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Original Research Paper

Impact of Climate Variability, Agricultural Expenditure and Arable Land Expansion on Food Output in Nigeria (1978-2009): A Bounds Cointegration Approach

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ABSTRACT

This study was carried out to investigate the impact of climate variability, aggregate agricultural expenditure, level of aggregate farm mechanization (farm technology) and arable land use on food output in Nigeria from 1978 to 2009. Secondary data were obtained from Central Bank, National Bureau of Statistics and World Bank and analyzed using Autoregressive Distributed Lagged (ARDL) model. The series were first tested for stationarity using Augmented Dickey Fuller and Philips Perron tests. The ARDL model was then applied after confirming that the series were mixture of I(0) and I(1). Tests for serial correlation (Breusch-Pagan test), stability (CUSUM), specification (RAMSEY RESET), heteroscedasticity and Jarque-Bera normality tests were also conducted. These tests validated the variables and specification of the model applied. The model showed a good fitting with an R^2 of 0.71. The statistically significant F-ratio ($p<0.01$) of 4.72 (greater than critical bound level of 3.74) confirmed cointegration of the series. Results showed that on the long-run, climate variability (rainfall), level of aggregate farm mechanization and arable land use exerted significant positive effects ($p<0.01$) on food production in the country. Nonetheless, its effect was considered to be negative in the ong-run. Thus, it was concluded that Nigerian government should concentrate on ensuring the efficiency of agricultural expenditure through prudence and proper accountability.In addition, agricultural transformation based programmes should be in place to improve agricultural mechanization and building capacities of farmers to adopt climate resilient technologies such as investment in irrigation facilities especially in the semi-arid regions of the country.

Key word: Climate change, food security, agricultural finance, arable land intensification, agricultural mechanization, Autoregressive Distributed Lag Model (ARDL)

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INTRODUCTION

At a time when food insecurity and poverty are taking their toll on developing countries, it was observed that total factor productivity of agriculture (ratio of total output growth to total input growth) is low and is on the decline in some developing regions of the world especially Nigeria (Adesina, 2010). Overall growth in productivity averaged 2.1% for all developing regions. East Asia and Latin America have experienced higher growth rates in agricultural productivity, averaging 2.7% in 1997-2003. However, South Asia and Sub-Saharan Africa recorded low growth rates in agricultural productivity. There are regional variations as well. For example, East Africa experiencing only 0.4% growth while, West and Southern Africa averaged 1.6% and 1.3%, respectively. These rates do not keep up with the rate of population growth and call for greater investments and efficiency to increase agricultural productivity and as well as food security level. This apparent inefficiency has led to significant burden of increasing imports of food using scarce foreign exchange.

In Nigeria, before the discovery of oil in the 1960's and the oil boom of the 1970's, the importance of agriculture to the economic development was huge due to the fact that agriculture was the main source of food, employment and raw materials for the industry. Mogues et al., (2008) was of the opinion that that during the 1970's and 1980's, agriculture became a low priority area for the Nigerian government. Budget allocations to the sector remained below 3% of the total budget. In addition, rural interests were traditionally weak and leading politicians were drawn from non-farming occupations. A few agriculture support programmes were initiated (such as subsidies for fertilizers and other inputs), yet they did not compensate for the effects of severe currency overvaluation coupled with price controls. The oil boom led to a severe disruption of the agricultural sector. By 1981, agricultural imports in Nigeria had increased to US$39/ capita (Mogues et al., 2008).

