary at level but become stationary on first difference at the 1% level. Nominal rate of assistance was found stationary at level at the 1% significance level.

3.1 OUTPUT RESPONSE OF RICE

To ensure reliability of estimates for the output response of rice, diagnostic tests for serial correlation in the residual series, normality, structural stability (through CUSUM and CUSUM of Squares tests) and misspecification of the function through a Reset test were applied to both the long and short-run estimates. Results of the test show that the function is appropriately specified, the estimates are stable and the residual series is normally distributed, homoscedastic and free from serial correlation.

Table 4.0 Long-run and short-run estimates of output response of rice

	Short-run		Long-run	
Variables	Coefficients	t-statistic	Coefficients	t-statistic
Δ ln$PROD_{t-1}$	-0.168484	-1.303466		
ln HA_t			0.736453	5.290863***
Δ ln HA_t	0.842487	5.300499***		
ln PPR_t			0.611092	4.742443***
Δ ln PPR_t	0.623112	4.874308***		
ln PPM_t			-0.461451	-3.716858***
Δ ln PPM_t	-0.273731	-1.860175*		
ln (WPR_t/PPR_t)			0.159896	1.292689
Δln (WPR_t/PPR_t)	0.105559	0.917795		
ln $(WPCORN_t/PPM_t)$			-0.208028	-1.626404
Δln $(WPCORN_t/PPM_t)$	-0.026441	-0.205072		
ln WPU_t			0.137540	1.450718
Δ ln WPU_t	0.053123	0.639326		
NRA	0.089686	1.892968*	0.144147	2.599466**
ln AL_t			0.851923	1.846444*
Δ ln AL_t	1.380126	1.999156*		
ln IRA_t			-1.101571	-2.509476**
Δ ln IRA_t	-0.893554	-1.119584		

Intercept	-0.031947	-1.298866	-2.167512	-0.415111
RESIDUAL (-1)	-0.915457	-3.563153***		
Adj R^2	0.634252		0.986189	
D-W stat	1.996335		1.863880	
F-statistic	7.305894		334.2208	
Prob(F-statistic)	0.000008		0.000000	
Log Likelihood	42.18573		43.03574	
Akaike info criterion	-1.472475		-1.536546	
Schwarz criterion	-0.970941		-1.126964	
Hannan-Quinn criter.	-1.289844		-1.385505	
Mean dependent var	0.057778		7.225489	
S.E. of regression	0.102826		0.101528	

Figure 6.0 CUSUM and CUSUM of Squares Tests

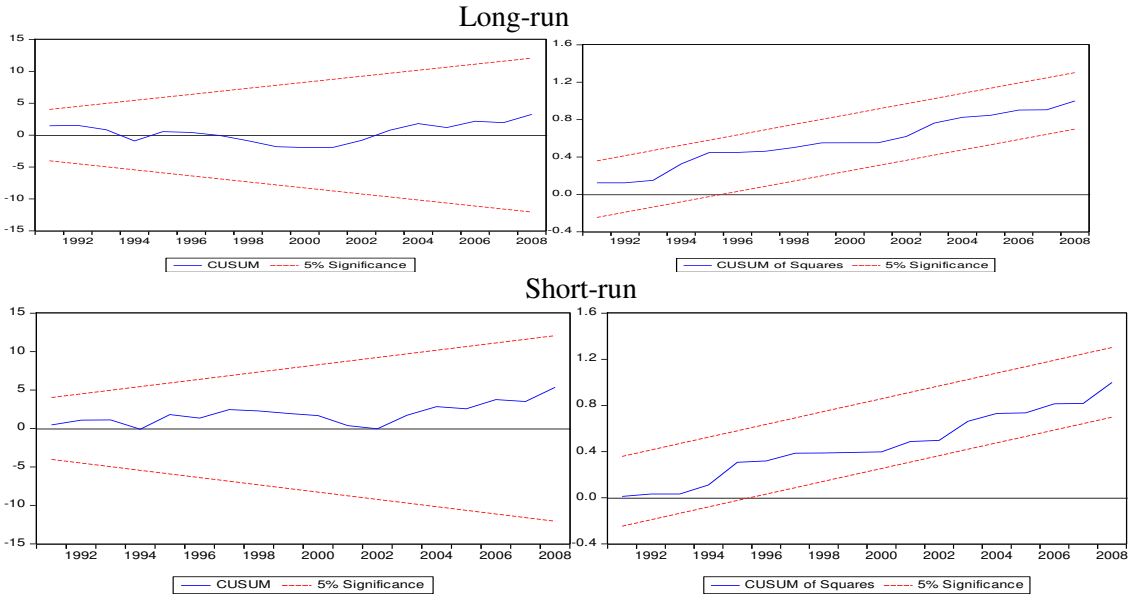


Table 5.0 Diagnostic Tests

	Short-run estimates	Long-run estimates
Jarque-Bera	1.322651(0.516167)	0.069349 (0.9659)
B-G LM (1)	0.257621(0.6157)	0.109816 (0.7425)
(-2)	0.155513(0.8567)	0.085631 (0.9181)
Q-stat (-1)	0.1447(0.704)	0.1101 (0.740)
(-2)	0.1780(0.918)	0.1484 (0.928)
ARCH Test (1)	0.207499(0.6513)	0.672691(0.4170)
Reset test	3. 41200(0.075)	1.986670 (0.1683)

