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Macroeconomics determinant of agricultural productivity in Nigeria: Evidence from crop production

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Abstract

This study examined the effect of macroeconomic variables on agricultural productivity, evidence from crop production between 1990 to 2021. The variables include interest rate (INT), exchange rate (EXR), inflation rate (INF), government expenditure on agriculture (GXP), gross capital formation (GCF), and household expenditure (HCX). The variables were verified for unit root. Hence, the various order of integration 1(0) and 1(1) paved the way for the adoption of ARDL. The ARDL co-integration test revealed the existence of a long-run relationship between the variables. The regression result showed that the coefficient of INT, GXP, and GCF are positive and statistically not significant. Suggesting that a 1% rise in these coefficients will result in a 0.02%, 0.02%, and 1.6% respectively increase in crop production. More so, the coefficient of EXR and HCX was found to have positive and statistically significant effects on crop production for the period under review. However, the coefficient of INF was found to exert a negative effect on crop production. This suggests that a 1% rise in INF will result in a (0.08) decrease in crop production. The study concluded that crop production is influenced by the macroeconomic variables. Based on this, the study recommended that the federal government, through the monetary authority, develop a system that would ensure that farmers would receive an interest rate in the single digits. Additionally, the government should give adequate attention to agriculture and should make sure that its financial allotment for agriculture is properly executed and that the funds are used efficiently in order to boost agricultural output.

Keywords: Macroeconomic variables, exchange rate, inflation rate, Agriculture, interest rate

1. Introduction

Macroeconomic policy and agriculture work together harmoniously. While agriculture is a developing nation's principal economic driver, macroeconomic policy may also be a catalyst. An economy's production would not be complete without agriculture, and the productivity of this sector depends on wise macroeconomic policy. Macroeconomics provides the "big picture" of an economy's functioning as a whole Odior (2014). This indicates that although the agricultural sector may be a method of achieving macroeconomic policy goals, macroeconomic policy may also determine the course of the agricultural sector's development (Ojo, & Olayinka, 2019). As a result, moving toward strong evidence-based policies anchored on sound

macroeconomic policies is required to encourage more equitable and economically sustainable growth in the agricultural sector. According to economists, changes in macroeconomic policy frequently have a considerable influence on the global agriculture sector. The agricultural sector frequently suffers unintended and negative effects from policies that are intended to boost the national economy, according to Odior (2014). Onakoya, Aroyewun-Khostly, & Jonhson (2018) made a suggestion to this effect, arguing that the behavior of macroeconomic variables has become asymmetric over time, to the disadvantage of the overall economy, particularly agriculture.

Before oil was discovered in 1956, the agricultural industry was unquestionably the foundation of the economy and the main source of income for the nation. Due to the country's significant exports of rubber, groundnuts, hides and skins, cocoa, coffee, palm oil, and palm kernels, it served as the foundation of the Nigerian economy (Sylvester 2018). Nearly 65% of the GDP's total production, more than 80% of Nigeria's export profits, and nearly 50% of government income were all derived from agriculture in the 1960s (PWC, 2019). Approximately 35% of Nigeria's GDP was contributed on average by this sector, and 88% of the country's non-oil export revenue was earned in foreign currency (CBN, 2010). Additionally, it gave nearly 70% of the labor force jobs (WDI, 2017). That has changed now. Okeke & Okeke (2022) claim that the government's lack of interest in the agricultural sector was accelerated by the ascent of the oil industry in the 1970s and the subsequent surge in crude oil revenues in the early 1970s. The industry accounted for about 65-70% of overall output in the 1960s, but that percentage dropped to around 40% in the 1970s and then sank to less than 2% in the late 1990s (PWC, 2019). The shocks to the macroeconomic variables anticipate economic imbalance because of the excessive reliance on oil and the externally set pricing and output quotas. This broadened the potential perspective for other industries, like agriculture. The behavior of macroeconomic variables resulting from the occasionally competing fiscal, monetary, and trade policies of emerging economies is significantly influenced by the volatility of oil prices (Okeke & Okeke, 2022).

