



EFFECTS OF CEREAL OUTPUTS ON MICROECONOMIC HEALTH INDICATORS IN NIGERIA

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ABSTRACT

Study examined the effects of cereal outputs on Macroeconomic Health Indicators in Nigeria between the periods of 1980 to 2022. Time series data obtained from the database of World Bank (WB, 2022), Central Bank of Nigeria (CBN, 2022) for a time period of forty two (42) years was used in the study. The data collected were described using descriptive statistics and analyzed using Autoregressive Distributed Lag (ARDL), Augmented Dickey Fuller Test (ADF), Unit Root Test and Bounds Co-integration. The Descriptive statistics showed that all the variables employed were normally distributed. The unit root test result using Augmented Dickey-Fuller (ADF) shows that exchange rate, GDP, Inflation, Maize output, millet output, rice output, sorghum output and wheat output were stationary at level whilst only interest rate was stationary at first difference. The Autoregressive Distribution Lag (ARDL) bound test was used to separate long and short run dynamics. Calculated F-statistics for all the models were all higher than the upper critical bound for (5%) and (10%) critical values. Based on the standard deviation (S.D) of the variables, rice output had the highest standard deviation of (109936.1), whereas interest rate has the lowest standard deviation of (3.476016). Rice output had the highest kurtosis of (37.64146) indicating that the distribution were peaked. The autoregressive distributive lag (ARDL) result showed that cereal output and Macroeconomic Health Indicators had significant effect on Economic Growth in both short and long-run at (5% level of significance. R^2 was 0.998; indicating that cereal output explained 99.8 percent of the variation in interest rate. The study, therefore recommend that farmers should be encouraged to increase their level of cereal outputs as it helps to strengthen macroeconomic health indicators.

Keywords: Effects, Cereals, Outputs, Microeconomic Health, Indicators

INTRODUCTION

Cereals are always preferred to other crops and it is fast becoming an industrial crop in SubSaharan African countries (Kolawole 2018). Nigeria has been divided into low, medium and high cereal production potential groups. Traditionally cereal crops were mostly grown in the forest ecology in Nigeria but large scale production has moved to the savannah zone



especially the northern and southern part of the country, where yield potential is much higher (Fakorede 2021).

Cereals are astonishing crop with an astonishing capacity to surprise human for instance one speed planted can produce over 500 kg/s in returns (Abiodun T.F 2020). It is a crop that utilizes sunlight effectively and outstrips yield of other grains. Indeed cereals which are fast becoming an industrial sort after thereby making it the first crop to be harvested for food during hunger period and also it help to enhance economic growth. Balaguer-Cou (2021). Cereals are one of the most important crops of significant economic importance in African countries that cannot be replaced, sorghum and millet it is a staple food crop growth in diverse environment and consumed by people with varying food preference and socioeconomic background in Africa. Other reasons and expansion of cereal crop output for economic growth include the fact, that, it gives one of the highest yields per man-hour of labour spent on it (Onu, 2020)

Importance of cereal crop cannot be over-emphasized in the developing countries or world including the potential to mitigate the present food insecurity and alleviate poverty thereby leading to economic growth and development. Cereals are preferred staple food for over 900 million poor consumers, 120-140 million poor farm families and about one third of malnourished children (International Institute of Tropical Agriculture, 2021). In Sub-Saharan Africa, the absence or shortage of cereal crops invariably leads to famine and starvation. It is estimated that by year 2025, cereals would have become the crop with the greatest production in developing countries will double due to the fact maize. Rice, wheat and sorghums are highly responsive to production inputs its food and industrial uses and values are many and its production potentials can hardly be matched by any of the other major cereals. It is therefore definitely a solution to hunger and economic growth which can help to salvage famine population (International Institute of Tropical Agriculture, 2021).



Agriculture is the economic mainstay of the majority of households in Nigeria and is a significant sector in the Nigeria economy. The important benefits of the agriculture sector to the Nigeria's economy include; the provision of food, contribution to the gross domestic product, provision of employment, provision of raw materials for agro-allied industries, and generation of foreign earnings labour agricultural exports were the main source of foreign exchange earnings (Udoh, 2020). Agriculture, in the 1960s, was both the mainstay of the Nigerian economy and the chief foreign exchange earner (Ekine, 2018); and accounted for well over 80 percent of the export earnings and employment; about 65 percent of the GDP and about 50 percent of the government revenue (Federal Government of Nigeria, 2019). As noted by the Vision 20: 2020, National Technical Working Group (NTWG) on agriculture and food security, agriculture has always played a key role in the nation's economy, currently contributing about 42% of Gross Domestic Product (GDP) as against 13% for Oil & Gas; and employing two thirds of the entire labour force, but, over the past 20 years, value added per capita in agriculture has risen by less than one (1) percent annually (NTWG, 2019).

