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Determinants of Agricultural Output in Nigeria

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Abstract

This study examined the determinants of agricultural output in Nigeria from 1985 to 2022 using an ex-post facto research design and the Autoregressive Distributed Lag (ARDL) model. Results revealed that government expenditure on security, inflation, labour costs, literacy rate, and mortality rate had significant positive effects on agricultural output in both the short and long run. Weather conditions had a positive short-run effect but a negative long-run impact. The study recommends that the government and citizens prioritise agriculture to enhance output. Specifically, strengthening internal security to safeguard farmlands, rivers, and rural communities is essential. Furthermore, the government should provide genuine farmers and food producers with grants, subsidies, and loans to boost productivity. Overall, ensuring security, improving access to resources, and

supporting modern farming practices are critical to maximising Nigeria's agricultural potential.

Keywords: *Agricultural output, government expenditure, internal security, technology and innovation.*

Introduction

Agriculture has long been the backbone of Nigeria's economy, sustaining the population and driving development. It provides food, raw materials, and employment, especially in rural areas. Globally, agriculture is recognised as a key driver of poverty reduction and economic growth. The World Bank (2020) reports that it accounts for 80% of rural poor incomes worldwide, while the Food and Agriculture Organisation (FAO, 2019) identifies it as the second-largest employer globally, employing 26% of the workforce.

Agriculture in Nigeria spans farming, fishing, livestock, poultry, and forestry, supplying local raw materials for industries and generating revenue (Abdulrafiu & Christopher, 2022). It also supports trade and economic growth. Yet, despite its potential, the sector continues to face challenges such as climate variability, inadequate infrastructure, and poor technology adoption (Karolina & Małgorzata, 2020; Porkka, Kummu, Siebert, & Varis, 2013). FAO (2019, 2020) stresses the need for significant investment to boost productivity, while the Maputo Declaration (AUDA-NEPAD, 2003) urged African countries to allocate 10% of public expenditure to agriculture.

Nigeria, however, relies heavily on imports of rice, wheat, dairy, and fish despite its vast resources. Issues such as insecurity, flooding, desertification, high production costs, and inefficient subsectors worsen the problem (ITA, 2022). FAO (2022) noted that agriculture contributed 22.35% of GDP in 2021, but challenges like poor land tenure, low irrigation, climate change, high costs, and poor market access have weakened productivity, with imports (₦3.35 trillion) far exceeding exports (₦803 billion) between 2016 and 2019. Subsector-specific issues include low rice sufficiency, weak dairy production despite large cattle herds, declining forestry resources, and fisheries struggling with high input costs (ITA, 2022). These constraints highlight the urgent need to identify and address the determinants of agricultural output across Nigeria's 36 states.

State of the Problem

Despite Nigeria's abundant land and labour resources, agricultural output has remained below potential. The country still imports a significant share of staple foods, dairy, and fish, while insecurity, low technology adoption, poor financing, and adverse weather conditions undermine output. Although agriculture contributes notably to GDP, the gap between available resources and actual productivity raises critical questions about what truly drives Nigerian agricultural output.. Previous studies provide mixed evidence: while some emphasise land area, rainfall, population, or credit facilities (Kelechi, 2011; Nasir, 2016), others stress technology, fisheries, food production, or climate factors (Raza & Siddiqui, 2014; Oluwatoyes & Applanaidu, 2014; Omekwe, Bosco & Obayori, 2018; Aisha, 2019). These inconsistencies underscore the need for a comprehensive empirical assessment of the determinants of Nigeria's agricultural output over time.

Review of Related Literature

Conceptual Issue: (Agricultural Output)

Agricultural output refers to the quantity and quality of agricultural goods and products, including crops, livestock, and fisheries, produced within a specific region, country, or area over a defined period. It serves as a crucial measure of a nation's agricultural productivity and economic strength, reflecting the overall performance of the agricultural sector. According to the Central Bank of Nigeria Statistical Bulletin (2021), agricultural output comprises produce from the crop production, livestock, forestry, and fishing subsectors.

I. ***Crop Production Subsector*:** The crop production subsector focuses exclusively on cultivating and harvesting crops for food, fodder, fiber, and industrial raw materials.

II. ***Livestock Subsector:*** The livestock subsector is the branch of agriculture focused on raising animals for various purposes, including meat, milk, leather, wool, and labour. Livestock commonly includes cattle, sheep, goats, poultry, and pigs.

