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CLIMATE VARIABILITY AND FOOD SECURITY IN NIGERIA (1986-2022)

***KAREEM, R.O.,[1] ADENIYI, B.A.,[2] WILLIAMS, S.B.,[3] GBADAMOSI, G.R.[1] AND RAHEEM, K.[1]**

[1]Department of Economics and Actuarial Sciences, College of Arts, Social and Management Sciences (CASMAS), Crescent University, Abeokuta (CUAB), Ogun State, Nigeria

[2]Department of Economics Education, Emmanuel Alayande University of Education, Oyo, State

[3]Nigerian Women in Agricultural Research and Development, Victoria Island, Lagos, Nigeria

*Corresponding address: rskventures@yahoo.com

Abstract

The study investigated Nigeria's climate variability (CV) and food security (FS) using secondary data from the Central Bank of Nigeria Statistical Bulletin and NIMET. Unit root test was carried out using Augmented Dickey-Fuller to ascertain the stationarity of the variables, and they were found to be stationary at order I (0) and I (1). ARDL (Autoregressive distributed lag) bound test was used to analyse the model as no long-run co-integration existed among the variables. The result of a short-run Autoregressive Distributed Lag (ARDL) analysis was used to examine the impact of CV on food security in Nigeria. The Granger causality test was used to test for the causality among the variables in the model as well as checked the direction of causality among variables. The result revealed that the short-run autoregressive distributed lag (ARDL) showed that the value of agricultural output (a proxy for food security) of the previous year had an insignificant effect on CV in Nigeria. The result also showed a uni-directional causality between carbon emission and food security, between temperature and food security, and between government expenditure on agriculture and food security. The study concluded that the FS of the previous year had an insignificant effect on CV in Nigeria. Still, government expenditure on agriculture was positive but insignificant on food security in Nigeria within the period under review. Therefore, the study recommends that the Government enact carbon reduction policies through global climate initiatives and agreements to enhance food security.

Key Words*: Climate Variability, Augmented Dickey-Fuller, ARDL, Granger Causality, Food Security, Uni-directional, Nigeria*

Introduction

Climate variability (CV) has been described as a statistical variation that persists for an extended period, typically for a decade or longer. It includes shifts in the frequency and magnitude of sporadic weather events as well as the slow but continuous rise in global average surface temperature (IPCC, 2014). The United Nations Framework Convention on Climate Change (UNFCCC) defined Climate change as a change of climate which is attributed directly or indirectly to human activity, that alters the composition of the global atmosphere and in addition to natural CV, observed over some comparable period (Ibrahim, 2014).

Nigeria has been identified as one of the sub-Saharan African states that are vulnerable to changing climatic conditions (Ughaelu, 2017). Some researchers such as Ughaelu (2017), and Ikem (2018) have noted that recurring environmental disasters in parts of Nigeria have worsened food productivity and human suffering in the past decade. In 2012, severe flooding that had not been recorded in the country in the past four decades occurred in many parts of Nigeria leading to heavy losses in human lives, crops, and livestock as well as human displacement (Ogbuchi, 2020).

Food security (FS) is an essential element of overall well-being. Increasingly, in the last decade, attention has been focused on means of eliminating food insecurity and hunger worldwide. The idea of food security was presented for the first time at the World Food Conference in 1974 and viewed solely from the perspective of having adequate availability of food on a national scale. Today it is a condition in which all people have access at all times to enough food of an adequate nutritional quality for a healthy and active life (Adebayo, 2010).

Despite Nigeria's rich agricultural resource endowment, the agricultural sector has not been developed in a way to combat the problem of food insecurity in the country. The challenges of adequate food security in a world faced by global climate change could be enormous. This is also coupled with the milestone of an ever-increasing population which is accompanied by increased human and industrial activities (Abegunrin and Abegunrin, 2018).

