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Forecasting Future Output Trends of Selected Food Grains in Nigeria Using an Autoregressive Integrated Moving Average Model

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Abstract

The study analysed the impacts of price fluctuation on the production of selected food grains in Nigeria, with a focus on forecasting future output trends of rice, maize and wheat using the Autoregressive Integrated Moving Average (ARIMA) model. The study covered the period 1981 to 2023, while projections extended from 2024 to 2054. Secondary data were sourced from the National Bureau of Statistics (NBS) and the Food and Agriculture Organisation Statistical Database (FAOSTAT). These sources provided reliable long-term time series data on production and price-related variables for the selected food grains in Nigeria. The results from the ARIMA-based forecasts revealed an overall increase in the production of all three food grains between 2024 and 2054. Rice production is projected to rise from 9,098,425.69 tonnes to 14,637,910.23 tonnes, an increase of 5,539,484.54 tonnes (60.88%). Maize production is projected to increase from 11,686,665.38 tonnes to 16,957,635.60 tonnes, representing 5,270,970.22 tonnes (45.10%). Wheat production is projected to increase from 50,184.67 tonnes to 70,382.78 tonnes, representing 20,198.11 tonnes (40.25%). Thus, rice records the highest projected percentage increase, followed by maize and wheat. The study concluded that while rice and maize production are expected to experience stronger and more sustained growth over the forecast period, wheat production will remain structurally weak and insufficient to meet national demand. Though general food grain output is projected to rise, the growth rate is inadequate to ensure self-sufficiency in all selected cereals without targeted interventions. The study therefore recommends that government planning agencies and agricultural stakeholders utilise these forecast results to strengthen long-term food security strategies, stabilise agricultural prices and enhance productivity in order to coincide domestic production with Nigeria's growing population and consumption needs.

Keywords: Price fluctuation, food security, rice production, maize production, wheat production, ARIMA modelling, Nigeria.

1. Introduction

Agriculture remains a dynamic sector of the Nigerian economy, serving as a major source of food, employment, income, and raw materials for industries. Despite the growing importance of the petroleum sector, agriculture continues to play a vital role in ensuring food security and supporting the livelihoods of millions of Nigerians. Within the agricultural sector, food grains such as rice, maize, and wheat are staple foods and contribute meaningfully to national food consumption requirements. Nigeria's population, estimated at over 220 million people, has deepened demand for these food grains, making their sustainable production a strategic national priority (FAO, 2023). Agricultural production in Nigeria has historically been influenced by economic factors, among

which price fluctuations remain particularly important. Price fluctuations refer to persistent changes in the prices of agricultural commodities and production inputs over time. These fluctuations create uncertainty in production decisions and directly affect farmers' profitability, investment capacity, resource allocation, and output levels. According to production theory, farmers respond to market price signals by adjusting the quantity of inputs used and the scale of production. Thus, favorable output prices often stimulate increased production, while unstable or declining prices may discourage investment and reduce output growth (Tomek and Kaiser, 2014). Between 1981 and 2023, Nigeria's agricultural sector experienced price instability resulting from structural adjustment policies, exchange rate fluctuations, inflationary pressures, subsidy reforms, trade liberalization, climatic shocks, insecurity, and global commodity market disturbances. These developments affected both the output prices received by producers and the input prices paid for seeds, fertilizers, agrochemicals, labor, machinery, transportation, and energy. Rising production costs have increasingly become a major problem confronting food grain producers across the country. As production costs rise without corresponding increases in commodity prices, farmers have reduced cultivated areas, lowered input use, and, in many instances, abandoned production altogether, thereby affecting overall food grain output.