III. ***Forestry Subsector:*** The forestry subsector involves the sustainable management, conservation, and utilisation of forests

and forest resources for various purposes, including timber, fuelwood, paper, and non-timber forest products. It encompasses activities such as tree planting, logging, forest conservation, and wildlife management.

IV. ***Fishing Subsector:*** The fishing subsector involves commercial and subsistence activities related to harvesting harvesting fish and other aquatic organisms from freshwater and marine environments. This sector includes various fishing methods such as trawling, netting, angling, and aquaculture.

Theoretical Literature

Theories relevant to the determinants of agricultural output in Nigeria were reviewed. These theories included the following:

The Production Function Theory (Douglas, 1928) highlights the role of inputs such as land, labour, capital, and technology in shaping agricultural productivity.

The Institutional Theory (Meyer & Rowan, 1977) emphasises how rules, norms, and structures - including government policies, property rights, credit access, and extension services - affect agricultural practices and output.

The Technology Adoption Theories (Davis, 1986) stress the impact of adopting modern technologies on productivity. Within this, the Technology Acceptance Model (TAM) explains farmers' adoption decisions based on perceived usefulness and ease of use of innovations such as improved seeds and precision farming tools.

Empirical Review

Using OLS regression, Kelechi (2011) investigated the determinants of agricultural output in Abia State and identified land area, rainfall, and population as key drivers. The study recommended increased government funding to support rural agrarian growth. Raza and Siddiqui (2014), applying Johansen cointegration in Pakistan, highlighted technology, improved seeds, water availability, and labour as significant factors enhancing productivity.

In Nigeria, Oluwatoyes and Applanaidu (2014) showed that fisheries and food production positively influenced economic growth, urging policy support for these sub-sectors. Nasir (2016) analysed the Agricultural Credit Guarantee Scheme Fund and found it improved farmers' input adoption, output, and living standards, recommending sustained credit policies with effective monitoring.

Omekwe, Bosco, and Obayori (2018) employed Johansen Cointegration and ECM, identifying agricultural funding, credit, and climate change as key output determinants. Similarly, Aisha (2019) assessed 1981–2018 data and found that agricultural credit and government expenditure negatively affected output, while money supply exerted a positive effect, recommending easier loan access for farmers.

Policies and Strategies Adopted by the Nigerian Government towards Achieving Maximum Agricultural Output

Since gaining independence, the Nigerian government has adopted various methods, approaches, and strategies to increase agricultural output. Some of these policies and strategies, according to Nigeria Finder (NF, 2022), include: the Agriculture Extension, Technology Development and Transfer Policy; Agricultural Credit Policy; Agricultural Product Marketing Policy.

Problems Confronting Agricultural Sector in Nigeria

According to Taiwo (2020), Nigeria's agricultural sector faces several key challenges, including a lack of access to finance, resource shortages, violent conflict, and outdated farming systems.

Significance of the Study

This study contributes by clarifying the drivers of agricultural output in Nigeria using updated data and robust econometric techniques. It builds on earlier findings - Kelechi (2011) on land and rainfall, Raza and Siddiqui (2014) on technology, Oluwatoyes and Applanaidu (2014) on fisheries and food production, Nasir (2016) on credit schemes, Omekwe, Bosco, and Obayori (2018) on funding and climate change, and Aisha (2019) on agricultural credit and government expenditure-to resolve conflicting results and provide a broader perspective.

The findings are expected to guide policymakers in prioritising interventions such as improving security, ensuring effective funding and credit delivery, and promoting technological adoption among smallholder farmers who dominate the sector. For researchers, the study expands existing literature by delivering new evidence regarding short- and long-run determinants of agricultural output in Nigeria. For practitioners and stakeholders, the results will help identify where to channel resources for maximum productivity and food security.

Limitations:

This study used proxies to measure weather conditions and technological innovations, necessitating a 90% confidence level for testing. Given that over 80% of farmers are smallholders relying on traditional methods, future research should compare the adoption levels and outputs of the minority using modern technologies to determine the need for supportive government policies and the potential for wider adoption.