Despite the fact that petroleum contributes around 80% of the nation's yearly export revenue in recent time, agriculture has made a larger contribution to Nigeria's GDP than petroleum. Over 40% of the country's GDP in 2011 and 2012 came from agriculture. The agriculture industry made the largest contribution to Nigeria's overall GDP in 2018 (an estimated 25%), followed by the oil sector (8.6%), which made the smallest contribution (Adedotun, 2022). The country's GDP increased by 2.27 percent in 2019 (from ₦69.80 trillion in 2018 to ₦71.39 trillion in 2019). The agriculture sector contributed the most (₦10.50 trillion), followed by the trade industry (₦5.94 trillion), and the information and communication sector (₦4.66 trillion). In 2020, the oil industry contributed less than 9% of Nigeria's GDP, while the agriculture sector contributed 24%. In 2021, the agriculture sector contributed 25.88% of the country's GDP, while the oil industry's share was still less than 10% (7.24%). Agriculture has unquestionably been the most significant factor in Nigeria's recent economic expansion.

Moreover, employment in Nigeria's agriculture sector represented close to 35% of the country's overall employment in 2019 and 2020, according to a set of development indicators compiled by the World Bank (Adedotun, 2022). Nearly 71 million hectares of Nigeria's land area are

being utilized for farming activities including crop production, according to the United Nations Food and Agriculture Organization (FAO, 2021). This enormous expanse of agricultural land includes 30.3 million hectares of meadow and pasture, 6.5 million hectares of permanent crops, and 34 million hectares of arable land, which ranks seventh in the world for arable land area. With livestock, forestry, and fisheries making up the remaining 10% of agriculture's GDP, crop production accounts for almost 90% of it. Nigeria's main crops are cassava, yam, maize, sorghum, rice, and millet. Together, these crops occupy 65% of the entire farmed area (Adedotun, 2022).

Consequently, despite this contribution to the nations GDP, the sector has not maximized its potential fully considering the size of arable lands left uncultivated and surge in unemployment. However, there has been a lot of work done to address this concern and accelerate agricultural productivity, but many of these efforts have not yet been successful in doing so. None of these seem to have thoughtfully addressed the industry concerns. Agricultural programs, direct orders, extension services, and subsidies are further examples of government initiatives that aim to strengthen the industry. However, according to Enoma & Musa (2019), these have not produced the best results. The measures, such as selective interest rates, agricultural credit programs, extension services, and subsidies, maybe too direct and unable to reach many farmers. The agricultural sector, however, has a significant influence on an economy, according to research done by a number of classical and neo-classical researchers. Thus, the condition of the agricultural industry may be illustrated in terms of increasing productivity and reducing production costs within the industry (Christinah & Teboho, 2019). Thus, the industry has a favorable influence on the country's development, social welfare, employment creation, and food security. Nigeria has to enhance its agriculture sector most importantly since it is a developing nation with a burgeoning economy. Poor governance and inconsistent policy execution, according to Cristea, Marcu, & Meghisan (2015), are major factors in the lack of progress in the agricultural sector. It is essential to promote more equitable and environmentally sustainable growth in the agricultural sector in the 21st century due to the shift in agriculture and agricultural productivity (Sunday, Ini, Glory & Daniel, 2012). This paradigm shift calls for sound evidence-based policies that are anchored in sound macroeconomic policies.

As a result, a number of variables may be argued to be to blame for the subpar performance of Nigeria's agricultural industry. The macroeconomic environment is made up of fiscal, monetary, exchange rate, and trade policies, among others, that have a tendency to control the production activities in the real sectors and other sectors, including the agricultural sector (Sunday, Ini, Glory & Daniel, 2012). Nevertheless, the results of macroeconomic policy in every country vary widely depending in part on the objectives and tools used, as well as the operational environment (Agu, 2007). The achievement of national development goals through agricultural growth depends on sound macroeconomic policy. Low productivity, notably in the yield of cereal crops that were overrun by macroeconomic instability, was the cause of the sector's slowing contribution to Nigeria's GDP. Agriculture, on the other hand, has a reputation for being one of the biggest employers of labour in developing nations like Nigeria. The study's main goal is to determine how macroeconomic factors affect agricultural production in Nigeria.

2. Literature Review

2.1 Theoretical Literature

The Mundell-Fleming and high-payoff input models serve as the foundation for this study's theoretical perspective. The capacity to annex present agricultural resources, which are presumed to come from outside the agricultural sector itself, is the fundamental premise of the high-pay-off input model (Enoma, & Musa, 2019). It is proposed that elements promoting agricultural growth should be exogenous and supported by legislation, instruction, and technology that is accessible to and inexpensive for peasants. The Mundell-Fleming model shows how macroeconomic policy tools relate to the real sector, which includes agriculture. The model suggests that policy instruments, such as macroeconomic variables, can act as efficient conduits for the transmission of government policy to the real sector. If these instruments are properly managed, they can significantly enhance the performance of the sectors (Enoma, & Musa, 2019).