The agricultural sector comprises crop production, fishery, livestock and forestry. Crop production is the dominant activity accounting for 87.6%, relative to livestock (8.1%), fishery (3.2%) and forestry (1.1%) (National Bureau of Statistics, 2020). According to National Agricultural Extension Research and Liaison Services [NEARLS] (1996), the major cereal crops in Nigeria are rice, maize, sorghum, wheat, pearl, millet, sugar cane and fonio millet with rice ranking as the sixth major crop in terms of the land area while sorghum account for 50% of the total cereal production and occupies about 45% of the total land area devoted to cereal production in Nigeria. Cereals are a major contributor to agriculture and food security in Nigeria; consist of between 55 - 60% of subsistent farmers output, and provide incomes as well as form the basis of many a households' diets both in the rural and urban areas (Balami *et al.*, 2017).



Today, cereal grains are the single most important source of calories to a majority of the world population. Developing countries depend more on cereal grains for their nutritional needs than the developed world. Close to 60% of calories in developing countries are derived directly from cereals, with values exceeding 80% in the poorest countries (Isahet *et al.*, 2015). The three most important food crops in the world are rice, wheat, and maize (corn). The three cereal grains directly contribute more than half of all calories consumed by human beings. In addition, other minor grains like sorghum and millet are particularly major contributors of overall calorie intake in certain regions of the world, particularly semi-arid parts of Africa. A large part of cereal grain production (particularly corn, barley, sorghum, and oats) also go into livestock feed, thus indirectly contributing to human nutrition (FAO, 2014).

The extraordinary growth in cereal crop productivity, aptly termed the Green Revolution, according to (Gregory, 2019), resulted from an increase in land productivity and occurred in areas of growing land scarcity and/or areas with high land values. It was always associated with strong market infrastructure and supportive government policies

However, in the recent past, indicators show a decrease in the growth rate of productivity of cereal crops, especially in the intensively cultivated lands. This reduction in productivity growth, according to (Gregory, 2019) can be attributed to degradation of the land resource base due to intensive cultivation, declining infrastructure and research investment; and the increasing opportunity cost of labor.

Prabhu and Hese (2019) further noted that cereal output and productivity growth rates had been particularly low in sub-Saharan Africa over the last few decades. Balami *et al.* (2019) asserted that factors militating against the realization of potentials of cereal growth in productivity in sub-Saharan Africa include: failure to modernize agriculture on a large scale, poor access to credit, high cost of farm inputs, low adoption of research findings, outdated land



tenure system, weakened extension services, over emphasis on inefficient fertilizer procurement and distribution and poor and inadequate access to markets. In many parts of the region, rapid population growth has outstripped more modest gains in food crop production. The changing global trends pose food security threats to countries such as Nigeria, which are food import dependent.

Consequently increased demand for such cereal crops resulting from an increase in population density and income growth, relative to the low productivity of some cereal crops by farms; Nigeria has become a net importer of some cereal crops with about 5.6 million tonnes total cereal import in 2019 (International Grains Council, 2020). Thus, Nigeria first goal is to meet the domestic demand and then if possible seek to become competitive of such cereal crops with other countries. Nigeria cereal crops production is potentially competitive in the domestic market if the crops industry would enhance the overall economic development through the income and employment effects in the rural and urban economics.

OBJECTIVES

The main objective of the study was to examine the effects of cereal outputs on Macroeconomic Health Indicators in Nigeria.

The specific objectives were to:

describe the trend of cereal (maize, rice, wheat, sorghum and millet) outputs on Macroeconomic Health Indicators in Nigeria; describe the trend of Macroeconomic Health Indicators (GDP, Exchange rate, Interest rate, and inflation);

determine the effects of cereal outputs on GDP;

determine the effects of cereal outputs on exchange rate;



determine the effects of cereal outputs on interest rate; and

determine the effects of cereal outputs on inflation

METHODOLOGY

This study was conducted in Nigeria and it is situated in the West African regions and lies between longitudes (3 long 14°) degrees and latitudes (4 lat 14°) degree. It has a land mass of 923,768sq.km (Johnson, M.L 2021). It is bordered to the north by the Republics of Niger and Chad; it shares borders to the west with the Republic of Benin, while the Republic of Cameroon shares the eastern borders right down to the shores of the Atlantic Ocean which forms the southern limits of Nigerian territory. The 800km of coastline confers on the potentials of a maritime power (Lawal, C.R, 2021). Land is in abundance in Nigeria for Agricultural, Industrial and Commercial Activities.