According to Nigeria's Bureau of Statistics as reported by Premium times (2024), Nigeria's food inflation rate in September 2024 was 37.77%. It said on a year-on-year basis, it was 7.13 percentage points higher than the rate recorded in September 2023 (30.64%). One of the major reasons why climate change has remained a global concern is the threat it poses to agricultural production. Empirical studies have revealed that higher and varying temperatures and rainfall patterns witnessed in Nigeria within the past decade are gradually shifting the usual agricultural production pattern in Nigeria (Ikem, 2018; Wossen *et al*., 2018). Food insecurity and climate change are, more than ever, the two major global challenges humanity is facing, and climate change is increasingly perceived as one of the greatest challenges for food security (HLPE, 2012).

Agricultural output components (livestock, food, forestry sectors etc) are being proxied by FS in Nigeria has remained the largest non-oil contributor to the national economy, but despite this, the impact of climate change has been a threat to food security in Nigeria. Hence, the need to study the impact of CV on FS.

There is dearth of literature on the nexus between CV and FS in Nigeria (Kareem *et al*., 2022).

There have been several schools of thought on whether CV contributes to FS positively or whether it contributes in a negative form. The school of thought concluded on climate vulnerability on food security in a negative form (Agri *et al*., (2020).

The few studies that have been conducted on CV and FS are limited in the scope of studies. It is no longer a gain to say that Nigeria's agricultural sector proxied for FS has become highly vulnerable to climate change. This thus, necessitates this study of the impact of climate change on FS in Nigeria with a view to proffer possible solutions. Given the scope of study of previous research outcomes or findings, there is a need to have current information on the relationship between CV and FS. For instance, the scope of study of Kareem *et al*. (2022) was limited to 1981-2016 while Ogbuabor and Egwuchukwu (2017) was limited to 1981-2014. In addition to the scope of the study, it is also very interesting to note that the different conclusions on their findings.

Abegunrin and Abegunrin (2018) examined the effects climate change has on the availability of food for the teeming populace of Nigeria to ensure FS. The current practice of Agriculture in Nigeria was taken into consideration, the impact it has on the entire population and the effects climate change has on it. Nigeria, like most other developing countries, is affected in a very important and critical manner by the adverse effects of environmental crises, most of which are direct influences of climate change and this change in the long run has effect on FS.

The study by Agri *et al.* (2020), indicated that Climate change is not healthy for FS in Nigeria. The OLS result also revealed that there was a negative relationship between Agricultural Output and Value Added in Agriculture while there was a positive relationship between Agricultural Output and Government Expenditure. The regression result revealed that there is a negative relationship between the dependent variable Agricultural Output (AO) and the independent variables Average Rainfall (ARF) and Carbon dioxide (CO_2). Kareem *et al*. (2022) examined the impact of climate change on agricultural output and economic growth in Nigeria. The study showed that rainfall, temperature and carbon emission have significant impacts on the economic growth and agricultural output of Nigeria. The study concluded that in the long run relationship, climate change has significant effect on agricultural output and economic growth of Nigeria. The study recommends that the Nigerian government should evolve policies to encourage the use of environmentally friendly techniques towards having a sustainable economic growth and all the stakeholders involved in the global phenomenon need to increase public awareness, promote research and establish an agency that will handle issues related to climate change.

Abdullahi and Abdullahi (2023) investigated the impact of climatic change on agricultural production in Nigeria. The result of these findings indicates the existence of long run relationship between agricultural production and climatic change variables in Nigeria. The result of the short run analysis indicates that all the variables except temperature have a significant influence on agriculture production. Both the short run and long run analysis provide evidence of the strong influence of rainfall on agricultural production. The study recommends the need of policies that will mitigate carbon emission such as the adoption of new approaches in agriculture production, regulating industrial activities especially oil industries and deforestation which are the major contributor of GHG emission in Nigeria.