2.2 Empirical Literature

Okeke & Okeke (2022) investigated the effect of macroeconomic variables on agricultural output in Nigeria, using time series data ranging from 1995 to 2020. The study applied the cobb-Douglas production function. The study's empirical findings demonstrated that the money supply, the rate of inflation, and the exchange rate all have a positive influence on agricultural output, whereas commercial bank loans to the sector, interest rates, and government spending on the sector had a negative impact. Massive financing for the agriculture sector was advised by the report.

Okafor & Isibor (2021) utilized time series data from 1986 to 2020 in their study on the effects of macroeconomic factors like exchange rate and inflation on the growth of Nigeria's agriculture business. Data analysis for the study employed Ordinary Least Squares. The empirical results showed that while the inflation rate was adversely significant, the influence of the exchange rate on the dependent variable was favorably significant. The interest rate was inconsequential. The study recommends that the monetary authorities use measures to lower inflation, such as reducing the money supply. Reduced inflation would help the agriculture sector grow since it would enhance demand for agricultural products.

Christinah, & Teboho (2019) in their empirical analysis of macroeconomic variables towards agricultural productivity in South Africa. The study used three different equation variants to arrive at a range of outcomes. The findings suggested that all estimated equations' variables are in a long-run equilibrium. Overall findings show that capital creation and GDP both positively and significantly influence agricultural production. Additionally, the findings imply that there is proof of a causal relationship between macroeconomic factors and agricultural production. The findings recommends that policymakers should provide the agricultural sector with enough financial assistance in South Africa in order to raise agricultural production. This support might take the form of funding for the development of agricultural infrastructure and giving development skills.

Enoma, & Musa, (2019) examined the effect of macroeconomic variables on agricultural output in Nigeria employing time series data from 1981 to 2017. In order to analyze the time series data, they used an ordinary least square (OLS) and error correction model. The examination of short-run error correction showed that long-run equilibrium was quickly reached. The study provided proof of a long-term connection between macroeconomic factors. The study also showed that the importance of the exchange rate in affecting the increase of agricultural production. The research recommended that the government

improve its financial assistance for farmers and that the apex bank carefully consider the stability of the currency rate.

Similarly, Obasaju and Baiyegunhi (2019) studied the effect of macroeconomic variables on the agricultural sector over a period of 36 years using time series data ranging from 1980–2016. The study used a vector error correction model (VECM) and Variance Decomposition approaches to analyze the short- and long-term relationships between macroeconomic policies and real agricultural output in Nigeria (1980: Q1 - 2014: Q4). According to his research, the two macroeconomic factors that are statistically significant in the long run for explaining variance in real agricultural production are inflation and money supply, with inflation having a bigger effect on real agricultural output. His research revealed, among other things, that Nigeria's real agricultural output is influenced by the inflation rate Granger. He advised policymakers to implement thoughtful interest rates while also maintaining price stability in order to increase effective demand and investment and thus increase real agricultural output in Nigeria.

Enilolobo, Mustapha & Ikechukwu (2019) investigated the effect of macroeconomic indicators on agricultural output in Nigeria using quarterly time series data for the period 1981-2018 from various publications of the CBN Statistical Bulletin and National Bureau of Statistics. According to the research's findings, Nigeria's inflation rate fluctuates across the study period and has a negative but substantial effect on agricultural growth. The influence of the exchange rate and the cost of finance on agricultural output varies.

Given the volatility of the macroeconomic variables during the past ten years, the empirical literature review revealed that there have only been a few recent research related to this subject matter. However, it appears that the majority of current research focuses more on using interest rates, exchange rates, gross domestic product, and inflation to explain agricultural expansion. Consequently, this current study is adopting a unique perspective through its specific focus on crop production, and by the introduction of gross capital formation and household consumption into the model. This is expected to produce a more robust result to what is currently available in the existing works of literature.