The agricultural sector in Nigeria currently makes up about 23 percent of total GDP. That represents a relatively small share compared to those of most other countries in Sub-Saharan Africa. However, when the comparison is made with other mineral-rich countries on the continent (e.g., Botswana, South Africa, Angola, and Chad), agriculture still plays a relatively important role in Nigeria. Following the decline in agricultural commodity exports, the performance of Nigerian agriculture became less erratic, and after a long period of contraction, the sector began to expand once again. After having very slow growth during the 1970's and 1980's, agricultural Gross Domestic Product (GDP) began to pick up during the 1990's before being accelerated sharply. Since 2000, agricultural growth has averaged 5.6% per year (Morgues, 2008), well above the Africa-wide average and close to the government's target rate of 6% per year. But it is doubtful whether this trend will be sustainable. From the above backdrop,, this study was designed to look into the major determinants of food supply in Nigerian economy from 1978-2009 with specific emphasis on the role of climate variability, agricultural expenditure by the government and mechanization levels. Results of the study are expected to give useful indices for planning the agricultural transformation programme of the current Federal Government, aid other policy makers including international agencies involved in food security interventions such as World Food Policy (WFP); World Bank, Food and Agricultural Organization (FAO), International Food Policy Research Institute among other agencies as well as scholars engaged in the climate change and livelihood studies. Recent research findings by Assessments of Impacts and Adaptations to Climate Change (AIACC) (2012) exposed some of the major factors influencing food security in West Africa with Nigeria used as a case study.

The report focused on the impact of contemporary climate variability and potential climate change on crop yield and human livelihood in Sub-Saharan West Africa. It was evidenced from the report that crop yield is sensitive to variability in the time of onset and cessation of the rainy or growing seasons. However, departures from normal levels of crop yield amounting to crop failures were observed only at decadal range of intervals in years with unusually low rainfall. Crop yield is also sensitive to potential climate change as derived from outputs of Hadley M2 General Circulation Models (AIACC, 2012), the report further noted. These provide evidences to the effect that increased crop yield could characterize the first half of the 21st Century as a consequence of improvements in water availability, increased solar radiation and higher concentrations of atmospheric carbon dioxide. However, crop yield projections for the second half of the century indicate decreased yields resulting from an over-ruling effect of "supra optimal temperature levels". Vulnerability of peasant households to climate variability and climate change is assessed to be primarily determined by their dependence on agriculture, a sector that is by itself vulnerable to climate drivers.

Vulnerability of the same livelihood group is also a function of existent poverty, high child dependence burden, low health status as well as low levels of educational attainment which impose limits on their adaptive capacity. The northern, drier regions tend to be more vulnerable than the southern, wetter and coastal zone. Widespread poverty has been cited as the main cause of a low capacity to adapt to climate change in Africa (IPCC, 2001a). Poor persons, poor communities and, poor nations do not have enough of these resources, hence their low adaptive capacity. A low capacity to adapt to climate change automatically implies vulnerability.

The low capacity to adapt to climate variability is exacerbated by poor farm technology adopted by Nigerian farmers. It is in the line with this that Nzeh and Eboh (2010) noted that agricultural production could be increased by doubling the crop areas (arable land use area) or by investing (increased agricultural expenditure) in agriculture management and indigenous technology.Summary of the results from the National Integrated Survey of Households 1995 (FOS, 1996c) showed that practices that could have boosted the adaptive capacity of the peasant households were still being constrained by lack of funds at the individual household level.

The foregoing underlies the significance of agricultural expenditure and technology as well as arable land intensification in boosting food crop production in a country under threat of climate change.

Theoretical Framework

This study is based on theory of environmental crisis. Homer-Dixon, the proponent of this theory indicated as to how the total effect of human activity on the environment in a particular ecological zone is mainly a function of two variables: first, the product of total population in the region and physical activity per capita and second, the vulnerability of the ecosystem in that region to those particular activities.