In interpreting the results, harvested area of rice has respective long-run and short-run coefficients of 0.736 and 0.842, implying that, a 1% increase in area cultivated of rice leads to increases of 0.736% and 0.842% in output in the long-run and short-run respectively. Each of these effects is significant at the 1% level. With rice production in Nigeria dominated by small-holder producers and with land sizes ranging between 1-2 hectares, farmers are unable to exploit any benefit associated with economies of scale. The small sizes of farms in addition limit the capacity of farmers to mechanize or

modernize their production and make efficient use of available labor (which is usually obtain at a high cost due to alternative off-farm employments which are as well more remunerative) . Increasing area cultivated of rice, will therefore pave room for farmers to exploit economies of scale and make optimum use of labor available to them. These benefit would however be realized only on complementing area expansion with intensification measures to mitigate any adverse effect on yield, as most fields are reported to be low in fertility due to the high cost of fertilizer and the sub-optimal use of it by the farmers due to financial constraints among other challenges.

A unit increase in the farm gate price of rice leads to a 0.611% increase in rice output in the long-run, with an increase of 0.623% expected for the short run. Increasing the farm gate price of rough rice (if increments are appropriately transmitted) increases the financial base of rice producers and enable them to effectively meet the cost of vital inputs of production like labor, fertilizer, pesticides, and to ensure effective coverage of the cost of controlling diseases and weeds, the latter being a major problem with rice production in most West African countries. A unit increase in the price of maize (a competitive field crop) leads to decreases of 0.461% in output for the long-run and 0.274% for the short-run. Increasing the price of a competitive field crop, whiles that of the main crop of interest (rice in this case) is maintained or decreased could lead to reallocation of resources in favor of maize production. Such reallocations would result in the obvious significant adverse effect on output.

As a major importing nation of rice, State intervention through support to farmers (captured by the nominal rate of assistance) is observed to have beneficial effect to producers in both the long-run and short-run. State intervention in the rice industry for Nigeria has mostly been through the use of restrictive measures on imports and subsidization of inputs (the latter however is been reported by Daramola (2005) to have been mostly compromised by government officials and their agents through rent-seeking on their part). Although observed to have beneficial effect to producers, the nominal rate of assistance has exhibited multiple extreme oscillations in short-time intervals since the year 1974. This observation however is not commendable as it has likely limiting effect on investment by farmers in their fields by virtue of risk and uncertainty of assured future market for their produce on harvest. A unit increase in nominal rate of assistance is observed to lead to a 0.144% increase in output in the long run and 0.090% in the short-run, the latter being significant at the 10% level and the former at the 5% level.

With rice production in Nigeria being labor intensive, a unit increase in available farm hands leads to 0.852% increase in output in the long-run and 1.38% in the short-run; both being significant at the 10% level. Increases in labor ensure better and timely undertaking of vital cultural practices like fertilizer application, weed control and harvesting. Increases in labor also serves indirectly as an incentive for increasing area under cultivation with hope of getting more hands to help in management of the field. The negative significant association observed between rice output and irrigated area is regarded a mixed signal resulting either from wrong choice of proxy (thus, low share of irrigate rice area in total irrigated area) or from inappropriate response from farmers by virtue of some financial, structural and biophysical constraints they may be facing. Of the total variations in rice outputs observed in Nigeria for the long-run, about 98.62% are explained by variables in the output response model, with a total of about 63.43% been explained by the variables in the short-run. A total of about 91.55% of deviations from the long-run equilibrium are restored in the current period and this restoration is significant at the 1% level. The combined effect of the variables in the long-run is highly significant, so is it in the short-run (as reflected by the probability of the F-statistic).

3.2 YIELD RESPONSE OF RICE

To ensure reliability of the estimates for the yield response of rice, diagnostic tests for serial correlation in the residual series, normality, structural stability (through CUSUM and CUSUM of Squares tests) and misspecification of the function through a Reset test were applied to both the long and short-run estimates. Results of the test show that the function is appropriately specified, the estimates are stable and the residual series is normally distributed, homoscedastic and free from serial correlation.