3. Methodology

The econometrics model for this study is specified below;

$$AGP_t = \beta_0 + \beta_1 INT_t + \beta_2 EXR_t + \beta_3 InGCF_t + \beta_4 INF_t + \beta_5 HCX_t + \beta_6 GXP_t + \varepsilon_t \ldots. (1)$$

Where β0 is the intercept and β_1, β_2, β_3, β_4, β_5 are explanatory variables coefficients and μt is the error term. AGP: agricultural productivity proxied by crop production, INT: rate of interest, EXR: rate of exchange, GCF: gross capital formation, INF: rate of inflation, HCX: household consumption expenditure, and GXP: government expenditure on agriculture.

Certain variables are therefore converted into logarithms to obtain the elasticity of coefficients and remove the outlier effect. In terms of log-linear form, the function becomes:

$$AGP_t = \beta_0 + \beta_1 INT_t + \beta_2 EXR_t + \beta_3 InGCF_t + \beta_4 INF_t + \beta_5 InHCX_t + \beta_6 GXP_t + \varepsilon_t \ldots.. (2)$$

The principles of economic theory examine the apriori expectation and make reference to the sign and size of the parameters of economic relationship. It is expected that; $\beta1 < 0$; $\beta2 <> 0$; $\beta3 > 0$; $\beta4 <> 0$; $\beta5 > 0$; $\beta6 > 0$. Where $\beta>0$ denotes a positive relationship between AGP and the

coefficients of the explanatory variables, β<>0 implies that the coefficient could be positive or negative.

Therefore, to facilitate the interpretation of the coefficients as elasticities, the equation 2 would be required to be transformed using logarithm. As such, the transmuted model is given as:

$$\Delta lnAGP = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i}\Delta lnAGP_{t-1} + \sum_{i=1}^{q} \alpha_{2i}\Delta lnINT_{t-1} + \sum_{i=1}^{q} \alpha_{3i}\Delta lnEXR_{t-1} + \sum_{i=1}^{q} \alpha_{4i}\Delta lnGCF_{t-1} + \sum_{i=1}^{q} \alpha_{5i}\Delta lnINF_{t-1} + \sum_{i=1}^{q} \alpha_{6i}\Delta lnHCX_{t-1} + \sum_{i=1}^{q} \alpha_{7i}\Delta lnGXP_{t-1} + \gamma_8 lnAGP_{t-1} + \gamma_9 lnINT_{t-1} + \gamma_{10} lnEXR_{t-1} + \gamma_{11} lnGCF_{t-1} + \gamma_{12} lnINF_{t-1} + \gamma_{13} lnHCX_{t-1} + \gamma_{14} lnGXP_{t-1} + e_t \quad \text{eq 3}$$

In equation 3, Δ denote the first difference operator. Whereas p is the dependent variable optimal lag length, while, the optimal lag length for the regressors is denoted by q, α_1,... α α denote short-run dynamics of the model. Nonetheless, the long run elasticities are represented by γ_8 – γ_{14}.

4. Results and Discussion

Stationarity Test

Table 1: Augmented Dickey-Fuller Unit Root Test

Variable	ADF Stat.	Critical value (5%)	Order of integration	Prob.
L(AGP)	-5.275953	-2.960411	1(0)	0.0001
INT	-3.703740	-2.991878	1(0)	0.0108
EXR	-3.495615	-2.986225	1(1)	0.0168
L(GCF)	-10.46824	-2.967767	1(1)	0.0000
INF	-5.275953	-2.960411	1(0)	0.0001
LHCX	-6.513977	-2.963972	1(1)	0.0000
GXP	-7.689090	-2.986225	1(1)	0.0000

Source: *authors computation, eviews 10, 2023*

The stationarity result showed that not all the variables achieved unit root at order 1(0). Hence, while L(AGP), INT, & INF are stationary at level 1(0), variables such as the EXR, L(GCF), L(HCX) & GXP were differenced at the first level, order 1(1) for stationarity to be achieved. The varied order of the variables thus, paved the way for adopting ARDL bound cointegration test.

Table 2: Cointegration Test Results

F-statistic	49.45453	K= 6
Critical Value Bounds		
Significance	**I(0) Bound**	**I(1) Bound**
10%	2.53	3.59
5%	2.87	4
2.5%	3.19	4.38
1%	3.6	4.9

Source: *authors computation, eviews 10, 2023*The ARDL result showed a long-term bond between the dependent variable, agricultural productivity (AGP), and the explanatory variables. Therefore, the null hypothesis of no co-integration can be rejected, since the calculated F-statistics (49.45453) is greater than the upper critical bound at a 5% level of significance.