Research Methodology

Model Specification

The model of this work is specified based on the objectives it set to achieve.

$$AO=f(D) \quad (1)$$

Equation 1 is the functional notational form of Agricultural Output (AO) and its determinants (D). By transforming equation 1 gives equation 2 below

$$AO_t = B_0 + B_1 GEXA_t + B_2 POS_t + B_3 INFR + B_4 GEXS_t + B_5 LR_t + B_6 MUR_t + B_7 LABFC_t + B_8 TECH_t + B_9 WC_t + \mu_t \quad (2)$$

Where: AO = Agricultural Output

D = (Determinants of Agricultural Output) as:
GEXA = Government Expenditure on Agriculture as a ratio of GDP
GEXS = Government Expenditure on Security as a ratio of GDP

INFR = Inflation Rate
LABFC = Labour Cost (minimum wage)
LR = Literacy Rate
MUR = Mortality Rate (proxied as the total mortality rate of both adult males and females)
POS = Population Size
TECHN = Technology and Innovation Development (Proxied as Professional, Scientific and Technical Services)
WC = Weather Condition (proxied as Total Rainfall in Nigeria)
Bi = parameters to be estimated
t = time series of the estimated variables
μ = error term

A-Priori Expectations

$\beta_1>0$; $\beta_2<0$ or >0; $\beta_3<0$; $\beta_4>0$; $\beta_5>0$; $\beta_6<0$; $\beta_7<0$; $\beta_8>0$; and $\beta_9>0$ or <0. The sign (>0 or <0) associated with the B's represents the apriori expectation of each explanatory variable used in the study. An explanatory variable with a $B>0$ (positive parameter) is expected to have a positive impact on the independent variable and vice versa.

Statement of Hypotheses

H_0: Agricultural Output in Nigeria is not determined by the following variables: Government Expenditure on Agriculture, Government Expenditure on Security, Inflation Rate, Labour Cost, Literacy Rate, Mortality Rate, Population Size, Technology and Innovation Development, and Weather Condition.
H_1: Agricultural Output in Nigeria is determined by the following variables: Government Expenditure on Agriculture, Government Expenditure on Security, Inflation Rate, Labour Cost, Literacy Rate, Mortality Rate, Population Size, Technology and Innovation Development, and Weather Conditions.

Nature and Sources of Data

The data used in this work are secondary data. They were sourced from annual time series from the period of 1985 to 2022. All data were obtained from the National Bureau of Statistics (NBS), the Central Bank of Nigeria Statistical Bulletin (CBN), and the World Bank.

Unit Root Test

The unit root test was conducted to ascertain the order of integration (or stationarity) of a given series. The Augmented Dickey-Fuller (ADF) and the Philip-Perron unit root test were utilised. The test was conducted under the constant and trend assumption on the level and first difference of the series. The unit root test was conducted to ascertain the order of integration of the variables. This is because regressing non-stationary time series variables produces spurious results, showing a strong relationship that lacks a real underlying causal link (Studenmund, 2017). Given a time series variable, say X, the test equation is presented below:

$$\Delta X_t = \propto_0 + \propto_1 X_{t-1} + \sum_{i=1}^{m} \propto_2 \Delta X_{t-1} + \varepsilon_t \quad ----------(3)$$

And that

$$\Delta X_t = \propto_0 + \delta t + \propto_1 X_{t-1} + \sum_{i=1}^{m} \propto_2 \Delta X_{t-1} + \varepsilon_t \quad ----------(4)$$

Where X_t is a time series, t is a linear time trend, Δ is the first difference operator, β_0 is a constant, i is the optimum number of lags in the independent variables, and ε_t is a random error term.

Autoregressive Distributed Lag (ARDL) Bounds Test Co-integration

The ARDL model is used if the variables are integrated of different orders, precisely order 1(0) and 1(1) after conducting unit root test. After specifying the ARDL model, the next step is to determine whether cointegration exists. Before using the ARDL model to test for cointegration, it must first be specified in its generalised (p, q) format. In the generalised form, the model is specified as follows:

$$Y_t = \gamma_{oj} + \sum_{i=1}^{p} \delta_j Y_{t-1} + \sum_{i=j}^{q} \beta_j X_{t-1} + \Sigma_{jt} ----------4$$

Where Y_t is a vector and the variables in (X_t) are allowed to be purely 1(0) or 1(1) or integrated; β and δ are coefficients; ϒ is the constant; j=1,…..k: p, q are optimal lag orders; ∑it is a vector of the error terms – unobserved zero means white noise vector process.

