NIGERIA RICE OUTPUT FORECAST: AUTOREGRESSIVE INTEGRATED MOVING AVERAGE (ARIMA) APPROACH

ABSTRACT

Nigeria has implemented various policies and programs aimed at ensuring self-sufficiency in rice production since 1970. The trade policy instruments employed included tariffs, quotas, subsidies, import restrictions and outright ban on rice import at various times. All these policies failed to bridge ever increasing demand-supply deficit in rice production. However, there is considerable potential for expansion of rice production in the five rice-growing ecosystems in Nigeria in order to attain self-sufficiency. The current government has again placed a total ban on the importation of rice with the target of attaining self- sufficiency in rice production by 2020. Given the current production level, this study intended to forecast the rice output from 2018 to 2025 so as to ascertain the likelihood of attaining the self-sufficiency level within the target period, and also to describe trends in rice output from 1980-2016. The study was based on time series data collected on national rice output from 1980 to 2016. Descriptive statistics and ARIMA (111) model were used to analyze data collected. Results shows that on the average, national rice output maintain a steady increase of 69 % per decade from 1980 to 2016, with the peak of 93% increase recorded within the years 2000- 2009. Given the current production environment, the national paddy-rice output was projected to reach 7.4 million tonnes (equivalent of 4.9 million tonnes of milled-rice) by the year 2020. This is short of 6 million tonnes of milled-rice target. However, the projected result also show that self-sufficiency level of 6 million tonnes of milled rice (about 10 million tonnes of paddy-rice) could only be attainable by the year 2025. It is recommended that until 2025 when the country was projected to attain self-sufficiency in rice production, effort should be geared towards bridging demand –supply gap by ensuring strict quota policy of rice import. This would eliminate price increase associated with disequilibrium in demand –supply of rice commodity in the market

Keywords: National Rice Output, Forecast, ARIMA

INTRODUCTION

Rice (*Oryza sativa*) is a cereal which has become a staple food of considerable importance in many African Countries, where its consumption among urban and rural poor households has increased considerably [1]. The per-capita rice consumption is estimated at 24.8Kg/annum, representing 9% of total caloric intake. Population growth and urbanization are the principal factors driving consumer's preference towards rice in Nigeria [2]. The status of rice in the average household meal has changed from a luxury food to that of a staple, taken over the place of cassava, yam and sorghum. The empirical evidence has shown that the price elasticity of demand for rice is low particularly at the urban markets. Meanwhile, the gap between domestic supply and demand continues to increase.

Although the rice paddy production rose from 1.9 million tonnes in 1980 to 6.3 million tonnes in 2017 [3], production has not kept pace with demand. According to United State Department of Agriculture [4], domestic milled- rice consumption rose from 6.5 million tonnes in 2016 to 6.7 million tonnes in 2017, which represents 2.29% increase. There is considerable potential for extending and intensifying rice production in the five rice-growing ecosystems found in Nigeria: - plateau, rained plains, irrigated plains, lowlands and mangrove [5]

Nigeria has implemented various policies and programs aimed at ensuring self-sufficiency in rice production since 1970. The trade policy instruments employed included tariffs, quotas, subsidies on inputs designed for trade protection and development, import restrictions and outright ban on rice import at various times. According to [1] as a respond to the prevailing rice production and consumption deficit situation in Nigeria, successive governments intervened in the rice sector by increasing tariffs so that local production could be encouraged. [6] Observed that the policy of outright ban on rice imports as practiced some years ago, trigger increased in the relative price of rice against other major staples and boosted rice production mainly through land area increase.

Past policies did not help local rice producers secure a significant market needs and meeting the much talked about self-sufficiency in rice production in spite of abundant potentials, instead imports have increase rapidly in spite of successive increases in the import tariff from 50% to 100%. Imported rice represents more than 20% of agricultural imports and currently constitutes 33% of the total rice consumption. Nigeria has thus become a second major rice importer of rice with about 2 million tonnes, next to China's import of 5 million tonnes, while European Union is third in the rice import ranking with about 1.8 million tonnes over the period of 1980-2016 [7].

In a bid to ensure self-sufficiency in rice production, the current Nigeria government has again placed a total ban on the importation of rice with the target of attaining self- sufficiency in rice production by 2020, provided the implementation of the Anchor Borrowers' Programme launched on Nov 17, 2015 is sustained. Given the current production level, this study intended to forecast the rice output from 2018 to 2025 so as to ascertain the likelihood of attaining the self-sufficiency level within the target period, and to describe trends in rice output from 1980-2016 in Nigeria.