An analysis of historical production trends for rice, maize, and wheat revealed substantial changes in Nigeria's food grain subsector over the study period (1981–2023). Rice production showed an overall upward trend despite periodic fluctuations. The United Nations Department of Economic and Social Affairs (2022) reported that rice output rose from relatively low levels in the early 1980s to about 4.47 million tonnes in 2010 and further to about 8.26 million tonnes in 2020. This growth has been linked to government interventions, including import restrictions, the Anchor Borrowers' Programme, agricultural credit schemes, and private-sector investments in rice value chains (Modibo, 2021). Nevertheless, periods of rising input prices and market instability have occasionally constrained production expansion. Maize production also grew markedly from 1981 to 2023. Rising demand for maize as human food, livestock feed, and an industrial raw material has driven sustained expansion. Historical trends indicate that maize output increased consistently over the decades, supported by the adoption of improved varieties, the expansion of cultivated areas, and the increasing commercialization of agriculture. However, fluctuations in fertilizer prices, transportation costs, and inflation have periodically affected productivity and profitability among maize farmers. The FAO (2017) estimated that global demand for maize will increase substantially due to population growth, urbanization, and rising incomes, suggesting that a sustained increase in domestic production will be necessary to meet future demand. Wheat production in Nigeria has historically remained relatively low compared to rice and maize, owing to ecological limitations and heavy dependence on imports. Historical records show that wheat output increased gradually from nearly 26,000 tonnes in the early 1980s to over 61,800 tonnes by 2020 (FAO, 2023). Although production growth has been modest, increasing domestic demand for wheat-based products such as bread, pasta, and confectionery has stimulated renewed interest in indigenous wheat cultivation. Beillard and Nzeka (2019) attributed growth in wheat demand and production, in part, to population expansion and changing dietary preferences among Nigerian consumers. However, rising production costs and market uncertainties continue to pose significant challenges to domestic wheat production.

Historical trends indicate that the production of rice, maize, and wheat has generally increased over time, despite recurrent fluctuations linked to changing economic conditions. Key drivers of these fluctuations include variations in commodity prices and production costs. Understanding how these price dynamics influence food grain production is therefore important for developing effective agricultural policies and ensuring long-term food security. Given the strategic importance of food grains to Nigeria's economy and food system, reliable forecasts of future output trends have become increasingly necessary. Forecasting enables policymakers, researchers, and investors to

anticipate future production levels and design appropriate interventions. Time-series forecasting models, particularly the Autoregressive Integrated Moving Average (ARIMA) model established by Box et al. (2016), have been widely recognized for their effectiveness in predicting future values based on historical observations. This study employs ARIMA modeling techniques to analyze historical output patterns and forecast future output trends for rice, maize, and wheat in Nigeria from 2024 to 2054.

Objectives of the Study

The broad objective of this study was to forecast the future production trends of selected food grains (rice, maize and wheat) in Nigeria from 2024 to 2054 using the Autoregressive Integrated Moving Average (ARIMA) modelling approach. The specific objectives were to:

1. Assess the historical production trends of rice, maize and wheat in Nigeria;
2. Estimate suitable Autoregressive Integrated Moving Average (ARIMA) models for forecasting the production of rice, maize and wheat in Nigeria;
3. Project the future production levels of rice, maize and wheat in Nigeria for the period from 2024 to 2054.

2. Materials and Methods

A longitudinal trend research design was adopted for this study to analyze the dynamic relationship between price fluctuations and the production of selected food grains in Nigeria. Nigeria is located between latitudes 4°N and 14°N and longitudes 3°E and 15°E, with diverse agro-ecological zones that support the cultivation of rice, maize, and wheat across different regions of the country (FGN, 2012). According to O'Neill (2021), the country's population was estimated at over 211 million people in 2021. This population continues to exert increasing pressure on food demand and agricultural output, making it a highly relevant setting for analyzing price-driven production behavior in food grain markets. Its exposure to global commodity price shocks, input cost volatility, and policy reforms further strengthens its suitability for analyzing the impacts of price fluctuations on agricultural production outcomes. The study sourced data from the National Bureau of Statistics (NBS), the Food and Agriculture Organization Statistical Database (FAOSTAT), and relevant annual reports and publications. These sources were selected for their reliability, consistency, and broad temporal coverage of agricultural production and price-related variables. The dataset covered annual time-series records on rice, maize, and wheat production, as well as their corresponding price indicators, inflation rates, and exchange rate movements in Nigeria from 1981 to 2023.

The study's analytical framework is anchored in the Autoregressive Integrated Moving Average (ARIMA) modeling technique and is complemented by econometric and time-series diagnostic procedures. Prior to model estimation, the Augmented Dickey-Fuller (ADF) test was used to assess the stationarity of the variables and avoid spurious regression results. The ADF specification assumes a trend-stationary process that includes both a constant and a deterministic trend, consistent with established econometric practice in time-series analysis (Oyinbo and Rekwot, 2013). The estimated ARIMA models obtained under Objective 2 were used to generate out-of-sample forecasts of rice, maize, and wheat production for the period 2024–2054. The forecast results provided projections of future production trends and served as a basis for assessing the likely trajectory of food grain output in Nigeria over the forecast horizon. Thus, the study utilized both the semi-logarithmic growth model and the ARIMA model, but for different purposes. The semi-log growth model was employed to assess historical production trends (Objective 1), whereas the ARIMA model was employed to estimate forecasting equations and generate future production projections (Objectives 2 and 3). The ADF specification is expressed as follows:

$$\Delta Y_t = \alpha_0 + \alpha_1 t + \beta Y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta Y_{t-i} + \varepsilon_1 \quad (1)$$