If there is no cointegration, the ARDL model is specified as:

$$\Delta AO_t = a_0 + \sum_{i=0}^{q} a_1 \Delta GEXA_{t-i} + \sum_{i=1}^{q} a_2 \Delta INFR_{t-i} + \sum_{i=1}^{q} a_3 \Delta LABFC_{t-i} + \sum_{i=1}^{q} a_4 \Delta POS_{t-i} + \sum_{i=1}^{q} a_5 \Delta LR_{t-i} + \sum_{i=1}^{q} a_6 \Delta MUR_{t-i} + \sum_{i=1}^{q} a_7 \Delta TECH_{t-i} + \sum_{i=1}^{q} a_8 \Delta GEXS_{t-i} + \sum_{i=1}^{q} a_9 \Delta WC_{t-i} + \mu_{it} \quad (5)$$

If there is cointegration, the ARDL model is specified as:

$$\Delta AO_t = a_0 + \sum_{i=0}^{q} a_1 \Delta GEXA_{t-i} + \sum_{i=1}^{q} a_2 \Delta INFR_{t-i} + \sum_{i=1}^{q} a_3 \Delta LABFC_{t-i} + \sum_{i=1}^{q} a_4 \Delta POS_{t-i} + \sum_{i=1}^{q} a_5 \Delta LR_{t-i} + \sum_{i=1}^{q} a_6 \Delta MUR_{t-i} + \sum_{i=1}^{q} a_7 \Delta TECH_{t-i} + \sum_{i=1}^{q} a_8 \Delta GEXS_{t-i} + \sum_{i=1}^{q} a_9 \Delta WC_{t-i} + \lambda ECM_{t-i} + \mu_{it} \quad (5)$$

Where λ is the speed of adjustment parameters with a negative sign; ECM is the error correction sign; and a_1, a_2 a_3 and a_n are the short-run dynamic coefficients of the model's adjustment to long-run equilibrium.

Data Analysis and Discussion of Findings

Descriptive Statistics

The descriptive statistics here cover the mean, standard deviation, skewness and kurtosis, as well as the minimum values of the time series used. The results are presented in the tables below.

Table 1: Descriptive Statistics of Variables

	AO	GEXA	GEXS	INFR	LABFC	LR	POS	MUR	WC	TECHN
Mean	5.882	81.561	7.993	18.41	2.99	82.45	43.081	0.055	0.502	4.252
Median	4.022	23.083	5.156	12.15	2.93	89.07	16.303	-0.484	1.522	4.112
Maximum	55.578	1951.2	100.00	72.84	6.440	106.2	686.471	28.269	11.417	18.681
Minimum	-3.186	-89.31	-60.980	0.170	0.200	15.26	-86.211	-1.801	-12.394	-7.918
Std. Dev.	8.998	317.81	36.586	17.54	1.592	22.12	130.855	4.784	6.069	4.307
Skewness	4.618	5.5679	0.285	1.780	-0.022	-1.90	3.868	5.602	-0.548	0.905
Kurtosis	25.994	33.258	2.847	4.925	2.178	5.858	18.314	33.582	2.806	7.101
Jar-Bera	972.29	1645.9	0.554	25.93	1.070	35.84	466.141	1679.6	1.966	31.819
Prob.	0.000	0.000	0.757	0.000	0.585	0.000	0.000	0.000	0.374	0.0000
Sum	223.541	3099.3	303.759	699.8	113.67	3133	1637.09	2.111	19.113	161.59
Sum Sq.D	2996.06	373733	49527.17	11384.97	93.826	1818	633556.	846.85	1362.98	686.39
Observ.	38	38	38	38	38	38	38	38	38	38

Source: Researcher's computation using Eviews 10

Table 1 shows the descriptive statistics of the variables used. From the table, it can be seen that a total number of 38 observations were made based on the period from 1985 to 2022. Agricultural Output, Exchange Rate, Government Expenditure on Agriculture, Inflation Rate, population size and Mortality Rate were positively skewed towards the normal distribution curve as evidenced by their positive values of Skewness, while Literacy Rate, Labour Cost and Weather Condition were negatively skewed, showing that variables are tilted to the left of the normal distribution curve. The Jarque-Bera shows that agricultural output, government expenditure on agriculture, inflation rate, literacy rate, technology and innovation and total rainfall are normally distributed as

indicated by their significant p-values at 5% level of significance, while exchange rate, government expenditure on security, labour cost and total rainfall are not normally distributed, evidenced by their significant p-values at 5% level of significance.

Multi-collinearity Test

Correlation analysis was used to show the strength of the relationship between the variables under study. It was important to detect multicollinearity, as high correlation between independent variables can distort findings and lead to spurious results. This is because multi-collinearity inflates standard errors and renders parameter estimates inefficient, making the coefficient values and signs unreliable.