Nigeria measures 1200km from east to west and 1050km from north to south. (Lobell, D.B 2021) The country's topography ranges from lowlands along the coast and in the lower Niger valley to high plateaus in the north and mountains along eastern borders. Much of the country is laced with productive rivers .Nigeria ecology varies from tropical forest in the south to dry savannah in the far north, yielding a diver mix of plants and animals

Nigeria is famous for her huge population of 200,000,000 people, the largest National population on the African continents (National Population Commission Report, 2018). This population is made up of 374 distinct ethnic stocks. Three of them are Hausa, Ibo and Yoruba which consists of the major groups and constitutes over 40% of the population. In fact ten (10) ethnic linguistic groups constitutes over 80% of the population The other groups are Tiv, Ibibio, Ijaws, Kanuris, Nupe, Gwari, Igala , Idoma, Fulani, Benin, Urhobo .Nigeria in addition to its huge population is endowed with significant agricultural, mineral, marine and forest resources. Its multiple vegetation zones plentiful rain surface water and underground water resources and moderate climatic extremes allows for production of



divers food and cash crops .Over 60% of the population is involved in the production of the food crop such as cassava, maize, rice yams various beans and legumes soya ,sorghums, ginger, onions, tomatoes, melon and vegetables. The main cash crops are cocoa, cotton, groundnuts, oil palm and rubber (Nigeria High Commission, 2023). The various economic resources in the different geographical region of Nigeria are such that the Northern parts of Nigeria is basically blessed with resources such as coal, dolomites, feldspar, gypsum,iron ore ,kaolin , marble and gold, on the other hands the southern parts of Nigeria is basically blessed with gold, clay, glass sand, lignite, marble ,oil and gas (Ogah,D.O 2018).

The study adopted quasi-experimental research design, the focus for this research is very vital given its reliance on secondary data, dealing with dependent and independent variables involving time series (Chike, 2020).

Data used for this study were sourced from the World Bank (WB) development indicators, Central Bank of Nigeria (CBN), Annual Statistical Bulletin Food Agriculture Organization (FAO) and Food and Agriculture Statistics (FAOSTAT, 2023). The variables were Real Gross Domestic Products (RGBP), Inflation Rate (INFL), Exchange Rate (EXR), and Cereal Crops Output (C_{OUT}).

Augmented Dickey-Fuller (ADF) was used to checking the stationarity and knows when the test statistic (T-stat) is more negative than the critical values at 1%, 5% and 10% respectively.

Johansen Co-integration Model was used to test effect of cereal output on economic growth.

Unit Root Test was used to examine the stationarity of the data Fixed Random Coefficient Model was used to analyze data for cereal output efficiency. Ordinary Least Square (OLS) was used to analyze regression model.



The study utilized Augmented Dickey-Fuller (ADF) Test, Johansen Co-integration Model, Pre-estimation Tests, Unit Root Test and Post-estimation Tests in the estimation of parameters for the study.

$$GDP = f(MZ, RI, WH, ML, SG)$$

$$GDP = \beta_0 + \beta_1 M + \beta_2 R + \beta_3 WH + \beta_4 ML + \beta_5 SG + e_1 \dots \dots \dots \text{Equation 1}$$

$$EXR = f(M_z, R_i, W_H, M_L, S_G)$$

$$EXR = \alpha_0 + \alpha_1 M_z + \alpha_2 R_i + \alpha_3 W_H + \alpha_4 M_L + \alpha_5 S_G + e_2 \dots \dots \dots \text{Equation 2}$$

$$EXR = f(M_z, R_i, W_H, M_L, S_G)$$

$$ITR = a_0 + a_1 M_z + a_2 R_i + a_3 W_H + a_4 M_L + a_5 S_G + e_3 \dots \dots \dots \text{Equation 3}$$

$$INFL = f(M_z, R_i, W_H, M_L, S_G)$$

$$INFL = b_0 + b_1 M_z + b_2 R_i + b_3 W_H + b_4 M_L + b_5 S_G + e_4 \dots \dots \dots \text{Equation 4}$$

Where

GDP = Gross Domestic Product

EXR = Exchange Rate

ITR = Interest Rate

INFL = Inflation Rate

M_z = Maize

R_i = Rice

W_H = Wheat

M_L = Millet

S_G = Sorghum

$\beta_0, \beta_1, \alpha_0, \alpha_1, a_0, a_1, b_0$ and b_1 are autoregressive constants. e

= error term.



RESULTS AND DISCUSION

Descriptive Statistics

Table 4.1 Descriptive Statistics, using the observation 1980 – 2022

	EXR	GDP	INF	INTR	MAIZE	MILLET	SORGHUM	RICE	WHEAT
Mean	113.0851	4.880233	19.13047	2.258372	2639.272	4623.519	4775.563	23382.70	4042.386
Median	111.9400	4.200000	13.01000	1.400000	1509.900	1435.500	1546.600	1657.700	1335.200
Maximum	426.0000	15.33000	72.84000	15.83000	16634.80	34134.00	45230.00	712340.0	23122.00
Minimum	0.550000	0.060000	5.390000	0.050000	1112.200	1066.000	1023.500	1116.000	1030.200
Std. Dev.	119.0739	3.556995	16.22230	3.476016	3675.355	6883.855	8323.024	109936.1	5162.186
Skewness	1.047768	0.938083	1.883815	2.841856	3.007396	2.452500	3.197654	5.958332	1.843790
Kurtosis	3.273815	3.591753	5.525177	9.990456	10.48965	9.402633	14.41889	37.64146	5.834453
Jarque-Bera	8.002028	6.934055	36.85736	145.4315	165.3218	116.5528	306.8964	2404.485	38.75799
Probability	0.018297	0.031210	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	4862.660	209.8500	822.6100	97.11000	113488.7	198811.3	205349.2	1005456.	173822.6
Sum Sq. 1	5.08E+1 1.12E+09	Dev. 595500.9	531.3931	11052.84	507.4728	5.67E+08	1.99E+09	2.91E+09	
Observations	43	43	43	43	43	43	43	43	43