METHODOLOGY

This study was based on a time series data collected on national rice output, from 1980 to 2016. Data were obtained from Food and Agricultural Organization (FAO) website.

Autoregressive Integrated Moving Average, ARIMA (p,d,q) model was employed. According to [8] the model can be specified as follows:

$$Y_t = \theta + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{i=0}^{q} \beta_i \mu_{t-i}$$

Where;

Y_t = variable (national output) to be forecast for a given time period.

P=number of auto regression terms (that is P^{th} – order Auto regression)

d=variable integration order

q=number of moving average terms (that is q^{th} – order of moving average)

The predictive power of ARIMA (p,d,q) was tested using Root Means Percentage Square Error

$$\text{RMSPE}=\sqrt{\frac{1}{n}\sum_{i=1}^{n}\frac{(y_t^s-y_t^a)^2}{y_t^a}}$$

Where;

y_t^s=predictive value of the observation variable

y_t^a = actual value of the observation variables.

n = total observation period.

Results and Discussion

Description of trends in paddy-rice output from 1980-2016 was presented in Figure 1. The Figure showed that national rice output increased significantly from 1.09 million tonnes in 1980 to 3.3 million tonnes

1989, which represents 33% increase over 1980 national output. Similarly, Figure 1 showed that national rice output rose from 2.5 million tonnes in 1990 to 3.3 million tonnes in 1999. This showed that 1999 output increase by 76% over that of 1990. Also, between the years 2000 and 2009, the Figure 1 further showed that output increase from 3.3 million tonnes to 3.5 million tonnes, which represents 93% increases. In 2010, Nigeria recorded national rice output of 4.5 million tonnes, which later increased by 73% to 6.1 million tonnes in 2016 (Figure 1). This an indication that on the average, national rice output increases by 69 % every decade. These increases in the national rice output could be attributed to additional hectares allotted for rice production inputs support programmes, value chain addition, improved extension services, among others resulting from various relevant policies put in place by the various governments to boost local production and to discourage importation.