Another study by Amaefule *et al.* (2023) explored the impact of climate change on FS through agricultural productivity in Nigeria. The study adopted the transposed second-generation environmental Kuznets curve (EKC) model, which defined growth (agricultural productivity) as a function of climate change. The findings indicated a long-run relationship between climate change and FS (proxy agricultural output) in Nigeria. The result of the findings showed the existence of a long-run relationship between carbon emissions (proxy by CO_2 emissions and CO_2 intensity) and agricultural productivity (proxy by Agric. GDP, crop production index, and food production index) in Nigeria. The result of this study also implied that carbon emissions and carbon intensity cause decline and generates a dampening threat to Nigeria's agricultural productivity through physical risk channels. By extension, the study concludes that carbon emission causes climate vulnerability that affects agricultural yields, production, and productivity. Carbon emissions result in low agricultural productivity which in turn disrupts FS as well as distorting the poverty reduction strategy in the country.

Given the above statement of the problem, the research questions are: what are the impacts of CV on FS in Nigeria? And what is the causal relationship between CVB and FS in Nigeria? The broad objective of the study is to examine the impact of CV and FS in Nigeria. The specific objectives are to: determine the impacts of CV on FS in Nigeria, and determine the causal relationship between CV and FS in Nigeria. The significance of this study will be important to policymakers whereby it will assist the policymakers in the area of CV and FS implementation in Nigeria. It will also be important to researchers in which it will be useful material to the researchers, and scholars, especially to be used as a bundle of literature.

Methodology

Theoretical Framework

The theoretical framework of this study is anchored or justified based with reference to the Anthropogenic Global Warming Theory. This theory contends that human emissions of greenhouse gases, principally carbon emission (CAE), methane, and nitrous oxide, are causing a catastrophic rise in global temperatures.

The model for this study is specified following Ricardian model which states that economic model analyzes the impact of CV on agricultural productivity (proxy for FS) by estimating the effects of temperature and precipitation changes on crop yields. Thus, the foundation for this study can be linked to the empirical work of Yingjie *et al*. (2008), Ajetomobi and Abiodun (2010), Kucharik and Serbin (2008), Lobell *et al*. (2011), Changnon and Hollinger (2003), and Hu and Buyanovsky (2003). They estimated crop yield or agricultural output (proxy for FS) is assumed to be a function of anthropogenic factors (e.g., average temperature, precipitation and selected agricultural inputs). The estimated model is given as:

Y = f(Anthropogenic factors, government expenditure) ……………………… (1)

Equation 1 implicitly is stated below:

Y = f(T, PRE, FERT, TECH) ……. (2)

Equation 2 is explicitly defined as:

$Y_t = \alpha_0 + \alpha_1$ Tave + $\alpha_2 PRE_t + \alpha_3 FERT_t + \alpha_4 TECH_t + \mu$ …………………… (3)

Where;

Y = Yield (metric tonnes or marginal value product)

α_1 = Regressor coefficients (i = 1, …,4)

Tave = Average temperature in centigrade

PRE_t = Average annual precipitation / rainfall in millimeters

$Fert_t$ = Fertilizer used in tons/acre

$TECH_t$ = Technology (time used as proxy)

μ = Error term

Model Specification

In line with the modified work of Agri *et al*. (2020) and Yingjie *et al*. (2008) and from equations 1 to 3), the model specification for this study is adapted and stated below:

AO = f(ANR, CAE, TEMP) [implicit function] ………………………. (4)

Explicitly equation 4 becomes:

$AO = \beta_0 + \beta_1 ANR + \beta_2 CAE + \beta_3 TEMP + \mu_t$ …………………………… (5)

From equation 5 control variable (Government expenditure on Agriculture) is introduced into the model because it influences Agricultural Output (proxy for FS). Thus, the implicit function now becomes:

AO = f(GEA) ………………….… (6)

Equation 3.7 in econometrics form now becomes:

$AO = \beta_0 + \beta_1 GEA + \mu_t$ ……...…. (7)

