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Effects of farm inputs on performance of the Nigerian agricultural sector

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ABSTRACT

This study investigates the effects of farm inputs on the performance of the farming sector in Nigeria. Time series data from 1990 to 2022 obtained from the FAO Statistical Database, CBN Statistical Bulletin, African Development Bank Data Repository and World Development Indicators were used for analysis. Methods of analysis include the Phillips Perron unit root test, the Johansen cointegration test, the ordinary least squares regression model and the Granger causality test. Results revealed that after the unit root test, all variables were stationary at first difference I (1). The Johansen cointegration test confirmed a long-run relationship among the specified variables. Results of the Ordinary Least Squares regression model revealed that fertiliser use, exchange rate and pesticide use had a positive significant impact on the performance of the agricultural sector in Nigeria. Nevertheless, agricultural credit had no significant impact on the performance of the sector within the study period. There is a unidirectional causality between exchange rate and agricultural GDP due to exports of some agricultural produce. The study concludes that improved access to the use of fertiliser and pesticides will improve agricultural output in Nigeria. The research recommends more concerted efforts by government to ensure better access to credit and other agricultural inputs by farmers through appropriate targeted policies geared towards provision of subsidised inputs for farmers.

Keywords: Economic performance, inputs, agricultural sector, time series data

INTRODUCTION

The agricultural sector is a major sector contributing to the general welfare and economic stability of a nation (Bassette *et al.*, 2022). The growth of the sector is an enhancement and panacea for economic growth and development of most emerging economies (Awoyemi *et al.*, 2017). The United Nations stressed the importance of the agricultural sector in achieving some of its Sustainable Development Goals (SDGs), specifically those goals geared towards eradicating poverty, ending hunger and ensuring the good health and well-being of people. Thus, investment in agriculture is crucial to increasing food productivity and ensuring sustainable food systems necessary to eradicate poverty and hunger globally (Asaleye *et al.*, 2023).

In Nigeria, agriculture stands as a foundation of the economy, contributing importantly to employment generation, national income and food security (Amurtiya *et al.*, 2018). It holds considerable promise for the nation's future economic advancement, akin to its historical significance when agriculture comprised a major segment of the national income. Agriculture was the mainstay of the Nigerian economy before the discovery of crude oil in the late 1950s. The sector contributed 80% of receipts on exports and 65% of gross domestic product to the Nigerian economy annually (Asaleye *et al.*, 2023). However, since the time of the oil boom, growth in the agricultural sector has slowed significantly, and its contribution to economic growth has taken a downward turn over the years. The contribution of agriculture to GDP has now reduced to about 26.84% in 2021 and 25.54% in 2022 (Central Bank of Nigeria, 2022; Oyaniran, 2020; Sa'id and Singla, 2021). The resultant effect has reflected in food insecurity, poverty, malnutrition and hunger all across the nation.

Recently, however, there has been a concerted effort to enhance agricultural productivity through the strategic use of agricultural inputs. These inputs, which include seeds, fertilisers, pesticides, credit and machinery, play a fundamental role in shaping the performance and rapid growth of the sector. The strategic use of agricultural inputs has emerged as a key factor in enhancing the performance of Nigeria's agricultural sector (Opeyemi *et al.*, 2021). According to Ghimire and Dhakal (2021), the relation between agricultural inputs and agricultural sector performance is many-sided and crucial. On one hand, the adoption of modern inputs has the potential to increase crop yields, improve soil health, and reduce pest and disease incidence. On the other hand, the effectiveness of these inputs is influenced by factors such as their availability, affordability, and the level of technological adoption among farmers. Understanding the impact of these inputs is essential for formulating policies and strategies that can drive sustainable agricultural development (Sujan and Ananta, 2021; Ojiya *et al.*, 2017).

This study investigates the effects of agricultural inputs on the performance of the agricultural sector in Nigeria from 1990 to 2022. Specifically, the study examines the effects of various inputs, such as credit, fertilisers, pesticides and exchange rates, on the performance of the sector. It is expected that findings from this study will assist researchers, policy makers and relevant government agencies in research, planning and policy making, which will help in reducing the food insecurity gap and, more importantly, achieve food security. Findings from this study are expected to address the challenges and limitations faced by farmers with respect to availability and affordability of agricultural inputs, with the objective of achieving the broader goals of food security and economic stability for Nigeria. By highlighting key trends and providing insights into the interplay between agricultural inputs and sector performance, this study aims to contribute to a deeper understanding of how Nigeria can leverage its agricultural resources for sustainable growth. Findings from the research will also aid policy makers and government agencies in economic planning.