The theory equally stressed that environmental effects may cause "social effects" that in turn could lead to conflict. For instance desert encroachment on landmass may produce large-scale migration, which could create ethnic conflicts as migratory groups clash with indigenous (settled) populations. Within this paradigm, one must realize the interviewing role of population growth, demographic structure and patterns of population distribution (Ehrlich and Ehrlich, 1990). Similarly, researchers need to understand the effect of the ideational-factors in conflict generation. The threshold beyond or within which given societies could respond effectively to the inbuilt stress induced by climate/environmental change differs. Particularly, if we wish to understand a society's propensity towards conflict, given certain social effects due to the environmental stress, we need to understand the relationship between the ideational factors and conflict. However, environmental stress and consequent conflict relation does not occur if environmental and resource scarcity threshold is not attained. The thresh-hold of environmental scarcity could be attained as a result of interaction of scarcity of resources in a particular environment as proposed by Homer-Dixon (1994). According Homer-Dixon, the three sources of environmental scarcity often interact; in two distinct patterns "resource capture" and "ecological marginalization". Resource capture shows a situation where a fall in the quantity and quality of renewable resources can combine with population growth to encourage powerful or advantaged groups within a society to shift resource distribution in their favour. This usually produces acute environmental scarcity for poorer and weaker groups whose claims to resources are opposed by more powerful groups. On the other hand unequal resource access can combine with population growth to cause migration to regions that are ecologically fragile, such as steep upland slopes, areas at risk of desertification, and tropical rain forests. High population densities in these areas, combined with a lack of knowledge and capital to protect local resources, causes severe environmental damage and chronic poverty. The second process is usually called "ecological marginalisation" (Homer-Dixon, 1994).

METHODOLOGY

Nigeria is the most populous country in Africa with a population estimated at 162 millions by mid-2011. Population living below poverty line of $2/ day of 84 percent, Gross National Income/ capita of US $2,070 and CO_2 emission rate of 0.4 MTtones/ capita (Population Reference Bureau, 2011). According to CBN (2010), the GDP of Nigeria stood at about US$4.9 billion (N775.4 billion) at 1990 basic prices. There are credible reports of climate change effects in Nigeria (Nigerian Environmental Study/action Team, NEST, 2003; Odjugo, 2005 and Ikhile, 2007). Average rainfall hovers around 1282.2 mm varying from 500 - 1800mm. In 2007, agriculture contributed 42.08% to Nigerians GDP. Out of this figure, crops, livestock, forestry and fishing contributed 37.54%, 2.64%, 0.53% and 1.37% to the country's economy respectively. The agricultural products include cocoa, palm oil, yams, cassava, sorghum, millet, corn, rice, livestock, groundnuts, cotton. However, crude oil export remains the major source of revenue. Industry types include textiles, cement, food products, footwear, metal products, timber, beer, detergents and car assembling (CBN, 2010). Secondary data, mainly time series data from Central Bank of Nigeria's Annual Report and Statistical Bulletin containing data from National Population. Data from 1978 to 2009 were selected that is a sample of 32 years, for ease of accessing data that will cover all the variables or series within the period of study.

Theoretical Model

The bounds test allows a mixture of I(1) and I(0) variables as regressors, that is, the order of integration of appropriate variables may not necessarily be the same. Therefore, the ARDL technique has the advantage of not requiring a specific identification of the order of the underlying data. Third, this technique is suitable for small or finite sample size (Pesaran *et al.*, 2001 and Ellahi, 2011).Moreover, the bounds testing procedure (Pesaran et al., 2001) employed in this study is robust for small sample study. Furthermore, the bound testing approach is possible even when the explanatory variables are endogenous (see Alam and Quazi, 2003).

The ARDL cointegration test, assumed that only one long run relationship exists between the dependent variable and the exogenous variables (Pesaran et al., 2001, assumption 3). The bound test is basically computed based on an estimated unrestricted error-correction models (UECM) or error correction version of autoregressive distributed lag (ARDL) model, by Ordinary Least Square (OLS) estimator (Pesaran et al., 2001). Basically, the bound test developed by Pesaran et al. (2001) is the Wald test (F-statistic version of the bound testing approaches) for the lagged level variables in the right-hand side of UECM. That is, we tested the null hypothesis of non-cointegrating relation (Ho: $\delta_1 = \delta_2 = \delta_3 = \ldots = \delta_n = 0$) against the alternative hypothesis (H_A: $\delta_1 \neq \delta_2 \neq \delta_3 \neq \ldots \neq \delta_n \neq 0$) (a long-run relationship exists). The computed *F*-statistic value will be evaluated with the critical values tabulated in Table CI (iii) of Pesaran *et al.* (2001). According to these authors, the lower bound critical values assumed that the explanatory variables x_t are integrated of order zero, or I(0), while the upper bound critical values assumed that x_t are integrated of order one, or I(1). Therefore, if the computed *F*-statistic is smaller than the lower bound value, then the null hypothesis is not rejected and we conclude that there is no long-run relationship between agricultural export performance and its determinants. Conversely, if the computed *F*-statistic is greater than the upper bound value, then agricultural export performance and its determinants share a long-run level relationship. On the other hand, if the computed *F*-statistic falls between the lower and upper bound values, then the results are inconclusive. The researcher must conduct test to determine the order of integration before making a conclusive inference in this case.