Table 2: Correlation Matrix Test Result among Variables in the Model

	AO	**GEXA**	**GEXS**	**INFR**	**LABFC**	**LR**	**MUR**	**POS**	**WC**	**TECHN**
AO	1									
EXCH	-0.135									
GEXA	-0.015	1								
GEXS	0.205	-0.235	1							
INFR	-0.089	-0.038	0.313	1						
LABFC	0.204	-0.047	0.059	0.113	1					
LR	0.226	0.107	0.105	-0.031	-0.366	1				
MUR	0.224	-0.008	-0.087	-0.191	-0.327	0.187	1			
POVR	0.123	-0.027	-0.190	-0.032	-0.217	0.213	0.082	1		
WC	0.195	0.013	0.035	0.035	0.026	0.114	0.047	0.042	1	
TECHN	0.269	0.016	-0.191	-0.197	0.044	0.323	0.425	0.357	0.063	1

Source: Researcher's computation (E-views 10)

From Table 2, it can be observed that all the matrix elements outside the leading diagonal are less than 0.8, which confirms the absence of multicollinearity, according to Cooper and Schindler (2009).

Unit Root Test

Table 3: Augmented Dickey-Fuller Test Results for Variables in Model 1

Variables	**Level**	**1st Difference**	**2nd Difference**	**Order of Integration**
AO	-5.868(0.000)**	----------		1(0)
GEXA	-6.422(0.000)**	----------		1(0)
GEXS	-6.421(0.000)**	----------		1(0)
INFR	-3.513(0.016)**	----------		1(0)
LABFC	-4.061(0.003)**	----------		1(0)
LR	-2.128(0.234)**	-6.873(0.000)**		1(1)
MUR	-3.065(0.038)**	----------		1(0)
POS	-9.434(0.000)**	----------		1(0)
TECHN	-4.240(0.001)**	----------		1(0)
WC	-9.942 (0.000)**	----------		1(0)

Source: Researcher's computation with E-views 10
Note: ** ADF probability values at 5% level of significance

Augmented Dickey-Fuller test (ADF) and Phillip Perron (PP) unit root test for the variables used in the model are presented in Table 3. The unit root test result for variables in model 1 is in mixed order of integrations (levels and first differences). Agricultural Output, Government Expenditure on Agriculture, Government Expenditure on Security, Population Size, Technology and Innovation, Labour Cost, and Weather Condition were all stationary at a level with the application of ADF. Literacy Rate was stationary at first difference. Since the series are stationary at both levels and the first difference, the study adopts the ARDL Bounds test.

Table 4: ARDL Optimal lag length selection Criteria for Model 1

Dependent	Regressor	Total number of variables significant	Dependent	Regressor	Total number of variables significant
1	1	2	2	2	10

The optimal lag length for this work is 2: 2

Tables 5: ARDL Bonds Test Result for Model 1

Model		**F-Statistic =** 6.221
AO = f(EXCH, GEXA, INFR, GEXS, LABFC, LR, MUR, TECH, POVR, WC)		K = 10
Critical Values	Lower Bound	Upper Bound
10%	1.76	2.77
5%	1.98	3.04

Source: Researcher's computation from E-views10

Given that the F-statistic (6.221) in model 1 lies outside the lower and upper bounds values at 5% level (1.76 and 1.98 for upper and lower bounds, respectively), the null hypothesis of no long-run relationship is rejected, and it is concluded that there is level long-run relationship exists among dependent and independent variables.

Table 6: ARDL Error Correction Regression Estimate of the Short-Run **Coefficients Dependent Variable: Agricultural Output**

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-58.65961	21.44764	-2.735014	0.014**
AO(-1)	-1.214422	0.233712	-5.196239	0.001**
GEXA**	1.410855	1.385308	1.018441	0.323
GEXS(-1)	0.435897	0.065894	6.615099	0.000**
INFR(1)	-0.748188	0.122183	-6.123521	0.000**
LABFC(-1)	6.703807	1.620710	4.136340	0.000**
LR**	0.459966	0.110769	4.152467	0.000**
MUR(-1)	22.45028	3.604419	6.228543	0.000**
POS(-1)	-1.651075	0.295388	-5.589507	0.000**
TECHN**	-0.521709	0.282837	-1.844556	0. 005**
WC**	0.478719	0.157532	3.026177	0.008**
D(AO(-1))	-0.197389	0.127354	-1.549919	0.14
DI(GEXS)	0.215431	0.035005	6.154310	0. 000**
D(GEXS(-1))	-0.070248	0.024083	-2.916975	0.010**
D(INFR)	-0.238161	0.080096	-2.973431	0.008**
D(INFR(-1))	0.612643	0.101631	6.028130	0.000**
D(LABFC)	4.748610	0.886141	5.358751	0.000**
D(MUR)	-12.16110	6.264524	-1.941265	0.070**
D(MUR(-1))	-0.601623	0.292527	-2.056643	0.056**
D(POS)	0.200447	0.288233	0.695434	0.496
C	-58.65961	21.44764	-2.735014	0.014**
ECMt-1	-1.214422	0.099668	-12.18464	0.000**