Where:

Y_t denote value of the variable under consideration (prices of rice, maize, or wheat);
α_0 denote constant term;
α_1 denote coefficient of the deterministic time trend;
p denote lag order of the autoregressive process;
Y_{t-i} denote the first lag (one-period lag) of the variable Y_{t-i};
δ_i denote coefficients of the lagged first-difference terms;
ε_1 denote the stochastic error term assumed to be independently and identically distributed with zero mean and constant variance

To analyze the short-run and long-run relationships between price fluctuations and food grain production, the Autoregressive Distributed Lag (ARDL) model was employed. The general ARDL specification was expressed as:

$$\ln Y_t = \alpha_0 + \sum_{t-1}^{p} \alpha_i \ln Y_{t-I} + \sum_{j=0}^{q} \beta_j \ln Prfl_{t-j} + \sum_{k=0}^{r} Yk_1 \ln Inf_{t-k} + \sum_{l=0}^{r} \theta_1 \ln FExr_{t-l} + \mu_t \quad (2)$$

i. For maize production:

$$\ln My_t = \alpha_0 + \sum_{t-1}^{p} \alpha_i \ln My_{t-I} + \sum_{j=0}^{q} \beta_j \ln Mprfl_{t-j} + \sum_{k=0}^{r} \Upsilon k_1 \ln Inf_{t-k} + \sum_{l=0}^{r} \theta_1 \ln FExr_{t-l} + \mu_t \quad (3)$$

ii. For rice production:

$$\ln Ry_t = \alpha_0 + \sum_{t-1}^{p} \alpha_i \ln Ry_{t-I} + \sum_{j=0}^{q} \beta_j \ln Rprfl_{t-j} + \sum_{k=0}^{r} \Upsilon k_1 \ln Inf_{t-k} + \sum_{l=0}^{r} \theta_1 \ln FExr_{t-l} + \mu_t \quad (4)$$

iii. For wheat production:

$$\ln Wy_t = \alpha_0 + \sum_{t-1}^{p} \alpha_i \ln Wy_{t-I} + \sum_{j=0}^{q} \beta_j \ln Wprfl_{t-j} + \sum_{k=0}^{r} \Upsilon k_1 \ln Inf_{t-k} + \sum_{l=0}^{r} \theta_1 \ln FExr_{t-l} + \mu_t \quad (5)$$

Where:
My_t, denotes maize production;
Ry_t, denotes rice production;
Wy_t, denote wheat production;
$Mprfl_t$, denote maize price fluctuation;
$Rprfl_t$, denote rice price fluctuation;
$Wprfl_t$, denote wheat price fluctuation;
Inf_t, denote inflation rate;
$FExr_t$, denote foreign exchange rate;
α_0, denote the constant;
α_i, βj, Yk, θ_l, denote parameters to be estimated;
p, q, r and s, denote optimal lag lengths;
μ_t, denote random error term.

The Error Correction Representation of the ARDL model was subsequently estimated to capture the short-run dynamics and the speed of adjustment towards the long-run equilibrium relationship between price fluctuations and food grain production. This approach enables the simultaneous estimation of both short-run and long-run effects within a unified modelling framework.

Also, a growth modelling approach based on the Gordon Growth framework was employed to assess production trends and growth dynamics of the selected food grains as specified:

$$\ln Yt = \alpha + \beta Myt + \mu t \quad (6)$$

$$\ln Yt = \alpha + \beta Ryt + \mu t \quad (7)$$

$$\ln Yt = \alpha + \beta Wyt + \mu t \quad (8)$$

$$\ln Yt = \alpha + \beta Mpt + \mu t \quad (9)$$

$$\ln Yt = \alpha + \beta Rpt + \mu t \quad (10)$$

$$\ln Yt = \alpha + \beta Wpt + \mu t \quad (11)$$

Where:

α denotes the constant;

β denotes the vector of the trend variable μ in the econometric error term;

βMy, βRy, βWy, βMp, βRp, βWp, denote coefficients of the trend variables for rice, maize and wheat production and prices, respectively;

t denotes the time trend variable.