Table 3: Regression Result of the ARDL Cointegration and Long-Run form

Dependent Variable: AGP				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
Shor- Run ARDL				
DLog(INT)	0.024081	0.004706	5.117626	0.0361
DLog(EXR)	-0.108680	0.017019	-6.385654	0.0237
DLog(INF)	-0.043619	0.008309	-5.249954	0.0344
DLog(GXP)	-0.021043	0.004586	-4.588251	0.0444
DLog(LGCF)	-0.596966	0.279993	-2.132079	0.1667
DLog(LHCX)	-1.297967	0.187962	-6.905484	0.0203
CointEq(-1)*	-0.792243	0.021290	-37.21192	0.0007
Long-Run ARDL				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
Log(INT)	0.024479	0.011675	2.096652	0.1710
Log(EXR)	0.041038	0.009102	4.508695	0.0458
Log(INF)	-0.085466	0.010125	-8.440638	0.0137
Log(GXP)	0.025753	0.007927	3.248587	0.0831
Log(LGCF)	1.605456	0.783253	2.049728	0.1769
Log(LHCX)	0.559883	0.136389	4.105050	0.0545
C	-2.237573	0.061772	-36.22297	0.0008
@TREND	0.003266	0.001809	1.805654	0.2127
R-squared	0.999989	Durbin-Watson stat		2.410631
Adjusted R-squared	0.999847	F-statistic		7030.875
		Prob(F-statistic)		0.000142

Source: *authors computation, eviews 10, 2023*

The regression result of the ARDL cointegration is presented in Table 3 above. The implication of the Durbin-Watson test of 2.4 in this study is that all the variables are not correlated. It is expected that Durbin Watson must be equal to 2 or approximately 2 to prove that there is no autocorrelation among the variables. The R^2 of 0.99 implied that changes in the independent variables will bring a 99% change in the dependent variable.

The coefficient of interest rate (INT) exerts a positive association with the dependent variable. This suggests that a one percent rise in INT will result in a 0.02% increase in crop production. Though, this finding is statistically not significant. More so, the coefficient of the exchange rate (EXR) is positive and statically significant. This shows that a one percent increase in the coefficient of EXR will result in a 0.041% increase in crop production. Also, the coefficient of inflation rate (INF) was found to exert a negative and statistically significant effect on crop production. Suggesting that a one percent rise in the inflation rate will result in a (0.085%) decrease in crop production. Therefore, the finding of Okafor & Isibor (2021) study on the macroeconomic variable and Nigeria's agricultural sector development supports the study outcome of this current finding. Consequently, their study showed that the

coefficient of interest rate is positive and statistically insignificant. While the coefficient of the inflation rate is negative and statistically significant. Also, the coefficient of the exchange rate is positive and statistically significant.

The coefficient of government expenditure (GXP), and gross capital formation (LGCF) had positive implications on the dependent variable (crop production). This implies that a one percent rise in GXP and LGCF will result in a 0.025% and 1.60% respectively rise in crop production. However, this finding is statistically not significant. This may be attributed to corruption and poor policy implementation by the government. The budgetary allocation for agriculture often does not get to the end users (the farmers).

Finally, the coefficient of household expenditure (HCX) was found to have a positive and statistically significant impact on crop production. suggesting that a one percent rise in HCX will result in a 55% increase in crop production. This finding is in tandem with economic theory, such as the Keynesian consumption-income theory. Additionally, the finding also reflects the current economic realities in Nigeria.

Table 4: Diagnostic Test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.211810	Prob. F(1,1)	0.7254
Obs*R-squared	5.068851	Prob. Chi-Square(1)	0.0244

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.339249	Prob. F(26,2)	0.9298
Obs*R-squared	23.63980	Prob. Chi-Square(26)	0.5966
Scaled explained SS	0.157070	Prob. Chi-Square(26)	1.0000

Source: *authors computation, eviews 10, 2023*

The Breusch-Godfrey serial correlation test examines for serial correlation that isn't already present in a model. Because the test is based on the concept of Lagrange multiplier testing, the null hypothesis is that there is no serial correlation of any order up to p. If the p-value in this situation is higher than 0.05, we draw the conclusion that the residuals do not exhibit serial correlation. As a result, with a probability value of 0.7254, there is no proof that the residuals are serially correlated. Additionally, the heteroskedasticity was examined using the Breusch-Pagan-Godfrey test. The outcome indicates that there is a higher likelihood of 0.9298 than 0.05. As a result, the hypothesis that heteroscedasticity exists in the residuals is rejected. As a result, it can be said that the model is reliable and that it may be used directly to the formulation of policy.