Source: Author's Computation from E-views 2024

The descriptive statistics of the variables data utilized throughout the investigation are shown in Table 4.1, with special attention paid to the mean, median, maximum, minimum, standard deviation, skewness, kurtosis, and probability of each variable. The mean value for exchange rate (EXR) was around 113.0851, 4.880233 for GDP, 19.13047 for inflation rate (INF), 2.258372 for interest rate (INTR), 2639.272 for maize output, 4623.519 for millet output, and 4775.563 for sorghum output, 23382.70 for rice output and 4042.386 for wheat output, according to the findings. The series with the highest mean value (23382.70) was rice



output, whereas the series with the lowest mean value was interest rate (2.258372). Based on standard deviation of the variables, rice output had the highest standard deviation of 109936.1, whereas interest rate had the lowest standard deviation of 3.476016. Rice output had the highest kurtosis of 37.64146, indicating that the distribution was peaked because it exceeds the normal distribution of three as well as all other variables. The skewness of the selected variables were all positive. Positive skewness indicates that the distribution has a long right tail. Exchange rate, GDP, inflation rate, interest rate, millet output and wheat output were platykurtic because they were less than three (3), indicating that the distribution was flat relative to the normal distribution, whereas maize output, sorghum output and rice output were leptokurtic, indicating that the distribution was peaked relative to the normal distribution. At the 5% probability level, the Jarque-Bera statistic demonstrated that all of the variables were normally distributed.

Pre-estimation Tests

Stationarity Test

Stationarity test is an analysis that is executed to check for the absence or presence of unit root in time series. This test was required to look at for the random movement in the variables as a result of shocks and structural descriptions such as macroeconomic health crises, pandemics and policy changes

A stationarity variable is said to have no unit root test, thus unit test is the acceptable determinant to measure stationarity attributes of time series variable. The research work utilized Augmented Dickey Fuller (ADF) approach of unit root test



Unit Root Test

The study utilized the ARDL Bound test to determine the order of integration of all variables before proceeding with further estimation. According to Lawal, Oye, Toro and Fashina (2018), unit root test is necessary to avoid erroneous regression findings, this ensures that variables were not I(2) stationary. As a result, the ARDL procedure's unit root test may was used to verify that no variables were integrated in the order of I(2) or higher. The Augmented Dickey Fuller (ADF) unit root test was used to achieve the aforementioned statement.

Table 4.2: Results of Augmented Dickey Fuller Test at LEVEL and FIRST DIFFERENCE

Variables	Augmented Dickey-Fuller		
	Level	1 st difference	Remarks
EXR	-4.246059 (0.0017)		1(0)
GDP	-5.151526 (0.0001)		1(0)
INF	-3.612439 (0.0097)		1(0)
INTR	0.812196 (0.9930)	-4.094074 (0.0028)	1(1)
MAIZE	-4.533241 (0.0007)		1(0)
MILLET	-3.489681 (0.0132)		1(0)
RICE	-6.228705 (0.0000)		1(0)
SORGHUM	-4.111755 (0.0025)		1(0)
WHEAT	-4.414971 (0.0011)		1(0)

Source: Author's Computation from E-views 2024

Table 4.2 above summarizes the results of the ADF test. The table indicates that exchange rate, GDP, inflation rate, miازه output, millet output, rice output, sorghum output and wheat output



were stationary at level, whilst only interest rate was stationary at first difference. The implications for these empirical results are that the study’s variables are suitable tool of analyzing the error correction mechanism since the variables used in the model were stationary at level and first difference. As a result, the variables under investigation are not integrated in the same order, which justifies the adoption of the bounds approach to cointegration over other traditional methods that require the variables to be integrated in the same order.

ARDL Bounds Test for Co-integration

The ARDL Bound test was used to separate long and short run dynamics, ARDL help to separate the two periods. Integration to the order of 0 is represented by the lower bounds while integration to the order of 1 is assessed interpreted using the upper bounds. F-statistic results that are less than the lower bounds point to the absence of co-integration while cointegration in the long-run is confirmed if the resulting F-statistic is larger than the upper bound critical values.