Deducing from equations 4 and 6 in logarithm form, equation 8 now becomes:

$LnAO_t = \beta_0 + \beta_1 LnANR_t + \beta_2 LnCAE + \beta_3 LnTEMP + \beta_4 LnGEA + \mu_t$ …… (8)

Where;

AO = Agricultural Output proxy for FS (₦'BILLIONS) (Agri *et al*., 2020)

ANR= Annual Rainfall (millimeters per year)

CAE = Carbon emission (kt)

TEMP = Annual Mean Temperature (°C)

GEA = Government expenditure on Agriculture (measured in billions of naira)

β_0 = Intercept of the model

$\beta_1, \beta_2, \beta_3, \beta_4$ = are the slopes of the independent variables in equation (1)

μ = error term

t = 1986 – 2022

Ln = Natural logarithm

Agricultural Output (AO) is used to represent FS as dependent variable. The rationale behind the choice of AO is because the figure shows an indication of FS (Agri *et al*., 2020). Based on this work the Annual Rainfall, Carbon emission, Temperature, Government Expenditure on Agriculture were used as independent variables because they are relevant and related to this study.

Techniques of Estimation

The data was subjected to descriptive statistics and econometrics tests. The descriptive statistics involves the use of standard deviation, line graphs, (it was used to describe the trends of CV and FS proxied by value of agricultural output. The econometrics test involves subjecting the data to the unit root tests, Bound test Co-integration, Auto-regressive distributed lag Model (ARDL) to analyze the data. Likewise, the study adopts the

Augmented Dickey Fuller (ADF) to ascertain the level of stationarity of the variables in the model of the study. The study detected that there was no long run relationship among the variables from the result of the ARDL bound test. Thus, the study utilized the short run ARDL to examine the impact of CV and FS in Nigeria within the period under study. The Short-run ARDL model is specified below:

$$\Delta InAO = \alpha_{0i} + \Sigma^{p}_{i=1}б_i\Delta InAO_{t-1} + \Sigma^{q}_{i=1}Л_i\Delta InANR_{t-1} + \Sigma^{r}_{i=1}ƛ_i\Delta InCAE_{t-1} + \Sigma^{s}_{i=1}ƛ_i\Delta InTEMP_{t-1} + \Sigma^{t}_{i=1}\theta_i\Delta InGEA_{t-1} + \varepsilon_{it} \ldots\ldots \quad (9)$$

Where Δ represents the first difference operator, α is the drift term, ε is the error term. $б_i$, $Л_i$, $ƛ_i$ and θ_i, are short-run dynamic coefficients. The Akaike information (AIC) was used in selecting the optimal lag lengths (p, q, r, s, t)

Granger causality was also employed in this study to establish the causal relationship among variables.

Apriori Expectation

The expected signs of the coefficient of the explanatory variables according to economic theory (Environmental Kuznets Theory and Anthropogenic Global Warming)

$\beta_1 > 0$ or < 0, $\beta_2 < 0$ or $= 0$, $\beta_3 > 0$, $\beta_4 > 0$. β_1 = Annual rainfall – the average annual rainfall is expected to be either having a positive or negative impact of FS (i.e., depending on the intensity in a particular year); β_2 = Carbon emission – this is expected to be either positive or negative depending on how it affects the food production and availability; β_3 = Temperature – this is expected to be either positive or negative because temperature is expected to boost agricultural productivity (i.e., FS); β_4= Government expenditure on agriculture this is expected to be positive or negative because it is expected to boost agricultural productivity (i.e., FS).