Growth in food grain production was analysed using a semi-logarithmic (log-linear) trend model of the form:

$$\ln Yt = \alpha + \beta t + \varepsilon_t \quad (12)$$

Where:

Yt denote quantity of food grain production in year (t);

ln denote natural logarithm;

t denote time trend variable (1, 2, 3, ..., n);

α denote intercept term;

βt denote slope coefficient of the time trend variable; and

ε_t denote stochastic error term.

The parameter β used in the computation of growth rates was obtained from the estimated semi-logarithmic trend equation above. Specifically, β was the least-squares estimate of the coefficient of the time trend variable t, representing the average proportional change in food grain production over time. This specification allows for the estimation of both instantaneous and compound growth rates, thereby providing a clear understanding of the direction and magnitude of changes in food grain production over the study period. The Instantaneous Growth Rate (IGR) measures the percentage rate of change in food grain production at a particular point in time. It indicates the immediate growth response associated with a one-unit increase in time and was computed as:

Multiplying b by 100 gave the instantaneous growth rate (IGR) at a point in time.

$$IGR = \beta \times 100 \quad (13)$$

Where:

IGR denote Instantaneous Growth Rate (%);

B denote estimated coefficient of the time trend variable obtained from the fitted semi-logarithmic growth model.

The Compound Growth Rate (CGR) measures the average annual percentage growth rate over the study period while accounting for the cumulative and compounding effects of growth. It was estimated as:

$$CGR = (e\beta i - 1) * 100 \quad (14)$$

Where:

CGR denote Compound Growth Rate (%);

e denote the base of the natural logarithm (approximately 2.71828);

β denote estimated coefficient of the time trend variable from the respective growth equation.

The estimated growth coefficient β was used to determine the nature of the growth process. A positive and statistically significant value of β specifies accelerating growth in production over time, while a negative and statistically significant value specifies declining production. On the other hand, a statistically insignificant value of β suggests stagnation in the growth process, implying that production has not changed significantly over the study period. The model enable the identification of whether production trends exhibit acceleration, deceleration or stagnation based on the sign and significance of the estimated coefficients, consistent with the approach adopted in agricultural growth studies (Ndubusi *et al*., 2021; U.S. Department of Agriculture, Foreign Agricultural Service, 2019).

Furthermore, the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model was utilized to capture the volatility and fluctuation patterns in food grain prices. This is particularly important given the presence of time-varying variance in agricultural price series, where shocks in one period may influence volatility in subsequent periods. The GARCH specification is appropriate for modelling such heteroskedastic behaviour and provides a robust framework for understanding price instability and its potential effects on production decisions

$$Y_t = \alpha + \Sigma_{i=1}^{k} \eta_i X_{it} - \varepsilon_t \quad (15)$$

Where:

Y_t denote food grain price at time (t);
α denote intercept term;
η_i denote parameter associated with the i^{th} explanatory variable;
X_{it} denote i^{th} explanatory variable at time t;
ε_t denote error term.
For a complete GARCH (1,1) model, the variance equation should also be specified as:
$\varepsilon_t \sim N(0, h_t)$

$$h_t = w + \alpha_1 \Sigma_{t-1}^2 + \beta_1 h_{t-1} \quad (16)$$

Where:

h_t denote conditional variance at time (t);
w denote costant term;
α_1 denote ARCH parameter measuring the impact of past shocks;
Σ_{t-1}^2 denote lagged squared error term (news about volatility from the previous period);
β_1 denote GARCH parameter measuring the persistence of past volatility;
h_{t-1} denote previous period's conditional variance.
X_{it} denote variables.
This formulation is the standard presentation of a GARCH model in agricultural economics and price volatility studies.

$$\delta^2 = \sqrt{\frac{1}{N}} \Sigma_{i=1}^{N} (X_i - \bar{X})^2 \quad (17)$$

Where:

δ^2 denote variance of the observations;
δ denote standard deviation;
$\bar{X}$ denote arithmetic mean (scalar quantity, not a vector) of the observations;
X_i denote the ith observations;
N denote total number of observations.