The results of the ADRL bounds co-integration tests were presented in Table 4.3. Table 4.3 shows the Wald tests (F tests) for the joint null hypothesis that the coefficients of the lagged variables in the level form are zero (no co-integration between the variables), as well as the results of the calculated F-statistics and values for both the upper and lower bound. As shown in

Table 4.3. ARDL Bounds Test for Co-integration

Dependent variable: INTR F(MAIZE MILLET, RICE, WHEAT)		F-Statistics 20.58091
Critical Values K=5; n=39	Lower Bound 1(0)	Upper Bound 1(1)
10%	2.75	3.79
5%	3.12	4.25



Source: Author’s Computation from E-views 2024

Table 4.3 above shows calculated F-statistics for the entire model was higher than the upper critical bound for 5% and 10% critical values. This therefore, concludes from the ARDL bounds test that there is a long-run relationship among the variables (when interest rate was the dependent variable). Given that the variables were co-integrated, we obtain the long-run and short-run dynamic parameters for the variables. The implication of their co-integration is that the variables will not produce a spurious regression.

Johansen Test for Co-integration

Having established the status of stationarity of the variables of the study, the next action was to establish the existence of a long-run relationship. Co-integration is said to exist in a model if two or more variables have a long-term or equilibrium, relationship. The Johansen maximum likelihood approach for co-integration was employed because the unit root test showed the same order of integration I(0) for GDP, INF and EXR. The results of the Johansen co-integration tests were presented in Table 4.3.1.

Table 4.3. 1 Johansen Test for Co-integration

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05		Max-Eigen Statistic	0.05	
			Critical Value	Prob.**		Critical Value	Prob.**
None *	0.947025	359.5720	159.5297	0.0000	117.5176	52.36261	0.0000
At most 1 *	0.871087	242.0544	125.6154	0.0000	81.94473	46.23142	0.0000
At most 2 *	0.801699	160.1097	95.75366	0.0000	64.71882	40.07757	0.0000
At most 3 *	0.609390	95.39087	69.81889	0.0001	37.60178	33.87687	0.0171
At most 4 *	0.545016	57.78910	47.85613	0.0045	31.49974	27.58434	0.0149
At most 5	0.304943	26.28935	29.79707	0.1203	14.55045	21.13162	0.3216



At most 6	0.209211	11.73890	15.49471	0.1699	9.388966	14.26460	0.2552
At most 7	0.057056	2.349932	3.841466	0.1253	2.349932	3.841466	0.1253

Trace and Max-eigenvalue test indicates 5 cointegration equations at the 0.05 level

Source: Author's Computation from E-views 2024

From table 4.3.1 above, shows both the trace and maximum eigenvalue tests proved evidence of co-integration within the model. This is because the critical values of both the trace and max-Eigen statistics were much more than the critical values. Also the probability values of both tests which were less than 0.05 equally attest to the fact that the time series data were co-integrated. In conclusion, the tests proved that five (5) co-integrating equations exist within the model.

Post-estimation Test

Given the estimation of the variables of the study, the model was subjected to some diagnostic test to help verify how reliable and efficient the research work or variables are for the purpose of forecasting, recommendation and policy prescriptions.

Emphasis on the post-estimation tests were based on serial correlation to examined if the model were serially corrected and Ramsey RESET test was used to check for specification errors within the model and it was shown that the variables of the model were reliable and serially correlated based on the decision rule.

Effects of Cereal Outputs on GDP

From the stationarity test result, GDP as a dependent variable was stationary at level as well as other independent variables. The study then proceeded to estimate the Vector Error Correction



Model (VECM) after obtaining co-integration results that showed the presence of long-run convergence in the model (table 4.3.1). Table 4.4 provides the long-run and short-run findings.

Table 4.4 Vector Error Correction Model (GDP as Dependent Variables)

Cointegrating Eq:	Coefficient	Std. Error	t-Statistic
MAIZE(-1)	0.006371	0.00120	5.29042***
MILLET(-1)	0.001955	0.00132	1.48096
RICE(-1)	7.89E-06	6.9E-05	0.11471
SORGHUM(-1)	-0.002768	0.00090	-3.07147**
WHEAT(-1)	0.000472	0.00127	0.37127
C	-17.12775		
Error Correction: Exogenous variables	Coefficient	Std. Error	t-Statistic
ECM	-0.041812	0.04742	-0.88173
D(GDP ₍₋₁₎)	-0.575401	0.19878)	-2.89464
D(GDP ₍₋₂₎)	0.023765	0.18913	0.12565
D(MAIZE ₍₋₁₎)	0.000593	0.00030	1.98171
D(MAIZE ₍₋₂₎)	0.000674	0.00049	1.37595
D(MILLET ₍₋₁₎)	8.21E-05	0.00032	0.25610
D(MILLET ₍₋₂₎)	7.36E-05	0.00031	0.23485
D(RICE ₍₋₁₎)	1.80E-05	1.3E-05	1.41330
D(RICE ₍₋₂₎)	1.13E-05	1.2E-05	0.96309
D(SORGHUM ₍₋₁₎)	-0.000615	0.00046	-1.33467
D(SORGHUM ₍₋₂₎)	5.58E-05	0.00033	0.16743
D(WHEAT ₍₋₁₎)	7.25E-05	0.00028	0.26309
D(WHEAT ₍₋₂₎)	-7.89E-05	0.00023	-0.34347



R-squared	0.484371
Adj. R-squared	0.226557
Sum sq. resids	375.1628
S.E. equation	3.798597
F-statistic	1.878759