In interpreting the results, area harvested of rice had a significant (at 10% level) coefficient of -0.261, implying that a 1% increase in area harvested of rice leads to a 0.261% decrease in yield. Increasing area harvested of rice although is believed to pave way for exploitation of economies of scale and serves as a platform for mechanizing rice production, increasing area cultivated without completing it with other vital inputs of production like fertilizer, pesticides and adequate supply of water among other factors, would results in the observed adverse effect by virtue of induced competition on the plants for the limited resources available in the soil. This in the long-run leads to sub-optimal yields and a subsequent decrease in output if fertility measures are ignored for longer periods.

Table 6.0 Long-run and short-run estimates of acreage response of rice

	Short-run		Long-run	
Variables	Coefficients	t-statistic	Coefficients	t-statistic
Δ lnYLD_{t-1}	-0.175152	-1.244052		
ln HA_t			-0.260571	-1.874781*
Δ ln HA_t	-0.148515	-0.932344		
ln PPR_t			0.610902	4.747996***
Δ ln PPR_t	0.600494	4.666169***		
ln PPM_t			-0.463592	-3.739633***
Δ ln PPM_t	-0.279074	-1.896937*		
ln (WPR_t/PPR_t)			0.160213	1.297176
Δln (WPR_t/PPR_t)	0.127485	1.127746		
ln ($WPCORN_t$/PPM_t)			-0.210305	-1.646637
Δln ($WPCORN_t$/PPM_t)	-0.055656	-0.445141		
ln WPU_t			0.138369	1.461625
Δ ln WPU_t	0.053057	0.636829		
NRA	0.088152	1.860007*	0.143524	2.592070**
ln AL_t			0.864829	1.877193*
Δ ln AL_t	1.290577	1.860746*		
ln IRA_t			-1.105058	-2.521148**
Δ ln IRA_t	-1.013251	-1.257691		
Intercept	-0.037971	-1.548065	-2.283324	-0.437938
RESIDUAL (-1)	-0.920191	-3.574339***		
Adj R^2	0.619304		0.644709	
D-W stat	1.889127		1.867601	
F-statistic	4.288761		6.653524	
Prob(F-statistic)	0.000802		0.000023	
Log Likelihood	42.11339		43.09939	
Akaike info criterion	-1.468946		-1.539507	
Schwarz criterion	-0.967412		-1.129925	
Hannan-Quinn criter.	-1.286315		-1.388466	
Mean dependent var	0.000415		0.498397	
S.E. of regression	0.103007		0.101378	