For the study on food grain price volatility, the mean equation using one lag of each variable is as follows:

$$\Upsilon_t = \alpha + \eta 1\text{Rpt-1} + \eta 2\text{Mpt-1} + \eta 3\text{Wpt-1} + \varepsilon_t \quad (18)$$

Where:

Υ_t = food grain price at time (t);
α = constant term (intercept);
Rpt-1 = retail price lagged by one period;
$\eta 1$ = coefficient associated with the lagged retail price;
Mpt-1 = market price lagged by one period;
$\eta 2$ = coefficient associated with the lagged market price;
Wpt-1 = wholesale price lagged by one period;
$\eta 3$ = coefficient associated with the lagged wholesale price;
ε_t = random error term at time (t).

While, the GARCH (1,1) variance equation is as follows:

$$h_t = \text{w} + \alpha 1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} \quad (19)$$

Where:

h_t = the conditional variance of food grain prices at time (t);
w = constant variance parameter;
$\alpha 1$ = the ARCH coefficient measuring the impact of past price shocks on current volatility;
ε_{t-1}^2 = lagged squared error term (previous period's shock);
β_1 = GARCH coefficient measuring the persistence of volatility over time;
h_{t-1} = lagged conditional variance.
Measurement of Variables
1. Inflation rate: Inflation rate was measured in percentage (%) value.
2. Output: Selected food grains output was measured in tonnes.
3. Price fluctuation: Price fluctuation is measured in naira (N).
4. Prices: Selected crop prices were measured in Naira/tonnes as the producer prices of the food grains.

3. Results and Discussion

The result of 30 years' Autoregressive Integrated Moving Average (ARIMA) forecast of the trends of output of rice, maize and wheat in Nigeria is shown in Appendix 1 with the trends in figures 1, 2 and 3. The forecast of trends of output of rice, maize and wheat in Nigeria were presented as follows:

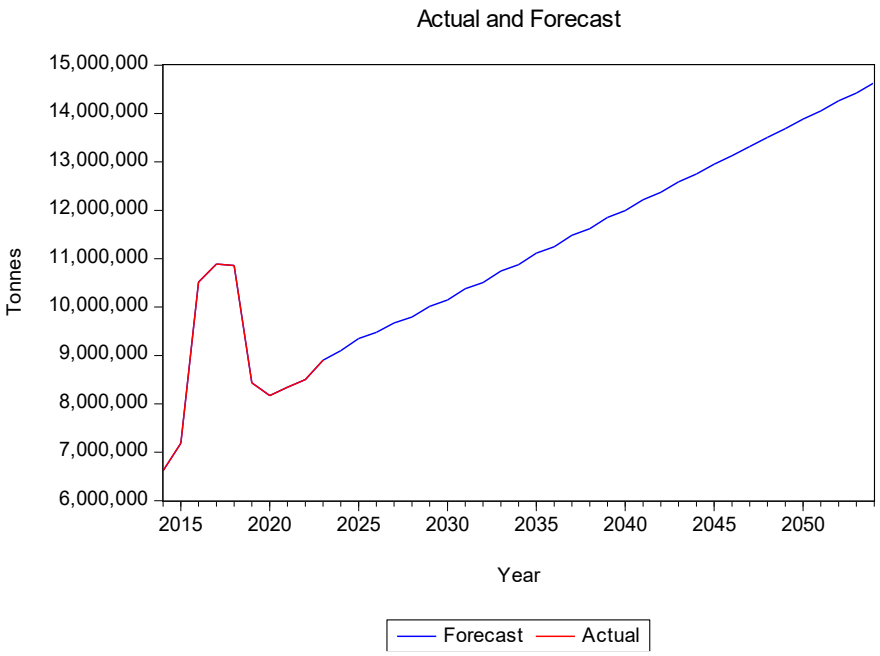


Figure 1: Trend of the output of rice (2024 – 2054). Source: Data analysis (2025).

Forecast of the trend of production of rice in Nigeria: The forecast results presented in Figure 1 and Appendix 1 indicate a sustained upward trend in rice production in Nigeria over the 30-year forecast period (2024–2054). Rice output is projected to increase from 9,098,425.69 tonnes in 2024 to 14,637,910.23 tonnes in 2054, representing an overall increase of approximately 5,539,484.54 tonnes. This trend reflects a gradual but consistent expansion in rice production and suggests an improving capacity of the sector to meet growing domestic demand.