Granger Causality Model

To achieve the third objective, the following causality models are estimated:

Causality between InAO and ANR Model

$InAO_t = \beta_1 + \sum InAO_{t-1} + \sum ANR_{t-1} + U_t \ldots\ldots (14)$

$ANR_t = \beta_2 + \sum ANR_{t-1} + \sum InAO_{t-1} + U_t \ldots..(15)$

Causality between InAO and CAE Model

$InAO_t = \theta_1 + \sum InAO_{t-1}1 + \sum CAE_{t-1} + U_t \ldots\ldots(16)$

$CAE_t = \theta_2 + \sum CAE_{t-1} + \sum InAO_{t-1} + U_t \ldots\ldots (17)$

Causality between InAO and InGEA Model

$InAO_t = Л_1 + \sum InAO_{t-1} + \sum GEA_{t-1} + U_t \ldots\ldots.(18)$

$GEA_t = Л_2 + \sum GEA_{t-1} + \sum InAO_{t-1} + U_t \ldots.....(19)$

Results and discussions

Unit Root Test

In order to achieve the impact of CV and FS. The order of integration of variables was established using the Augmented Dickey Fuller (ADF) and it was deployed to determine the properties of macroeconomic variables (AO, CAE, ANR, TEMP and GEA) of this study. Going by the ADF, we rejected the null hypothesis that the variables have a unit root. If the probability of the t-statistics is less than the critical value.

Table 1: Results of Unit Root Test

Series	Exogenous	ADF test (T- statistic) (Prob. Value) at Level	ADF test (T- statistic) (Prob. Value) at 1st difference	Decision
LOGAO	Intercept	[-0.534504] (0.8726)	[-5.645010] (0.0000)	I_1
LOGGEA	Intercept	[0.798106] (0.9926)	[-6.593574] (0.0000)	I_1
ANR	Intercept	[-7.087448] (0.0000)	[-13.76865] (0.0000)	I_0
CAE	Intercept	[-1.501008] (0.5217)	[-5.999012] (0.0000)	I_1
TEMP	Intercept	[-3.350091] (0.0198)	[-8.216531] (0.0000)	I_0

Table 1 above presents the results of unit root tests for Agricultural Output (LOGAO), Government Expenditure (LOGGEA), Annual Rainfall (ANR), Carbon Emission (CAE) and Temperature (TEMP) using the Augmented Dickey-Fuller (ADF) test at both the level and the first difference. From the table, it is evident that all variables, except for Annual Rainfall (ANR) and Temperature (TEMP), exhibited stationarity at the first difference, as indicated by p-values less than the significance level. This implies that the variables in the model are integrated at orders zero (I_0) and one (I_1). In other words, all the variables were significant at 1% probability level at first difference, expect ANR and TEMP.

Autoregressive Distributive Lag Model (ARDL) Bounds Test

Table 2 below represents the Auto regressive distributed lag model results carried out to examine the effect of each of the independent variables on FS (proxied by value of agricultural output). Optimum lag was automatically selected for the estimated ARDL system using the Akaike information criterion.

Table 2: Result of ARDL Bound Test

ARDL Bounds Test		
Date: 04/17/24 Time: 14:45		
Sample: 1986-2022		
Included observations: 34		
Null Hypothesis: No long-run relationships exist		
Test Statistic	Value	K
F-statistic	2.076887	4
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Table 2 also summarizes the results of the ARDL bound test conducted to assess the presence of long-run relationships among the variables. The calculated F-statistic of 2.0768 falls below the 2.86 for the I_0 bound and 4.01 for the I_1 bound. Consequently, the study accepts the null hypothesis that no long-run relationships exist among the variables at the 5% significance level. Therefore, the short-run Autoregressive Distributed Lag (ARDL) model was employed to analyze the model.

Table 3: Lag Length Selection Criteria Result

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-144.5799	NA	0.003546	8.547422	8.769615	8.624123
1	-23.92074	199.9494*	1.52e-05*	3.081185*	4.414341*	3.541391*
2	0.737023	33.81637	1.71e-05	3.100742	5.544860	3.944451

Table 3 shows the lag length selections which was based on the least selected lag length by different criterion. Based on this, the appropriate lag length is Lag 1 which happens to be the least based on Akaike Information Criterion (AIC). Hence, this study adopts one period lag for the analysis.