Table 5: Q-statistic probabilities adjusted for 2 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.**| . |	.**| . |	1	-0.277	-0.277	2.4597	0.117
.**| . |	.**| . |	2	-0.207	-0.307	3.8858	0.143
. | . |	.**| . |	3	-0.039	-0.238	3.9379	0.268
. | . |	.**| . |	4	-0.013	-0.224	3.9439	0.414

*Probabilities may not be valid for this equation specification.

Source: *authors computation, eviews 10, 2023*

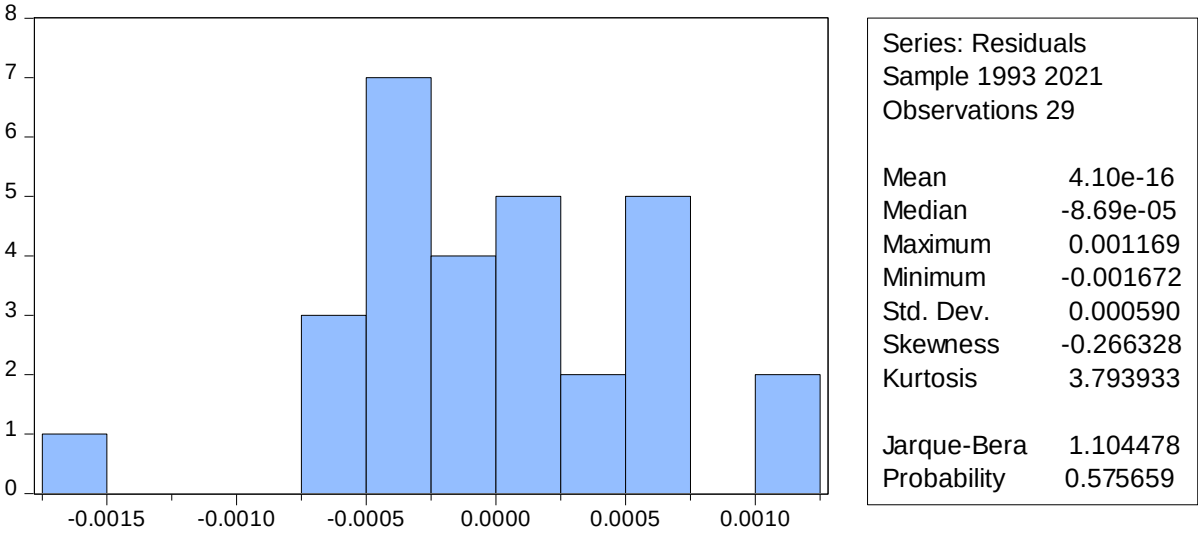

Fig 1: Normality Test

Source: *authors computation, eviews 10, 2023*

The Jarque-Bera is 1.104478 with an associated probability of about 0.57. Going by the decision rule, the null hypothesis cannot be rejected, therefore, it can be concluded that the error term is normally distributed.

4. Conclusion and Recommendations

Developing countries like Nigeria is faced with the issue of pro-poor agricultural productivity and hunger. While various studies have attempted to look at this issue with the aim of discovering ways out of the challenge. Most of these studies have incidentally failed to specifically addressed the issue from a specific standpoint point. Consequently, this study examined macroeconomic determinants of crop production in Nigeria, using a time series of data that ranged from 1990 to 2021. The study found that the coefficient of INT, EXR, GXP, LGCF, and LHCX had positive impact on crop production in Nigeria for the period under review. However, the coefficient of EXR, and LHCX were found to be statistically significant. While INT, GXP, and LGCF are statistically insignificant. Additionally, the coefficient of INF had a negative and statistically significant influence on the dependent variable (crop production). Therefore, it can be established from the finding that

crop production is influenced by the selected macroeconomic variables. Based on this conclusion, the research suggested that the federal government, through the monetary authority, develop a system that would ensure that farmers would receive an interest rate in the single digits. Additionally, the government should give adequate attention to agriculture and should make sure that its financial allotment for agriculture is properly executed and that the funds are used efficiently in order to boost agricultural output.

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