The forecast further shows that rice production is expected to rise steadily throughout the period, reaching 10,145,232.76 tonnes in 2030, 11,995,191.05 tonnes in 2040 and 13,884,965.39 tonnes in 2050, before attaining 14,637,910.23 tonnes in 2054 (Appendix 1). The absence of major declines in the projected series indicates a stable growth pattern, which may be attributable to continued improvements in agricultural productivity, expansion of cultivated land, adoption of improved rice varieties, increased mechanization and supportive government interventions aimed at strengthening food security and reducing dependence on imports.

The projected increase in output suggests that Nigeria's rice sector has considerable potential for long-term growth if existing production-enhancing factors are sustained. Nevertheless, these projections are conditional on the assumption that the socio-economic, technological and environmental factors influencing rice production remain relatively stable throughout the forecast horizon. Factors such as rising costs of fertilizers, improved seeds, agrochemicals, energy, labour and transportation may increase production costs and constrain farmers' ability to expand output. In such circumstances, actual production levels may fall below the projected values. Conversely, improved access to production inputs, favourable agricultural policies, enhanced extension services, increased investment in irrigation infrastructure and sustained government support could stimulate production beyond the forecast estimates.

The projected growth pattern is consistent with the assertion of the President of the Rice Farmers Association of Nigeria (RIFAN), who stated during the Kaduna Declaration that Nigeria's rice production increased from 2 million metric tonnes in 2015 to 9 million metric tonnes in 2021, reflecting the significant progress made in domestic rice production and the country's potential to

become a net rice exporter (Modibo, 2021). Thus, the forecasted increase in rice output reinforces expectations of continued growth and development in Nigeria's rice subsector over the coming decades.

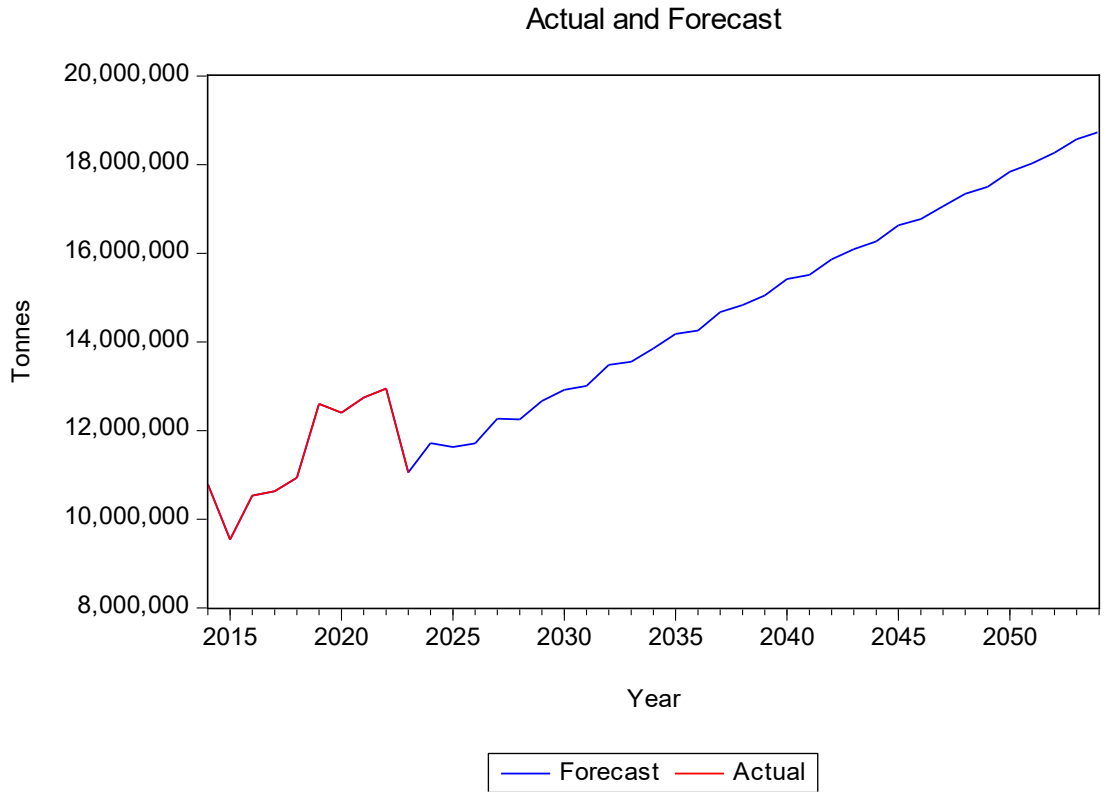


Figure 2: Trend of the output of maize (2024 – 2054). Source: Data analysis (2025).