Table 4: Result of Short run ARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
D(LOGAO(-1))	0.029667	0.210735	0.140779	0.8892
D(ANR)	-2.06E-05	0.002055	-0.010013	0.9921
D(ANR(-1))	-0.000193	0.001837	-0.104992	0.9172
D(CAE)	-0.396291	0.243279	-1.628960	0.1159
D(CAE(-1))	0.115228	0.263211	0.437777	0.6653
D(TEMP)	0.019228	0.043631	0.440687	0.6632
D(TEMP(-1))	0.047012	0.045205	1.039962	0.3083
D(LOGGEA)	-0.030718	0.027242	-1.127606	0.2702
D(LOGGEA(-1))	0.009478	0.028002	0.338466	0.7378
C	0.054617	0.020029	2.726836	0.0115
R-squared	0.480789	Mean dependent var		0.053925
Adjusted R-squared	0.444128	S.D. dependent var		0.069981
S.E. of regression	0.073866	Akaike info criterion		-2.138160
Sum squared resid	0.136406	Schwarz criterion		-1.693774
Log likelihood	47.41779	Hannan-Quinn criter.		-1.984758
F-statistic	4.613017	Durbin-Watson stat		1.776173
Prob(F-statistic)	0.034456			

*Note: p-values and any subsequent tests do not account for model selection.

Table 4 equally presents the results of a short-run Autoregressive Distributed Lag (ARDL) analysis examining the impact of CV on FS in Nigeria. The coefficient value of the one-period lag of LOGAO which is 0.029667 implies that a one percent increase in D(LOGAO (-1)) will result in 0.02% increase in the current level of FS (proxied by agricultural output) and the probability value of 0.8892 is insignificant. However, the coefficient values for one period lag of Annual Rainfall (D(ANR)), one period lag of Carbon Emission (D(CAE)), one period lag of Temperature (D(TEMP)) and one period lag of Government Expenditure

(D(LOGGEA)) are -0.000193, 0.115228, 0.047012 and 0.009478 respectively. The associated probabilities of 0.9172, 0.6653, 0.3083 and 0.7378 indicate that a one-unit rise in one period lag of annual rainfall yields a -0.19% decrease on FS (proxied by agricultural output), while a unit increase in one period lag of carbon emission leads to11.5%increase on FS (proxied by agricultural output), also a unit increase in one period lag of temperature results to 4.7% increase on FS (proxied by agricultural output). Conversely, a one percent increase in one period lag of LOGGEA results in a positive but insignificant effect on LOGAO in the short run.

The R-Squared value of 0.480789 indicates that approximately 48% of the variation in the dependent variable D(LOGAO) was explained by the independent variables (ANR, CAE, TEMP, GEA). Furthermore, the F-statistic of 4.613017 with a probability of 0.034456 indicates that the overall model is highly statistically significant, signifying that the independent variables collectively have a significant impact on the dependent variable.

Additionally, the Durbin-Watson statistic of 1.776173, which is close to 2, indicates that there was a positive autocorrelation in the model's residuals, implying that the error terms are not significantly correlated with each other.

Table 5: Diagnostic Test Result

Test	F-statistics	Probability	Conclusion
Heteroscedasticity	0.563062	0.7274	There is no heteroscedasticity in the model.
Serial correlation	2.990858	0.0947	Series is not serially correlated.

The table 5 above shows the diagnostics test of heteroscedasticity and serial correlation. The F-Statistics of 0.563062 and the probability value of 0.7274. With respect to the above table, it shows that there is no heteroscedasticity. This is based on the fact that the probability level is greater than 5%. The table also shows serial correlation, the F-statistics value of 2.990858 and probability value of 0.0947 which implies that the series is not serially correlated.