Source: Author's Computation using E-views 10

** indicates level of significance at 5%

R^2= 0.932(93.2%)
Adj. R^2= 0.909 (90.9%)
Akaike info criterion = 6.421
Schwarz criterion = 6.993
Durbin-Watson stat = 2.043

The short-run error correction regression results for model 1, shown in Table 6, reveal the short-run effects of the independent variables on agricultural output. The Error Correction coefficient (ECM) has a correction sign that is less than one, negative and significant. This confirms the evidence of a long-run relationship among the variables used. The short-run error correction of -1.214 indicates an over-correction mechanism and a strong speed of adjustment for agricultural output to return to long-run equilibrium following any short-run distortion. Furthermore, Table 6 also indicates evidence of good fit of the dynamic of variables, and with the R^2 value (0.932) indicating that variation in agricultural output is explained by its determinants at 93.2%. The remaining 6.8% are attributed to the stochastic error term in the model. According to Gujaraji (2009), if the R^2 is less than the Durbin Watson Statistic, then the estimated regression model will produce spurious results. Therefore, given that the Durbin Watson (DW) value of 2.043 (approximately 2) is less than the R^2 of 93.2, it implies that the result is not spurious and further suggests that the model is free from autocorrelation. The ECM results reveal that while some variables conform to a priori expectations, others do not. Specifically, government expenditure on agriculture displays a positive relationship with Nigerian agricultural output in both the short and long run, aligning with. economic theory. Government Expenditure on Security shows positive relationship with agricultural output in Nigeria in the short-run and long-run as expected. The inflation rate shows a negative relationship with agricultural output in Nigeria in the short-run and long-run, as expected. Labour Cost shows a positive relationship with agricultural output in the short-run and long-run, not as expected; and Literacy Rate shows a positive relationship both in the short-run and long-run with agricultural output in Nigeria, supporting the a priori statement of this work. Also, the mortality rate shows a negative relationship with agricultural output, conforming to a-priori expectation of this work. Weather condition show a positive short- and long-run relationship with agricultural output in Nigeria, conforming to the study's a priori expectations. Population size shows a negative relationship with agricultural output in support of apriori statement of this

work, and also technology and innovation shows a negative relationship with agricultural output in support of the a priori expectation.

From the short-run coefficient results in Table 6, the coefficient of government expenditure on agriculture is 1.410, indicating that a unit increase in government expenditure on agriculture exerts a positive and insignificant influence (1.4 units) on agricultural output in Nigeria. Also, the coefficient of government on security is 0.215, showing that government expenditure on security exerts positive influence of 0.215 unit on agricultural output in Nigeria. The inflation rate coefficient is -0.748, indicating that a-period lag in inflation rate exerts a negative and significant influence of 0.3 units on agricultural output in Nigeria. The labour cost coefficient is 6.703, which shows that without any lag period, labour cost exerts a positive and significant effect of 4.748 units on agricultural output in Nigeria.

Moreover, the coefficient of literacy rate is 0.459, indicating that a two-period lag exerts a positive and significant influence on agricultural output by increasing agricultural production by 0.459 units. Similarly, the mortality rate coefficient of -2.506 shows that, at one period lag, the mortality rate exerts a negative and significant influence, reducing Nigerian agricultural output by 2.5 units. The coefficient of weather condition is 0.476, indicating further that, without any period lag, weather condition exerts positive and significant effects on agricultural output in Nigeria. The population size coefficient is 0.200 showing that, without any period lag, population size exerts a positive influence on agricultural output in Nigeria. Technology and Innovation returned a coefficient of -0.521, indicating that it exerts a negative and significant influence on agricultural output. With zero lag, technology and innovation exert a 0.5-unit positive influence on agricultural output.

Long Run Result

The long-run results of the model are presented in the table below.