Forecast of the trend of maize production in Nigeria: The forecast results presented in Figure 2 and Appendix 1 indicate a sustained increase in maize production in Nigeria over the period 2024–2054. Maize output is projected to rise from 11,686,665.38 tonnes in 2024 to 16,957,635.60 tonnes in 2054, representing an overall increase of approximately 5,270,970.22 tonnes. The trend depicted in Figure 2 shows a gradual and consistent upward movement in maize production throughout the forecast horizon, suggesting continued growth in the country's maize subsector.

The forecast further reveals that maize production is expected to increase from 12,409,956.35 tonnes in 2030 to 14,299,309.66 tonnes in 2040 and 16,197,457.55 tonnes in 2050, before reaching 16,957,635.60 tonnes in 2054 (Appendix 1). This steady progression suggests that maize production will continue to expand over time, driven by growing demand for food, livestock feed, and industrial raw materials. The increasing trend also reflects the strategic importance of maize in Nigeria's agricultural economy and food security framework.

The projected growth in maize output implies that the sector has the potential to meet the increasing consumption requirements of a rapidly growing population. However, the realization of these projections depends largely on the stability of factors influencing maize production, including access to improved seeds, fertilizers, mechanization, irrigation facilities, extension services, and favourable government policies. Rising production costs associated with agricultural inputs, labour, transportation, and energy may adversely affect farmers' productivity and limit the attainment of

the projected output levels. On the other hand, enhanced investment in agricultural research, climate-smart technologies, and supportive policy interventions could further boost maize production beyond the forecast estimates.

The findings are consistent with the projections of the FAO (2017), which reported that the production and demand for maize products are expected to increase substantially in response to population growth, urbanization, and rising income levels. The projected expansion in maize output therefore underscores the need for sustainable intensification of production systems to ensure that increasing demand is met while conserving natural resources. Consequently, producing more maize with fewer inputs, while simultaneously improving the livelihoods of smallholder and family farmers, remains a critical challenge and priority for the future development of Nigeria's maize subsector.

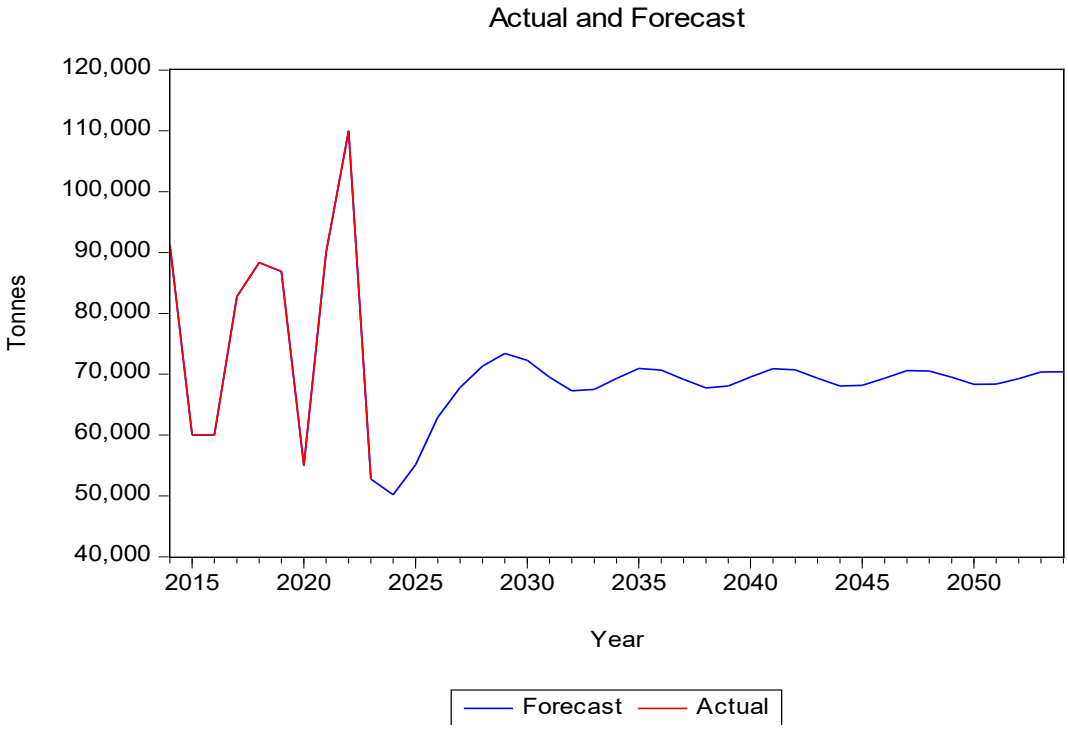


Figure 3: Trend of the output of wheat (2024 – 2054). Source: Data analysis (2025).