Table 6: Pairwise Granger Causality Result

Null Hypothesis:	Obs	F-Statistic	Prob.	Remarks
ANR does not Granger Cause LOGAO	36	0.34423	0.5614	No causality
LOGAO does not Granger Cause ANR		0.30528	0.5843	
CAE does not Granger Cause LOGAO	36	0.21146	0.6486	Unidirectional
LOGAO does not Granger Cause CAE		6.97995	0.0125	
TEMP does not Granger Cause LOGAO	36	0.23004	0.6347	Unidirectional
LOGAO does not Granger Cause TEMP		12.6838	0.0011	
LOGGEA does not Granger Cause LOGAO	36	4.89986	0.0339	Unidirectional
LOGAO does not Granger Cause LOGGEA		0.55413	0.4619	

Table 6 shows the result of the pairwise Granger causality test. This result presents the findings of the causal relationship between CV and FS in Nigeria over the study period. The results indicated that there was no causal relationship between Annual Rainfall (ANR) and Agricultural Output (LOGAO), as evidenced by probability values exceeding 0.005. However, a unidirectional relationship exists between Carbon Emissions (CAE) and LOGAO, there is also a unidirectional relationship between Temperature (TEMP) and LOGAO, as well as Government Expenditure (LOGGEA) and LOGAO. Specifically, agricultural output (LOGAO) granger causes both Carbon Emissions and Temperature while Government Expenditure granger causes Agricultural output.

Discussion

The study examined the effect of CV and FS in Nigeria from 1986-2022. The findings discovered a positive and insignificant between temperature and FS. This conforms to the work of Abdullahi and Abdullahi (2023) that discovered that temperature has a positive but insignificant impact on FS. Similarly, the findings also discovered that Annual rainfall has a positive but insignificant impact on FS in Nigeria. These findings conform with the work of Akomolafe *et al.* (2018). This result is also in line with the findings of Akomolafe *et al.* (2018) who found out that that carbon emission has an insignificant positive effect on FS which is in conformity with the outcome of this study.

Findings also revealed that there was a unidirectional causality among FS and carbon emission and temperature. Surprisingly, the finding is at variant with the work of Kareem *et al*. (2022) but supports the work of Edoja *et al.* (2016). The findings also discovered the short-run relationship between FS and climatic variability in Nigeria which does not conform with the work of Abdullahi and Abdullahi (2023) but conforms with the work of Akomolafe *et al*. (2018). Findings also revealed that the result of the short-run analysis indicates that all the variables have no significant influence on FS which is in line with the work of Akomolafe *et al.* (2018).

Based on the objectives of the study, it is important to state that the variables (TEMP, ANR) are inconformity with the *apriori* expectation while some variables (CAE, GEA) do not support the economic theory. These results might not be unconnected to the inconsequential policies of the government at all levels.

Conclusion

The study examined effect of CV and FS in Nigeria and concluded that the FS of the previous year had an insignificant effect on CV in Nigeria. The study also concludes that effect of Government expenditure on agriculture was positive but insignificant on FS in Nigeria.

The granger causality result shows that there was a unidirectional relationship between CAE, TEMP and GEA on FS (proxied by value of agricultural output) in Nigeria.

Recommendations

Based on the conclusion of this study, the following recommendations were made;

1. Government is advised to implement carbon reduction policies: To mitigate

the negative impact of carbon emissions on FS.

2. It is recommended that government should invest in research and development in the area of clean energy and eco-friendly methods to enhance sustainable FS and economic development.
3. The government should actively engage in global climate initiatives and agreements, collaborate with other nations to share best practices, and contribute to international efforts to combat CV.
4. The government should take proactive steps in addressing environmental problems, through awareness, workshops, and seminars as well as in climate smart agriculture which is an approach of integrating several agricultural friendly practices in line with the growing population of the world in order to avoid food scarcity.
5. Government may also adopt measures that could help to mitigate the adverse effects of inadequate rainfall through irrigation farming, drought resistant crops varieties among others should be put in place by the government.

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