Table 7: Estimate of the Long-Run Coefficients for the Model
Dependent Variable: Agricultural Output

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GEXA	1.161750	1.183585	0.981552	0.34
GEXS	0.358934	0.077214	4.648567	0.000***
INFR	-0.616086	0.143643	-4.289010	0.000**
LABFC	5.520163	1.771698	3.115748	0.006**
LR	0.378753	0.102608	3.691273	0.001**

MUR	18.48639	4.918339	3.758665	0.001**
POS	-1.359556	0.384067	-3.539892	0.002**
TECHN	-0.429595	0.222330	-1.932241	0.071*
WC	0.392548	0.150296	2.611838	0.018**
C	-48.30250	18.89950	-2.555755	0.021**

Source: Author's Computation using E-views 10
** indicates level of significance at 5%
*significance level at 10%

From Table 7, Government Expenditure on Agriculture indicates a positive and insignificant influence on agricultural output in Nigeria in the long-run. This indicates that a unit increase in government expenditure on agriculture will impact agricultural output positively by 1.167 units. Given that the coefficient of Government Expenditure on Security is 0.358, it means that a unit increase in government expenditure on security will lead to a 0.35 unit increase in agricultural output in Nigeria. Similarly, weather condition also exert a positive and significant effect on agricultural output in Nigeria, with favourable weather increasing output by 0.392 units.

Inflation Rate exerts a negative and significant influence on agricultural output with -0.616 coefficient, showing that a unit increase in inflation rate brings about a 0.6 unit decrease in agricultural output in Nigeria in the long-run. Also, Labour Cost indicates a positive and significant relationship with agricultural output in Nigeria, with a 5.520 coefficient, it implies that, a unit increase in labour cost will lead to 5.5 units decrease in agricultural output. Literacy Rate coefficient (0.378) shows that a one unit increase in literacy rate will result in a 0.4 unit increase in agricultural output in Nigeria in the long run. Furthermore, the mortality rate reveals a positive and significant effect on agricultural output. The coefficient of 18.486 thus implies that a one-unit increase in mortality rate in Nigeria leads to 18.5 units increase in agricultural output. The population coefficient of -1.359 shows that a unit increase in population size leads to a 1.36-unit decrease in Nigerian agricultural output. At 5% level of significance generally adopted in the study, Technology and Innovation Development exert no significant influence on agricultural output in the long run. However, since proxy variables are used to measure technology and innovation development, we test this at the 10% significance level to avoid the higher risk of missing its true effect on agricultural output. Wooldridge (2016) notes that while a 5% significance level is common, in some cases a 10% level is adopted when the research is exploratory or in areas where evidence is hard to obtain, and the cost of missing a true relationship (Type II error) is considered high. Hence, at 10% significance

level, the coefficient of -0.429. shows that improvement in technology and innovation in Nigeria brings a significant 0.4 decrease in agricultural output in the long-run.

Post Diagnostic Test

Table 8: Summary of Diagnostic Test Results for the Model
Dependent Variable: Agricultural Output

Test	Null Hypothesis	F-Statistics	Probability Value
Normality Test	No Normal Distribution	0.097	0.965
LM Test	No Serial Auto-Correlation	2.250	0.142
ARCH	No Heteroscedasticity	1.191	0.317

Source: Researcher's computation: E-views 10

From table 8, the F-Statistic (0.097) value for the histogram normal distribution is not statistically significant at 5% level of significant given its p-value of 0.965. This implies that the error term is not normally distributed. The F-Statistic value for the Serial Auto-Correlation (2.297) is statistically insignificant at 5% level of significance, given its p-value 0.142. Thus, the null hypothesis of no serial correlation is accepted, showing the model was free from auto-correlation. In the heteroscedasticity test, the F-Statistic (1.191) is not statistically significant, given that the p-value is 0.317. Thus, the null hypothesis of no heteroscedasticity cannot be rejected. Therefore, this implies that, there is homoscedasticity in the regression result, constant variance.