Forecast of the trend of production of wheat in Nigeria: The forecast presented in Figure 3 and Appendix 1 reveals an overall upward trajectory in wheat output, increasing from 50,184.67 tonnes in 2024 to 70,382.78 tonnes in 2054. Despite intermittent variations, the trend suggests a modest but sustained expansion in wheat production over the 30-year forecast horizon. This corroborates previous studies that reported a generally positive trend in Nigeria's wheat production, albeit with periodic variations attributable to climatic and policy-related factors (Auwal et al., 2026. The FAO (2017) further reiterated that, since 1990s the average annual increases in the yields of maize, rice and wheat at the global level have been slightly more than 1%, much lower than in the 1960s.

4.0 Conclusion

The study concludes that rice, maize and wheat production in Nigeria are projected to increase over the 2024–2054 forecast period. Rice records the highest projected growth, followed by maize and wheat. However, the projected increases are conditional on prevailing production trends and may be affected by changes in input costs, technology, climate and agricultural policies. Sustained

investment in agricultural productivity and supportive policies is therefore essential for realizing the projected growth in food-grain production.

Recommendations from the Study

1. Stakeholders in the agricultural sector, including government policymakers, Federal Ministry of Agriculture and Food Security as well as state agricultural development programmes should strengthen policies that stabilize input and output prices to reduce production uncertainty and encourage sustained investment in rice, maize and wheat production.

2. Agricultural research institutes, extension agencies and universities should intensify the development and dissemination of improved crop varieties and modern farming technologies that enhance yield as well as reduce production costs for farmers.

3. Financial institutions and agricultural credit schemes should expand access to affordable credit facilities for farmers to enable them to purchase quality inputs (fertilizers, improved seeds and machinery) on time.

4. The private sector and agribusiness value chains should invest more in storage facilities, processing industries and efficient market systems to reduce post-harvest losses and improve farmers' income stability.

5. Farmers' associations and cooperatives should encourage collective farming, bulk input purchasing and better market coordination to reduce production costs and improve productivity.

6. Government planning agencies should use the forecast results from this study to guide long-term food security planning and ensure that production growth coincides with Nigeria's rising population and consumption needs.

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Conflicts of Interest: *The authors declare no conflicts of interest.*

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Appendix

Thirty-year forecast of outputs of rice, maize and wheat in Nigeria

Year	Rice (tonnes)	Maize (tonnes)	Wheat (tonnes)
2024	9098425.692	11686665.38	50184.67
2025	9351837.698	11792094.44	55100.71
2026	9476870.622	11842983.82	62950.83
2027	9670258.846	11849243.19	67826.75
2028	9795019.379	12022436.46	71346.72
2029	10012598.07	12250822.2	73421.70
2030	10145232.76	12409956.35	72285.43
2031	10377394.64	12589818.53	69494.36
2032	10508517.83	12796231.64	67283.28
2033	10745421.51	12979116.56	67503.23
2034	10875141.25	13158339.72	69316.54
2035	11113905.05	13349776.26	70960.86
2036	11245817.86	13541272.52	70690.22
2037	11483046.13	13730116.47	69132.91
2038	11619606.12	13918561.48	67727.55
2039	11851466.59	14108549.01	68052.94
2040	11995191.05	14299309.66	69542.63
2041	12218872.96	14487993.47	70920.29
2042	12372215.97	14677106.63	70697.81
2043	12585622.96	14867991.39	69357.79
2044	12750241.01	15057785.38	68042.14
2045	12951950.37	15247134.7	68169.19
2046	13128671.01	15437484.71	69353.05
2047	13318194.86	15627550.65	70587.46
2048	13507047.63	15817280.62	70532.23
2049	13684815.25	16007379.61	69490.15
2050	13884965.39	16197457.55	68342.69
2051	14052202.75	16387449.51	68349.01
2052	14262024.19	16577516.1	69273.77
2053	14420659.11	16767557.68	70345.42
2054	14637910.23	16957635.6	70382.78

Source: Data analysis (2025).