MATERIALS AND METHODS

Data

Annual time series data from 1990 to 2022 were used for this study. The data were obtained from the FAO Statistical Database, World Development Indicators (2022), African Development Bank Data Repository and Central Bank of Nigeria (CBN) Statistical Bulletin. Logarithm forms of the data were taken and used for analysis to ensure stability of the data set.

Model Specification

The model specified annual agricultural GDP (AGRICGDP), a component of annual national GDP, as the dependent variable, while explanatory variables were specified as annual commercial bank credit to agriculture (CBCA), annual exchange rate (EXCH), annual fertiliser use (FERT) and pesticide use (PEST). The mathematical model specified for the study is expressed as:

$$\mathrm{AGRICGDP} = f\ (\mathrm{CBCA, EXCH, FERT, PEST})\ldots\ldots\ldots\ldots (1)$$

$$\log(\mathrm{AGRICGDP}) = \alpha_0 + \alpha_1 log(CBCA)_t + \alpha_2 log(EXCH)_t + \alpha_3 log(FERT)_t + \alpha_4 log(PEST)_t + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where;

AGRICGDP = Agricultural Gross Domestic product is the annual agricultural GDP component of total GDP (billion ₦)

CBCA = Annual Commercial Bank Credit to Agricultural Sector (billion ₦)

EXCH =Annual Exchange Rate (₦ per US dollar)

FERT =Annual Fertilizer Use (tonnes)

PEST = Annual Pesticide Use (tonnes)

μ_t =Error term

The description of the variables, the units of measurement, the sources of data, and the a priori expectations are presented in Table 1.

Table 1: Description of variables, unit of measurement and source of data

Variables	Description	Unit of Measurement	Source	Apriori expectations
AGRICGDP	Agricultural GDP	Billion ₦	CBN Statistical Bulletin	
CBCA	Commercial bank credit to agricultural sector	Billion ₦	CBN Statistical Bulletin	$\alpha_1 > 0$, Positive
EXCH	Exchange rate (official)	₦ per USD	World Bank Data (World Development Indicators)	$\alpha_2 < 0$, Negative
FERT	Fertilizer use	Tonnes	African Development Bank data repository & Africa Fertilzer (Data driven decision system for africa)	$\alpha_3 > 0$, Positive
PEST	Pesticide use	Tonnes	FAO Statistics	$\alpha_4 > 0$, Positive

Source; Author's compilations

Estimation technique and procedure

The Johasen co-integration test, Ordinary Least Squares regression model and Granger causality tests were the estimation techniques used in the study. The Johansen co-integration test was done to prevent spurious regression given the use of time series data for the study. It is most suitable for this model where the unit root test showed that the variables were stationary at first difference I (1). The Ordinary Least Squares regression model was thereafter used to estimate the effects of the agricultural inputs on the performance of the agricultural sector in Nigeria, measured by annual agricultural GDP.

RESULTS AND DISCUSSION

Pre-estimation analysis results

Table 2 presents the summary results of the descriptive statistics for the specified variables. The maximum and minimum values for AGRICGDP were ₦19,091.07 billion and ₦3,464.72 billion, respectively. The average value of commercial bank credit (CBCA) used for agricultural production over the period of study was ₦289.64 billion. The highest value of the exchange rate (EXCH) was ₦425.98, and this was recorded in 2021. The mean quantity of fertiliser (FERT) and pesticide (PEST) used for farm production was 351,208.30 tonnes and 208,21.67 tonnes, respectively. All the variables are positively skewed, having a long right-tailed distribution. All variables are also platykurtic with a kurtosis value of less than 3, except CBCA with a kurtosis value of greater than 3. Leptokurtic distributions have longer, heavy tails which contain more extreme values; thus, they have a greater tendency for outliers, while platykurtic distributions have thinner tails with less extreme outliers. The result of the unit root or stationarity test is presented in Table 3. Summary results revealed that the variables were all stationary at first difference I (1) as presented (Table 3).