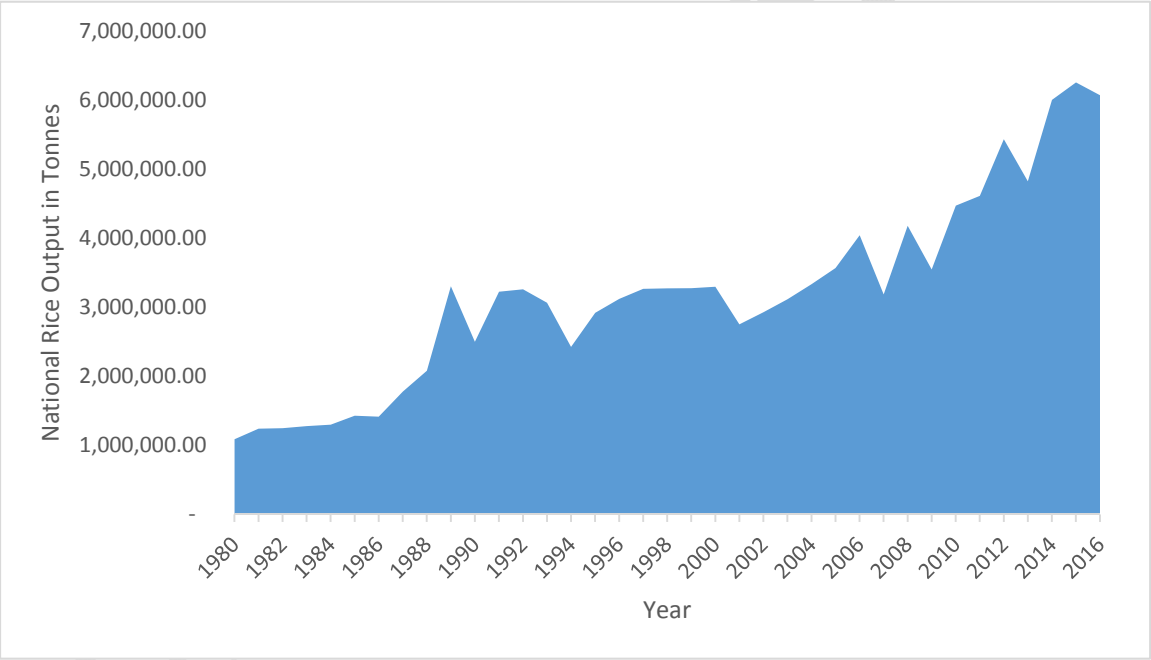


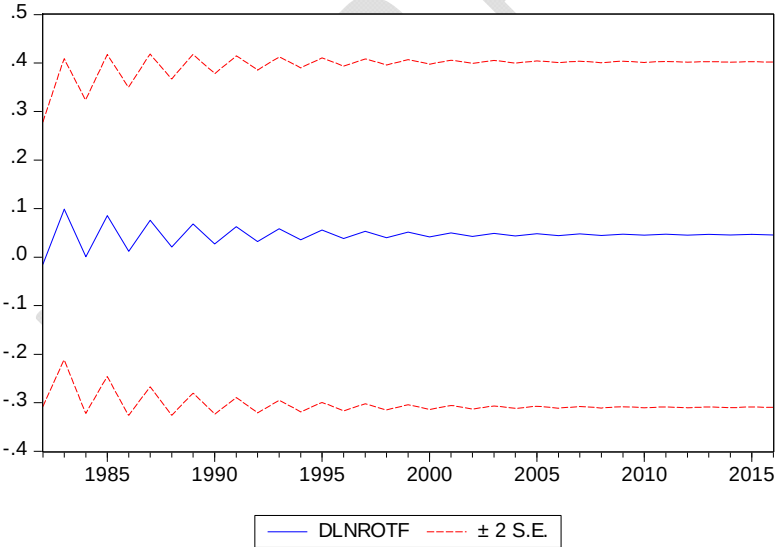
Figure 1: Trends of National Rice Output in Nigeria
Source: [3]

In forecasting national output of rice, the ARIMA model was used. The model follows Box-Jerkinn approach. The approach involved three stages namely; identification, estimation, diagnostic check and forecasting. The Table 1 shows the three different ARIMA models. The selection of the best model was based on the following criteria: high value of adjusted R-Squared, least value of akaike information criterion (AIC) and

residual sum of square (RSS), as well as number of significant coefficient of estimated models. Based on these criteria, the ARIMA (111) was selected as a lead equation for forecasting as presented in Table 1. ARIMA (111) was subjected to diagnostic check using Q-Statistics, which shows no serial correlation. Hence, the model was used to estimate *ex-post* prediction based on 1980 to 2016 national paddy-rice output data using Eviews version 7. Figure 2 shows that model predictive capacity was significant as Root Mean Squared Error (RMSE) was low at 15%. This confirms the predictive power of the selected model (ARIMA 111).

Table 1: Three ARIMA models based on analysis of autocorrelation function and partial autocorrelation function

Variables	Model 1 (ARIMA 111)	Model 2 (ARIMA 112)	Model 3 (ARIMA 113)
θ (t-statistics in parenthesis)	0.05 (2.29)	0.05 (2.28)	0.05 (2.92)
θ_1 (t-statistics in parenthesis)	-0.87 (-5.36)	-0.38 (-2.28)	-0.42 (-2.57)
θ_2 (t-statistics in parenthesis)	0.59 (2.21)	0.15 (1.54)	-0.08 (-0.42)
Adjusted R-squared	0.19	0.15	0.16
AIC	-0.99	-0.95	-0.95
RSS (residual sum of square)	0.64	0.67	0.67
Number of Significant coefficients	02	01	01
Q-statistics (NS)			



Forecast: DLNROTF
Actual: DLNROT
Forecast sample: 1980 2016
Adjusted sample: 1982 2016
Included observations: 35

Root Mean Squared Error	0.150783
Mean Absolute Error	0.110742
Mean Abs. Percent Error	400.2721
Theil Inequality Coefficient	0.714576
Bias Proportion	0.000000
Variance Proportion	0.793771
Covariance Proportion	0.206229

Figure 2: *Ex post* **Prediction (Model Validation)**

Given the current production environment, the projected national paddy-rice output from 2017-2025 was presented in Figure 3 and showed that the national paddy-rice output is expected to reach 7.4 million tonnes or 4.9 million tonnes in milled-equivalent by 2020. This is short of 6 million tonnes of milled-rice target set by the Federal Government of Nigeria. This implies that given the current production efforts, only 4.9 million tonnes of milled-rice or 7.4 million tonnes of paddy equivalent could be realized in 2020 as against government target of 6 million tonnes of milled-rice or about 10 million tonnes of paddy-rice. This would create a demand –supply gap of about of 1.1 million tonnes (18%) of target output. However, Figure 3 also showed that, given the predictive error of less than 15% by the model, the much needed self-sufficiency level of rice production of 6million tonnes of milled rice is only attainable by the year 2025 if the current production environment is sustained. This also means that until 2025 when the country is expected to be self-sufficient in rice production, effort should gear towards finding option of bridging demand –supply gap in the rice sector.