Discussion of Findings

The study examined the determinants of agricultural output in Nigeria and further examined the relationship existing between agricultural output and food security in Nigeria. The study has revealed those factors that affect agricultural output in Nigeria depends on. The determinants of agricultural output in Nigeria display mixed relationships with the dependent variable. Specifically, government expenditure on agriculture has a positive but statistically insignificant effect on agricultural output in both the short and long run. The implication is that, government expenditure on the agricultural sector does not have any positive contribution in agricultural output growth in Nigeria. The insignificant sign also signifies the possible likelihood of capital flight on the money assigned by the government for the agricultural sector development. It further shows that either the expenditures of the government have been misappropriated or embezzled

by the authorities involved. Similarly, government expenditure on security revealed a positive influence on agricultural output in Nigeria both in the short-run and long-run. The interpretation is that security of farmlands by the government plays a significant role in determining the level of output in the agricultural sector in Nigeria. Inflation rate in Nigeria, both in the long-run and short-run, showed negative relationship with agricultural output in Nigeria. This explains that, a unit increase in the inflation rate reduces agricultural output in Nigeria, as cost-push inflation drives up the cost of essential farming inputs.

The findings also revealed a positive and significant influence of labour cost on agricultural output in Nigeria, both in the short-run and long-run. The positive sign shows that labour plays a significant role in determining the output of the agricultural sector. It signifies the fact that higher labour cost in Nigeria's agricultural sector may be driving higher productivity and increased agricultural output, possibly through improved worker efficiency, technological adoption, or increased investments in human capital. Literacy rate revealed a positive sign on agricultural output in Nigeria, both in the short-run and long-run. The positive sign indicates that basic knowledge plays an important and significant role in the level of output of the agricultural sector produce in Nigeria. This further shows that as farmers acquire more basic education and knowledge, agricultural output increases, demonstrating that basic knowledge is a key determinant of agricultural output in Nigeria.

The mortality rate exhibits negative coefficients in both the short and long run, implying that a higher death rate subtracts from the level of agricultural output in Nigeria. Similarly, Oluchukwu, Michael and George (2019) reported in their findings that a unit loss in manpower (through death) is also a loss in agricultural output potentials. Weather conditions reveal positive relationship with agricultural output in Nigeria in the short-run. The interpretation is that more favourable weather conditions lead to higher levels of agricultural output in Nigeria. In the long-run, weather conditions revealed a negative and significant influence on agricultural output in Nigeria, showing that weather conditions do not determine to a large extent what agricultural sector is produced. Population size revealed negative and significant influences on agricultural output in Nigeria. The interpretation is that the population size of Nigeria affects the level of agricultural production negatively. Furthermore, technology and innovation development showed a negative and significant influence on agricultural output in Nigeria, implying that, agricultural output do not depend on the level of improvement in technology and innovation in the

country. Introducing technology and innovation development into agriculture in Nigeria would only decrease its output. This result is contrary to the already established impact of technology and innovation on agriculture because of the very low adoption or wrong application of technology in agriculture by Nigerian farmers, who are mostly smallholders. 90% of Nigeria's agricultural produce is from smallholder farmers who make up more than 80% of Nigeria's farmers (PWC, 2024).

Conclusion and Recommendations

Conclusion

This study has revealed those factors (determinants) that agricultural output in Nigeria depends on, and these determinants are: inflation rate, government expenditure on agriculture, government expenditure on security, literacy rate, mortality rate, population size, technology and innovation development, labour cost and weather condition. The findings of this study establish that the determinants of Nigeria's agricultural sector must be carefully managed before maximum output can be achieved.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. The government should set up an independent audit committee to check how public funds on agriculture were implemented in the country. Our findings have revealed that agricultural expenditures of the government in Nigeria for the past thirty-seven years have not yielded much positive impact on agricultural output.
2. The government should strengthen its security apparatus and mechanism towards boosting internal security in the country towards ensuring that, Nigerian farmlands, forests and sea/rivers are secure for all agricultural and food production activities. Rather than merely allocating funds for national security, the government must ensure that resources earmarked for internal security are properly utilised and implemented across all states of the federation.

3. Both fiscal and monetary authorities in Nigeria should put in place adequate and formidable inflation control targets and measures in the country to curtail incessant increases in the inflatio rate. Inflation rate has shown a negative and significant influence on agricultural output in Nigeria both in the long-run and short-run, showing that inflation rate deters agricultural output in Nigeria.
4. Farmers should be given financial assistance by the government. This assistance can be in the form of grants, subsidies and loans for maximum agricultural output in the country. There should be incentives that can boost manpower productivity across the country. This can come in the form of a wage increment and a better welfare package for farmers. This can boost productivity and maximise agricultural output yields.
5. The mortality rate of adult males and females in the country is responsible for a big loss to agricultural output potential. Primary healthcare facilities across the country should be upgraded with modern facilities because the majority of the populace who are into farming are domiciled in rural communities.

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