Table 2: Results of descriptive statistics

Variables	AGRICGDP	CBCA	EXCH	FERT	PEST
Mean	10359.91	289.64	146.55	351208.30	20821.67
Median	1022.47	67.74	129.22	296000.00	12797.80
Maximum	19091.07	1676.40	425.98	804093.00	57822.60
Minimum	3464.72	4.22	8.04	131458.00	948.80
Skewness	0.12	1.98	0.84	0.76	0.76
Kurtosis	1.51	6.36	2.94	2.46	2.26
Observations	33	33	33	33	33

Source; Author's computations

Table 3: Phillips- Perron unit root test (Intercept, Linear trend)

Variables	Phillips - Perron Test Statistic	1% Critical Values	5% Critical Values	10% Critical Values	Order of Integration	p-Value
LogAGRICGDP	-4.9436	-4.2846	-3.5629	-3.2153	I(1)	0.0020
Log CBCA	-6.7849	-4.2846	-3.5629	-3.2153	I(1)	0.0000
Log FERT	-15.9698	-4.2846	-3.5629	-3.2153	I(1)	0.0000
Log EXCH	-5.4443	-4.2846	-3.5629	-3.2153	I(1)	0.0006
Log PEST	-3.9663	-4.2846	-3.5629	-3.2153	I(I)	0.0208

Source; Author's computations

Co-integration test

Since the results from the unit root test affirm that the variables are stationary at first difference I (1), it is subsequently important to test for cointegration among the variables to affirm the result of the unit root test. The Johansen cointegration test was used to determine the presence of a cointegrating relationship among the variables, and the result is presented in Table 4. The trace statistic (104.51) exceeds the 5% critical value (69.82), leading to the rejection of the null hypothesis of no cointegrating equation in favour of the alternative hypothesis indicating the presence of cointegrating equations (Table 4). In confirmation of this, the p-value of the hypothesis is significant at less than 5% (0.0000). We also reject the null hypothesis of no cointegrating relationship of "At most 1" because the p-value of 0.0291 is less than 0.05. Nevertheless, we accept the null hypothesis of no cointegration of "At most 2" because its p-value (0.2980) is greater than 0.05 and therefore not significant at 5%. So, using the unrestricted co-integrating rank test (trace), there are two co-integrating equations. According to Pesaran and Shin (1999), the presence of co-integration justifies a long-run relationship between a dependent variable and explanatory variables. This means that some of the explanatory variables, which in the case of this study are agricultural inputs, have a significant effect on the agricultural GDP in Nigeria.

The unrestricted co-integration rank test (Maximum Eigenvalue) is also another method used to confirm the presence of co-integration among variables in time series data. Results in Table 5 reveal that the max eigenvalue statistic of no cointegrating equation (54.24) is greater than the critical value of (33.88); as such, we reject the null hypothesis of no cointegrating equation and accept the alternative hypothesis of the presence of a cointegrating equation. The p-value of the hypothesis is significant (0.001) at less than 5%. We also reject the null hypothesis of no cointegrating relationship of "At most 1" because the p-value of 0.0409 is less than 0.05. Nevertheless, we accept the null hypothesis of no cointegrating equation at "At most 2" because the p-value of the Max Eigen value statistic is not significant at 5%. The Max Eigenvalue test therefore confirms the presence of 2 cointegrating equations. Based on the above results, we conclude that both the trace test and the max eigenvalue test confirm the presence of cointegrating equations. There is therefore a long-run relationship between the dependent variable annual (AGRICGDP) and the explanatory variables (CBCA, EXCH, FERT, and PEST). A similar result of a long-run relationship between agricultural productivity and agricultural inputs was also reported by Ojiya *et al.* (2017) and Opeyemi *et al.* (2021).

Table 4: Unrestricted cointegration rank test (trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.826172	104.5132	69.81889	0.0000
At most 1 *	0.598168	50.27282	47.85613	0.0291
At most 2	0.302805	22.00946	29.79707	0.2980
At most 3	0.263594	10.82805	15.49471	0.2223
At most 4	0.042394	1.342871	3.841466	0.2465

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
Source; Author's computations

Table 5: Unrestricted cointegration rank test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.826172	54.24042	33.87687	0.0001
At most 1 *	0.598168	28.26336	27.58434	0.0409
At most 2	0.302805	11.18141	21.13162	0.6292
At most 3	0.263594	9.485178	14.26460	0.2480
At most 4	0.042394	1.342871	3.841466	0.2465

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
Source; Author's computations

The ordinary least squares regression model

After establishing the presence of cointegration among the variables, an ordinary least squares regression model was employed to determine the effects of agricultural inputs on the performance of the agricultural GDP in Nigeria. The results are presented in Table 6 and revealed that fertiliser consumption by the agricultural sector had a positive and significant impact on the performance of the agricultural GDP. It signals that a unit increase in fertiliser use will increase agricultural GDP by 12.28%. In the same vein, one unit increase in pesticide use had a significant positive impact on agricultural GDP by 20.37%. However, contrary to *a priori* expectation, the results further revealed that a unit increase in exchange rate impacts agricultural GDP positively by 19.05%. This could be as a result of foreign exchange being earned due to the export of some agricultural produce. Studies by Ghimire and Dhaka (2021) and Opeyemi *et al.* (2021) also confirm similar results.