Source: Author's Computation from E-views 2024 ** = 5% significance, * = 1% significance**

Result on Table 4.4 above shows that in the long run, maize output had positive (0.006371) effect on GDP at 1% level of significance while sorghum output had negative (-0.002768) effect on GDP at 5% level of significance. This implies that an increase in the output of maize will increase the GDP while an increase in sorghum output will decrease the GDP. This negative effect of sorghum output contrasts *a priori* expectation since increase in output should translate to increase in the nation's GDP. The implication is that crop production has strong positive influence on the performance of the Nigerian economy. This finding is consistent with Ewetan, Fakile, Urhie and Oduntan (2017), who found positive relationship between crop productions and output in Nigeria in the long-run. Also, Adedejo (2020) found a significant relationship between crop production output and economic performance in Nigeria.

However, in the short run none of the cereals had significant effect on GDP. This implies that in the short run, an increase or decrease in the output of these cereals do not significantly affect GDP.

The R^2 in Table 4.4 above were 0.484, indicating that selected cereal output explained 48.4 percent of the variation in GDP, while other variables not included in the model explained the remaining 51.6 percent. The economic implication is that maize, rice, millet, sorghum and wheat output can cause changes or variations in GDP. The error correction result in Table 4 shows that the error correction term was correctly signed (negative) and was not statistically



significant at 5% level of significance ($t = -0.881$). The error correction coefficient of -0.881 shows that previous period deviation from long run equilibrium was corrected in the current period at an adjustment speed of 88.1%.

Effects of Cereal Outputs on Exchange Rate

The study proceeded to estimate the Vector Error Correction Model (VECM) after obtaining co-integration results that showed the presence of long-run relationship in the model (table 4.3.1). Table 4.5 present the long-run and short-run outcomes.

Table 4.5: Vector Error Correction Model (EXR as Dependent Variables)

<u>Cointegrating Eq:</u>	<u>Coefficient</u>	<u>Std. Error</u>	<u>t-Statistic</u>
MAIZE(-1)	-0.741316	0.08715	-8.50652***
MILLET(-1)	0.093828	0.09658	0.97153
RICE(-1)	-0.021637	0.00500	-4.33151
SORGHUM(-1)	0.247169	0.06740	3.66731**
WHEAT(-1)	-0.036712	0.09571	-0.38358
C	718.8699		
Error Correction:			
Exogenous variables	Coefficient	Std. Error	t-Statistic
ECM	-0.000310	0.00268	-0.11563
D(EXR ₍₋₁₎)	0.362578	0.14495	2.50142
D(EXR ₍₋₂₎)	0.180902	0.14902	1.21393
D(MAIZE ₍₋₁₎)	-0.000361	0.00167	-0.21583
D(MAIZE ₍₋₂₎)	-0.002572	0.00194	-1.32743
D(MILLET ₍₋₁₎)	-0.004128	0.00119	-3.47185**
D(MILLET ₍₋₂₎)	-0.005306	0.00119	-4.47023**
D(RICE ₍₋₁₎)	-2.71E-05	5.8E-05	-0.46855



D(RICE ₍₋₂₎)	-3.11E-05	4.4E-05	-0.71107
D(SORGHUM ₍₋₁₎)	0.004535	0.00173	2.61798
D(SORGHUM ₍₋₂₎)	0.003271	0.00125	2.61935
D(WHEAT ₍₋₁₎)	0.002140	0.00098	2.18066
D(WHEAT ₍₋₂₎)	0.000773	0.00086	0.89762
R-squared	0.635585		
Adj. R-squared	0.453378		
Sum sq. resids	5332.925		
S.E. equation	14.32175		
F-statistic	3.488249		

Source: Author's Computation from E-views 2024

**** = 5% significance, *** = 1% significance**

The long-run and short-run results, shown in table 4.5 above showed that maize output had a negative (-0.741316) significant effect on exchange rate. This implies that an increase in maize output will decrease exchange rate. Also, sorghum output had a positive (0.247169) significant influence on exchange rate in the long run meaning that an increase in sorghum output would boost exchange rate. The positive relationship between sorghum output and exchange rate is inconsistent with *a priori* expectations because increment in output should increase export which will lead to decline in exchange rate; however, this could be attributed to the fact that these foreign currencies are not remitted to the nation in the long run. This research supports the findings of Ogah, Kotur, and Essien (2021), who found that exchange rate boosts rice productivity by 31%.

However in the short-run, millet output had a negative and significant influence on exchange rate in their first and second lags. The negative sign suggests that as millet produces are



exported, the dollar devalues against the naira thereby decreasing exchange rate. leading to a stable and favorable exchange rate in the nation.

The R^2 in Table 4.5 above was 0.635, indicating that selected cereal output explained 63.5 percent of the variation in exchange rate, with the remaining 36.5 percent explained by other variables not included in the model. The error correction result in Table 4.5 shows that the error correction term was correctly signed (negative) and was not statistically significant at 5% level of significance ($t = -0.115$). The error correction coefficient of -0.115 shows that the previous period deviations from long run equilibrium were corrected in the current period at adjusted speed of 11.5%.