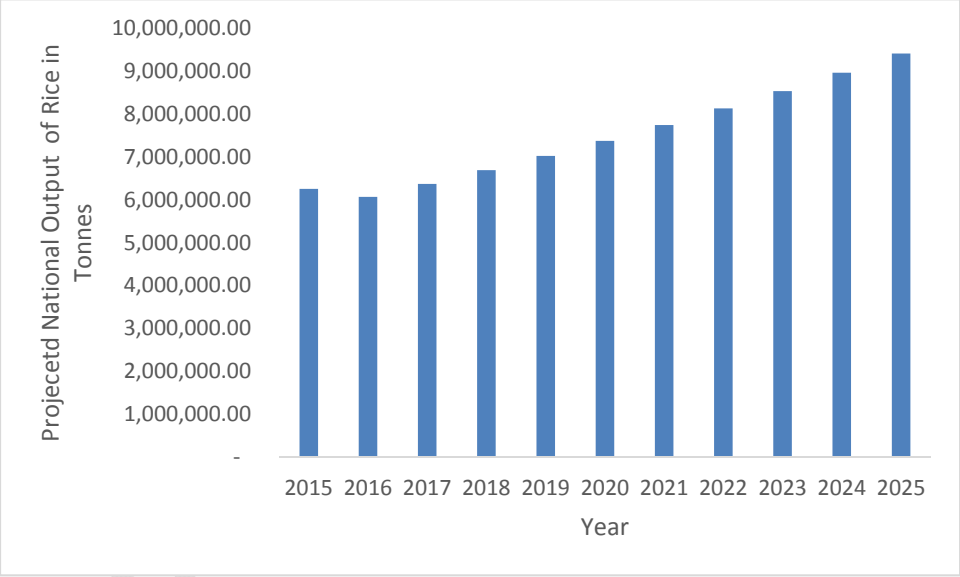


Figure 3: Projected National Output of Paddy-Rice from 2017-2025

Conclusion and Recommendations

On the average, national rice output maintain a steady increase of 69 % per decade from 1980 to 2016, with the peak of 93% increase was recorded within 2000- 2009. Given the current production trend, the national paddy-rice output was projected to reach 7.4 million tonnes or equivalent of 4.9 million tonnes of milled-rice by 2020. This is short of 6 million tonnes of milled-rice target set (by the Federal Government of Nigeria) by 1.1 million tonnes (18 %) of the target output. It was projected that the self-sufficiency level of 6 million tonnes of milled rice (about 10 million tonnes of paddy-rice) could only be attainable by the year 2025, if the current production efforts are sustained. It is therefore recommended that until 2025 when the country was projected to attain self-sufficiency in rice production, effort should be geared towards bridging demand –supply gap by ensuring strict implementation of quota policy of rice import. This would eliminate price increase associated with disequilibrium in demand –supply of rice commodity in the market

REFERENCES

1. Wudil, A.H., Katanga, Y.N and Nasiru, A. Econometric Analysis of the Effect of Rice Production and Importation on Domestic Consumption in Nigeria (1999-2013). Journal of Direct Research, Federal University Dutse, Jigawa. 2015:3 (12): 217-222.

2. Onu, D.O., Obike, K.C., Ebe, F.E. and Okpara, B.O. (2015). Empirical assessment of the trend in rice production and imports in Nigeria (1980-2013*).* International Journal of Agricultural Science and Soil Science. 2015: 5(6):150-158.

3. Food and agricultural organization: World trade report. 2018: Accessed on January 19th. Available on http://www.faostat.org.

4. United States Department for Agriculture Foreign Agricultural Services (USDA FAS), (2018). Database of production, supply and distribution. 2018. Accessed on 20th January. Available on http://www.fas.usda.gov/psdonline

5. Food and agricultural organization: World trade report. 2017: Accessed on January 19th. Available on http://www.faostat.org

6. Tijani, A.A. Analysis of the technical efficiency of rice farms in Ijesha Land of Osun State, Nigeria. Ife Journal of Agriculture. 2006: 45, (2)

7. United States Department for Agriculture Foreign Agricultural Services (USDA FAS), (2016). Database of production, supply and distribution. 2016. Accessed on 20th January. Available on http://www.fas.usda.gov/psdonline

8. Gujarati, D.N. and Porter, C. D. *Basic Econometrics* (5th Edition). McGraw-Hill, New. 2009