Table 6: Ordinary least squares regression results of Annual Agric GDP on Agricultural inputs in Nigeria, 1990- 2022.

Dependent variables: LOGAGRICGDP				
Variables	Coefficient	Std. Error	t-Statistic	Prob.
LOGCBCA	0.0862	0.0564	1.5276	0.1378
LOGFERT	0.1228**	0.0548	2.2390	0.0333
LOGEXCH	0.1905***	0.0646	2.9466	0.0064
LOGPEST	0.2037***	0.0566	3.5971	0.0012
C	1.8904	0.3369	5.6109	0.0000
R-squared	0.941766			
Adjusted R-squared	0.933447			
Log likelihood	43.72412			
F-statistic	113.2054			
Prob(F-statistic)	0.000000			
Durbin-Watson stat	2.113594			

****, ** and * represent 1%, 5% and 10% levels of significance*
Source; Author's computations

Nevertheless, commercial bank credit to the agricultural sector had no significant impact on agricultural GDP in Nigeria, but the effect is positively related to agricultural performance. This could be because many Nigerian farmers who contribute to agricultural output do not have access to credit loans for farm production due to lack of collateral security or access. Basically, a majority of Nigerian farmers are small-scale farmers, and because of their peculiar nature of being poor, they will need credit support to acquire inputs needed to boost agricultural output. Sufficient and timely credit loans for farm production are a crucial requirement for farming endeavours and will increase agricultural output. Our study results for fertiliser, pesticides and credit follow our *a priori* expectation of a positive sign, i.e., $\alpha > 0$. Consequently, the exchange rate did not follow our *a priori* expectation of a negative sign due to foreign exchange earnings from the export of agricultural products.

The value of the coefficient of determination (R^2) is 0.9418. This implies that about 94.18 per cent of the total variation in agricultural GDP is explained by the changes in the stated explanatory variables (agricultural inputs). The probability of the F statistic (113.2054) of the model is significant at 1 per cent (0.0000). This further shows that the model is a good fit. The Durbin-Watson statistic at 2.1136, which is around 2, reveals the absence of autocorrelation in the data set.

Pairwise Granger causality test

For the pairwise Granger causality test, to reject the null hypothesis formulated, the probability value of the F-statistics must be less than 5%. In cases where the probability of F-statistics is greater than the 5% level of significance, the null hypothesis is not rejected, thus concluding that the variable under consideration does not Granger-cause the other. Result extracts from Table 7 reveal that of all significant variables, the variables of interest are exchange rate and agricultural GDP. Results reveal a unidirectional causality between exchange rate and agricultural GDP over the period of study. Exchange rate could therefore predict agricultural performance over the period of study. This is because the major ingredients for compounding fertiliser and other machinery inputs needed for agricultural production are imported.

Table 7: Results of pairwise Granger causality test

Decision	F value	P – value
Presence of unidirectional causality between logexch and logagricgdp	7.0004	0.0037**
Presence of unidirectional causality between logagricgdp and logpest	7.4228	0.0028**
Presence of unidirectional causality between logpest and logexch	6.9677	0.0038**

*** represent 5% levels of significance*

Post estimation tests

Post-estimation tests help to validate the results of our analysis so as to ascertain the usefulness of the estimated model for policy making. Based on our diagnostic tests, the CUSUM (cumulative sum of recursive residuals) test and CUSUMSQ (CUSUM of squares) test used for testing the stability of the parameters presented in figures 1 and 2 show that the CUSUM plot and CUSUM of squares plot lie within the critical lines. This suggests that the estimated model is relatively stable and that valid conclusions can be drawn from its estimated coefficients. These tests are suggested by Pesaran and Shin (1999) for measuring the parameter stability. Results of the diagnostics test on Table 8 also reveal that there is neither autocorrelation nor heteroskedasticity among the variables. Jaque Bera statistics also show that the data set is stable. Reliable policy decisions can therefore be inferred from the results of the findings.