Effects of Cereal Output on Inflation Rate

The study proceeded to estimate the Vector Error Correction Model (VECM) after obtaining co-integration results that showed the presence of long-run relationship in the model.

Table 4.6 present the long-run and short-run findings.

Table 4.6: Vector Error Correction Model (INF as Dependent Variables)

Cointegrating Eq:	Coefficient	Std. Error	t-Statistic
MAIZE(-1)	-0.026120	0.00269	-9.71170***
MILLET(-1)	0.003338	0.00302	1.10466
RICE(-1)	-0.000823	0.00016	-5.27297***
SORGHUM(-1)	0.016028	0.00198	8.10328***
WHEAT(-1)	-0.010948	0.00279	-3.92398**
C	15.14016		
Error Correction:			
Exogenous variables	Coefficient	Std. Error	t-Statistic
ECM	-0.202535	0.06212	-3.26030**
D(INF ₍₋₁₎)	0.263020	0.19608	1.34139
D(INF ₍₋₂₎)	-0.330722	0.14719	-2.24685



D(MAIZE ₍₋₁₎)	-0.002719	0.00146	-1.85667
D(MAIZE ₍₋₂₎)	-0.000587	0.00166	-0.35432
D(MILLET ₍₋₁₎)	0.001688	0.00120	1.40460
D(MILLET ₍₋₂₎)	-0.000108	0.00132	-0.08149
D(RICE ₍₋₁₎)	-4.84E-05	5.2E-05	-0.92242
D(RICE ₍₋₂₎)	-1.72E-05	3.9E-05	-0.44511
D(SORGHUM ₍₋₁₎)	-0.000421	0.00162	-0.26044
D(SORGHUM ₍₋₂₎)	0.000464	0.00135	0.34355
D(WHEAT ₍₋₁₎)	-0.002023	0.00092	-2.18651
D(WHEAT ₍₋₂₎)	-0.000494	0.00081	-0.60967
R-squared	0.533802		
Adj. R-squared	0.300704		
Sum sq. resids	3909.101		
S.E. equation	12.26173		
F-statistic	2.290027		

Source: Author's Computation from E-views 2024

**** = 5% significance, *** = 1% significance**

The long-run and short-run results, as shown in table 4.6 above shows that maize, rice and wheat output had a negative (-0.026120, -0.000823 and -0.010948) significant effect on inflation rate in the long run meaning that an increase in the output of these cereals would lead to an increase in inflation rate. This implies that as the output of sorghum increases, inflation rate would decrease meaning that sorghum output is capable of decreasing inflation in the long run. Reverse was the case for sorghum output which shows a positive (0.016028) significant relationship with inflation rate. This implies that increase in output of sorghum would lead to increase in inflation. The finding of this study agrees with Sisay, Atilaw and Adisu (2022) who showed a statistically significant positive relationship between agriculture and inflation rate.



However in the short-run, the cereals under investigation were all not statistically significant in affecting inflation. This implies that their outputs in the short run have no significant effect on inflation.

The R^2 was 0.533, indicating that cereal output explained 53.3 percent of the variation in inflation rate, while other variables not included in the model explained the remaining 46.5 percent. The error correction term (ECT) was correctly signed (-3.26030) and significant at 5%; the negative sign indicates that the previous error was corrected in the subsequent term, implying a moderate speed (32%) of adjustment of cereal output towards equilibrium.

Effects of Cereal Outputs on Interest rate

The study proceeded to estimate the Error Correction Model (ECM) according to Persian & Shin (2020) after obtaining co-integration results that showed the presence of long-run relationship in the model (Table 4.3). Tables 4.7 provide the long-run and short-run findings.

Table 4.7 Error Correction Model result of Cereal Outputs and Interest Rate

Regressor	Coefficient	Standard error	T-Statistic	Probability
Long-Run Result				
C	1.259489	0.166081	7.583585	0.0000
@TREND	0.038980	0.008108	4.807415	0.0007
INTR(-1)*	-1.198735	0.150820	-7.948135	0.0000***
MAIZE(-1)	-0.000646	0.000136	-4.742106	0.0008***
MILLET(-1)	0.000220	5.64E-05	3.905464	0.0029***
RICE(-1)	-6.31E-06	4.65E-06	-1.356829	0.2047
SORGHUM(-1)	0.000318	5.37E-05	5.919490	0.0001***
WHEAT(-1)	-0.000305	4.89E-05	-6.233841	0.0001***