Figure 7.0 CUSUM and CUSUM of Squares Tests

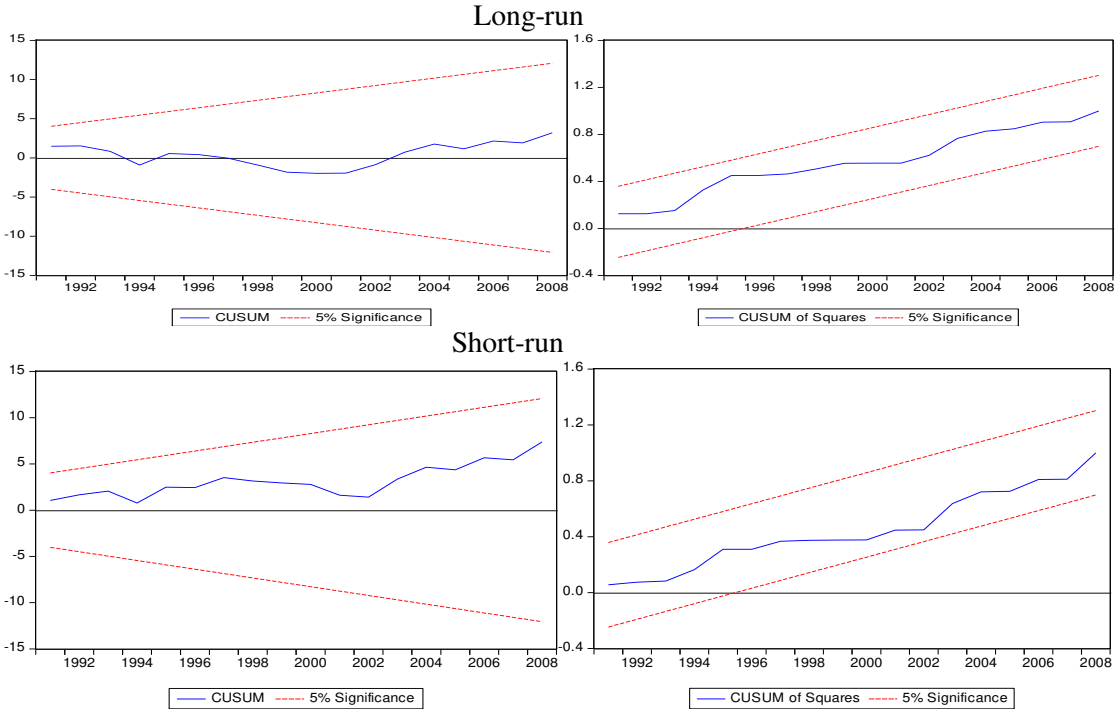


Table 7.0 Diagnostic Tests

	Short-run estimates	Long-run estimates
Jarque-Bera	0.561026(0.755385)	0.090964(0.955537)
B-G LM (1)	0.015104(0.9031)	0.103704(0.7495)
(-2)	0.008034(0.9920)	0.079672(0.9236)
Q-stat (-1)	0.0066(0.936)	0.1045 (0.746)
(-2)	0.0077(0.996)	0.1391(0.933)
ARCH Test (1)	0.687033(0.4124)	0.721966 (0.4006)
Reset test	0.481408(0.4935)	0.988814(0.3275)

Producer price of rice has associated respective long-run and short-run coefficients of 0.611 and 0.600, implying that a unit increase in the producer price of rice leads to a 0.611% increase in yield in the long-run and 0.600% in the short-run. With cost of vital inputs in the country reported to be high, increasing the farm gate price of rice, increases the financial base of rice farmers as well as their purchasing power. This ensures relatively effective covering and meeting of the cost of vital inputs of production. Yield of rice however decreases by 0.464% in the long-run and 0.248% in the short-run for a unit increase in the price of maize. This observation is attributed to influences from resource re-allocation in favor of maize production in times of increasing prices for maize and stagnation or decline in that for rice. As rational beings and risk averse by nature, farmers always go in for the most promising choice when faced with a dilemma, choosing maize production over rice in this case.

Increasing government support to farmers (nominal rate of assistance) is observed to have beneficial effects on yield of rice in Nigeria. Through subsidization of inputs financed with government revenue from imposed tariffs on imports, the cost of production may be lowered (based on the effective rate of protection). If cost is truly lowered, it enables farmers to access adequate amounts of such vital inputs of production for cropping. Ability of farmers to access and properly use sufficient amounts of vital subsidized inputs of production, would lead to the obvious significant positive effects on yield. A unit increase in the nominal rate of assistance leads to a 0.144% increase in yield in the long-run and

0.088% in the short run. A unit increase in available farm hands leads to a 0.865% increase in yield in the long-run and 1.291% in the short-run. Increase in the number of hands on the field ensures timely undertaking of some vital cultural practices necessary for ensuring optimum yields. These include weed control, fertilizer application, disease and pest control and timely harvesting of paddy to minimize losses. Once again, a mixed signal was observed for the effect of irrigated area on yield.

Of the total long-run variations observed in yield of rice in Nigeria, about 64.47% are explained by the variables in the yield response model, with about 61.93% been explained in the short-run. A total of about 92.02% of deviations from the long-run equilibrium are restored in current period and this restoration is significant at the 1% level. The combined effect of the variables in the long-run is highly significant, so is it in the short-run (reflected by the probability of the F-statistic)

4.0 CONCLUSION AND RECOMMENDATIONS

Hindered by inconsistent government policies, improper production methods, high cost and scarcity of vital inputs of production among other constraints, the local rice industry of Nigeria has failed to catch up with the increasing pace of consumption. With the rate of consumption increasing at a much faster rate since the year 1977 as against the relatively lagging nature of production, Nigerian government resorted to importation of increasing quantities of rice to bridge the supply gap, making Nigeria a net importer in the process. Attempts by previous regimes and current government to reverse the situation have proven futile as the supply-gap continues to widen. Among measures used in such attempts are high tariff impositions on imports, use of quantitative restrictions through quota, outright ban on imported rice and subsidies on inputs of production. Growth of the local rice industry is suggested to be impeded by various factors among which are low productivity of farmers' fields, scarcity of labor, high cost of inputs, inconsistent government policies and rent-seeking attitude of government officials and their agents in the distribution and sales of fertilizer and other inputs.

To help inform future rice policy decisions on the way forward, this study analyzed the output supply and yield response of rice in Nigeria for the period 1966-2008.

Output of rice is observed to increase with increasing harvested area, increasing farm gate price of rice, increasing nominal rate of assistance and increasing labor availability. In however decreased with increasing price of maize and with increases in irrigated area, the latter been considered a mixed signal. Yield of rice is observed to increase with increasing farm gate price of rice, nominal rate of assistance and availability of labor and decreases with increasing harvested area, price of maize and irrigated area, the latter been considered once again as a mixed signal. To improve upon its rice production, it is advised that policies measures be devised to coupled area expansion with intensification to help mitigate the adverse effect of area expansion on yield, reduce labor shortage through appropriate investment in development of the rural communities (to help minimize rural-urban migration), ensure continuous government support to the sector, maintain fair prices for the local rice farmers and ensure appropriate transmission in times of price increments.

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