Table 8: Diagnostic tests' results

Diagnostic Test	Test Value	Probability value	Significance	Decision
Autocorrelation test (Breusch-Godfrey Statistic)	0.4866	0.6206	Not significant	No autocorrelation
Heteroskedasticity Test	2.2056	0.0941	Not significant	No heteroskedasticity
Jarque- Bera Test	1.6850	0.4306	Not significant	Data is stable

Source; Author's computations

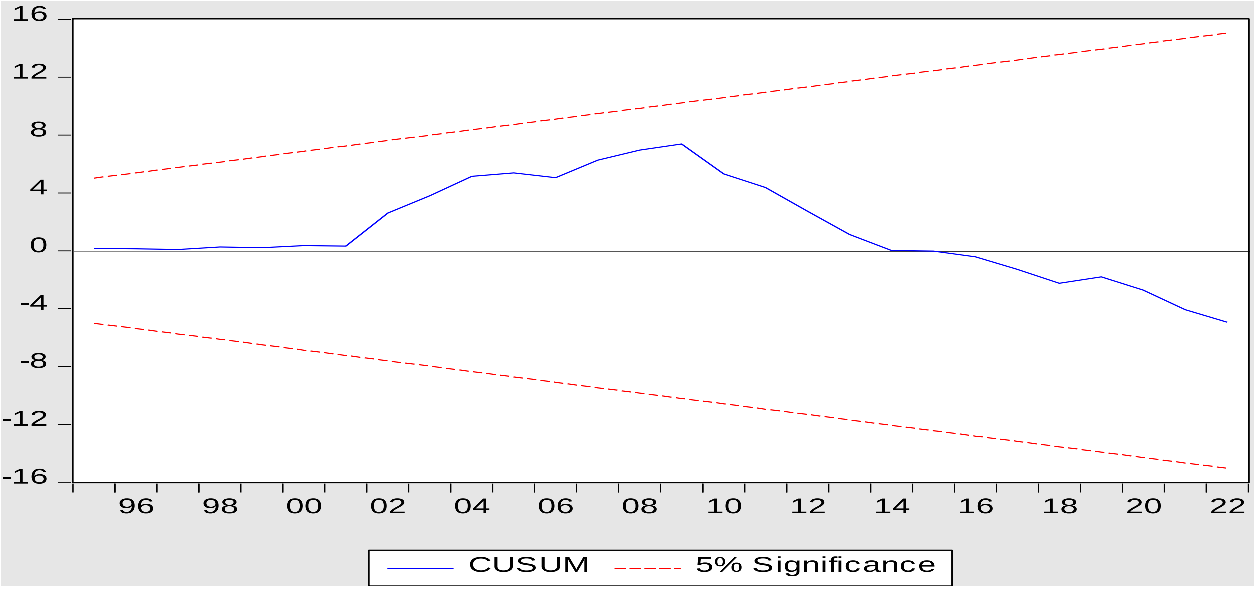

Figure 1: CUSUM Plot

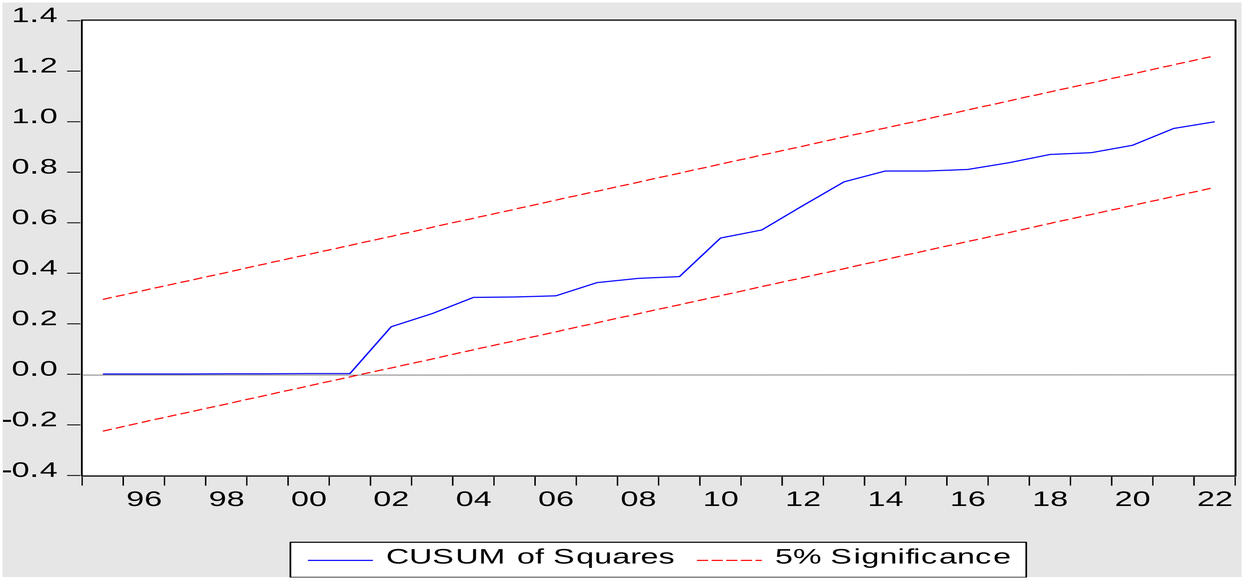

Figure 2: CUSUM of squares plot

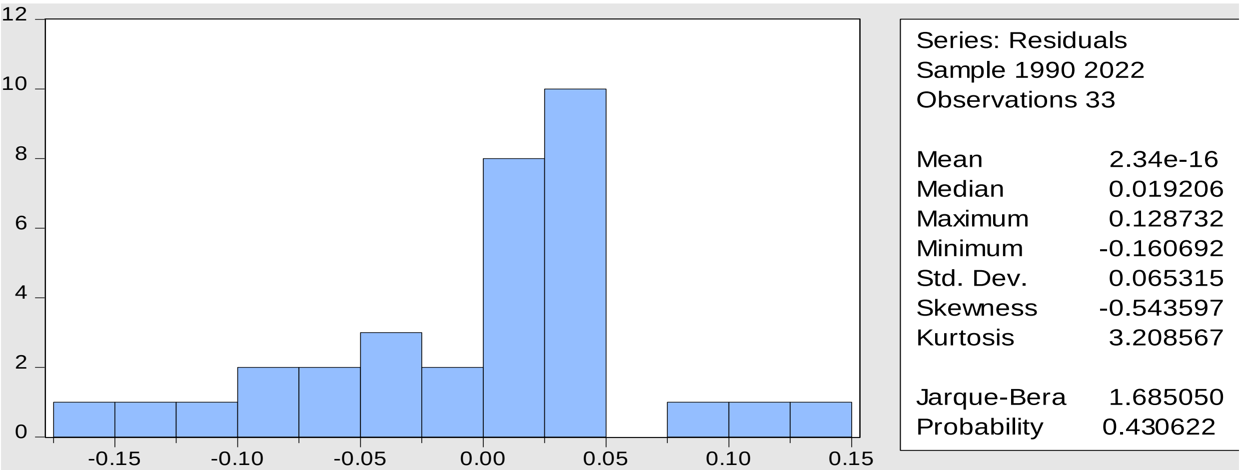

Figure 3: Histogram graph for the relationship between agricultural inputs and agricultural GDP

CONCLUSIONS

This study investigated the effect of agricultural input use on agricultural GDP in Nigeria. Time series, secondary data from 1990 to 2022 obtained from the FAO statistical database, CBN statistical bulletin, African Development Bank Data Repository and World Development Indicators were used for the analyses. Methods of analysis include the Phillips Perron unit root test, Johansen co-integration test, ordinary least squares regression model and Granger causality test. Given the double log model of the regression analysis, the parameters estimated are elasticities of the inputs, meaning a 1% change in the inputs will result in the corresponding value of percentage change in the output value. Results revealed that after the unit root test, all variables were stationary at first difference I (1). The Johansen co-integration test confirmed a long-run relationship among the specified variables. The results confirm a long-run equilibrium relationship between the dependent variable (AGRICGDP) and the explanatory variables (CBCA, EXCH, FERT, and PEST). Results of the Ordinary Least Squares regression model revealed that a 1% increase in fertiliser use, pesticide use and exchange rate had a significant positive impact on the performance of the agricultural GDP to the tune of 12.28%, 20.37% and 19.05%, respectively. On the other hand, credit loans had no significant impact on agricultural output, though the direction of the effect is positive. Granger causality tests reveal a unidirectional causality between exchange rate and agricultural GDP due to exports of some agricultural produce. The study concludes that improved access to fertilisers and pesticides will improve agricultural GDP. The study therefore recommends more concerted efforts by government to ensure better access to agricultural inputs by farmers through appropriate targeted policies.

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