Short-run Result				
C	1.259489	0.093713	13.43990	0.0000 0.0000
@TREND	0.038980	0.003612	10.79154	0.0010
D(INTR(-1))	0.377635	0.082358	4.585298	0.0000
D(INTR(-2))	2.521032	0.134169	18.78993	

www.ijaams.org				
D(INTR(-3))	1.470638	0.231812	6.344103	0.0001
D(MAIZE)	-8.10E-05	1.32E-05	-6.136786	0.0001***
D(MAIZE(-1))	0.000370	4.12E-05	8.975062	0.0000***
D(MAIZE(-2))	0.000171	2.52E-05	6.795943	0.0000***
D(MILLET)	7.09E-05	9.68E-06	7.329253	0.0000***
D(MILLET(-1))	-4.40E-05	1.11E-05	-3.975235	0.0026***
D(MILLET(-2))	-2.40E-05	8.17E-06	-2.931879	0.0150**
D(MILLET(-3))	-1.12E-05	6.05E-06	-1.846770	0.0945
D(RICE)	-1.60E-06	6.76E-07	-2.362870	0.0398**
D(RICE(-1))	-7.44E-06	6.06E-07	-12.27338	0.0000***
D(RICE(-2))	-1.76E-05	1.30E-06	-13.50830	0.0000***
D(RICE(-3))	-1.13E-05	1.69E-06	-6.671967	0.0001***
D(SORGHUM)	2.62E-06	2.14E-05	0.122197	0.9052
D(SORGHUM(-1))	-9.68E-05	2.38E-05	-4.070803	0.0022***
D(SORGHUM(-2))	9.37E-05	1.03E-05	9.076679	0.0000***
D(SORGHUM(-3))	0.000108	1.58E-05	6.856918	0.0000***
D(WHEAT)	-2.13E-05	1.14E-05	-1.863817	0.0919
D(WHEAT(-1))	0.000109	1.49E-05	7.283707	0.0000***
D(WHEAT(-2))	1.66E-05	8.60E-06	1.936394	0.0816
CointEq(-1)*	-1.198735	0.088078	-13.60986	0.0000***
R-squared	0.998919	Mean dependent var	0.343333	
Adjusted R-squared	0.997261	S.D. dependent var	1.269207	
S.E. of regression	0.066420	Akaike info criterion	-2.310376	
Sum squared resid	0.066174	Schwarz criterion	-1.286646	
Log likelihood	69.05234	Hannan-Quinn criter.	-1.943071	
F-statistic	602.6314	Durbin-Watson stat	1.321313	
Prob(F-statistic)	0.000000			

Source: Author's Computation from E-views 2024

** = 5% significance, *** = 1% significance

Table 4.7 above shows that, in the long run, all cereals, except rice, had considerable effect on interest rate. Maize and wheat output were negatively significant, whereas millet and sorghum



output were positively significant. The result suggests that while millet and sorghum output increases, interest rate rises, whereas maize and wheat output rise, interest rate declines. This positive relationship is consistent with the findings of Asaleye, Inegbedion, Lawal, Kadijat, Osakede and Ogunwole (2023) who discovered a positive relationship between agricultural output and interest rate.

In the short run, maize output had a significant negative (-8.10E-05) relationship with interest rate, however in the first (0.000370) and second (0.000171) lags, maize output had significant positive relationship with interest rate. We can explain this by saying that maize output influences interest rate, which leads to changes in interest rate. In the same vein, millet output positively influence interest rate in the current position while in the first and second lags, millet output negatively influenced interest rate. Rice output on the other hand, negatively influenced interest rate in the current (-1.60E-06), first(-7.44E-06), second (-1.76E-05) and third (-1.13E-05) lags respectively while sorghum output positively influenced interest rate in the second and third lags respectively and wheat output positively (0.000109) influenced interest rate in the first lag. This is consistent with Abubakar's (2019) findings, which showed a negative relationship between lending interest rates and agriculture sector activity in Nigeria.

Table 4.7 showed that the R^2 was 0.998, indicating that cereal output explained 99.8 percent of the variation in interest rate, while other variables not included in the model explained the remaining 0.2 percent. The error correction term (ECT) (-1) is well defined because it is negatively significant and measures the speed of adjustment back to long-run equilibrium after a short-run shock (-1.198735).

CONCLUSION

The study concludes that the variables of the study utilized the autoregressive distribution lag (ARDL) bound test to determine the order of integration of all variables and there is a longrun



relationship among the variables given the co-integration of the parameters. The result of the Augmented Dickey Fuller Test (ADF) shows that exchange rate, GDP, inflation, maize output, rice output, millet output, sorghum and wheat output were stationary at level whilst only interest rate was stationary at first difference. These indices have shown that they significantly influence the performance of agricultural output and thus can be used to enhance macroeconomic health and economic growth in Nigeria.

5.2 Recommendations

The findings from the empirical investigation form the basis for the following recommendations:

- 1) Farmers should be encouraged to increase cereal outputs given its economic importance and influence on macroeconomic health
- 2) Policy makers should strengthen macroeconomic health indicators as to help enhance cereal output given the relationships between the variables
- 3) More of the improved cereals should be produced and promoted to attract agricultural investors so as to increase Nigeria GDP.
- 4) Government investment in Agriculture should be more of cereals for macroeconomic healthiness because the parameters have proven to be influential on the economy

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