Following Pesaran *et al*. (2001); Atif et al., (2010) and Ellahi (2011) we assembled the vector autoregression (VAR) of order *p,* denoted VAR (*p*), for the following function:

$$Z_t = \mu + \sum_{i=1}^{p} \beta_i z_{t-i} + \varepsilon_t \quad (1)$$

where z^t is the vector of both x^t and y^t , where y^t is the dependent variable defined as food production index (foodindx), x_t is the vector matrix which represents a set of explanatory variables i.e., trade openness (TOP), financial development (M2) and *t* is a time or trend variable. According to Pesaran *et al*. (2001), y_t must be I(1) variable, but the regressor x_t can be either I(0) or I(1). We further developed a vector error correction model (VECM) as follows:

$$\Delta z_t = \mu + \alpha t + \lambda z_{t-1} + \sum_{i=1}^{p-i} \gamma_t \Delta y_{t-i} + \sum_{i=1}^{p-1} \gamma_t \Delta x_{t-i} + \varepsilon_t \quad (2)$$

where Δ is the first-difference operator. The long-run multiplier matrix λ as:

$$\lambda = \begin{bmatrix} \lambda_{YY} \lambda_{YX} \\ \lambda_{XY} \lambda_{XX} \end{bmatrix} \quad (3)$$

The diagonal elements of the matrix are unrestricted, so the selected series can be either I(0) or I(1). If $\lambda_{YY} = 0$, then *Y* is I (1). In contrast, if $\lambda_{YY} < 0$, then *Y* is I(0).

The vector error correction mechanism (VECM) procedures described above are imperative in the testing of at most one cointegrating vector between dependent variable y_t and a set of regressors x_t . To derive model, we followed the postulations made by Pesaran *et al*. (2001) in Case III, that is, unrestricted intercepts and no trends.

Empirical Model:

The series were tested for unit roots at their levels and first differences using Augmented Dickey Fuller and Philips Perron tests (Gujarati, 2006 and Greene, 2008). The results are presented in Appendix 1. When it was noted that some of the series were not I(0) but became stable at I(1) the researchers decided to apply the bound co-integration testing approach following Pesaran et al., (2001). Standard econometric diagnosis were performed including Breusch- Godfrey serial correlation LM test, Jacque-Bera normality test and Ramsey RESET specification test following Studenmund (2001), Patterson (2000), Gujarati (2006) and Greene (2008). The use of the bounds technique is based on three validations. First, Pesaran *et al*. (2001) advocated the use of the ARDL model for the estimation of level relationships because the model suggests that once the order of the ARDL has been recognised, the relationship can be estimated by OLS.The general co-integration hypothesis function can be stated as the following unrestricted error correction model (UECM):

$$\Delta (Foodindx)_t = \beta_0 + \beta_1(FOODINDX)_{t-1} + \beta_2 (AGRICEXP)_{t-1} + \beta_3 (ARABLAND)_{t-1} + \beta_4(RAINF)_{t-1} + \beta_5 (AGRICMECH)_{t-1} + \beta_6 \sum_{i=0}^{q} \Delta (FOODINDX)_{t-1} + \beta_7 \sum_{i=o}^{r} \Delta (AGRICEXP)_{t-1} + \beta_8 \sum_{i=0}^{s} \Delta (ARABLAND)_{t-1} + \beta_9 \sum_{i=0}^{t} \Delta (RAINF)_{t-1} + \beta_{10} \sum_{i=0}^{u} \Delta (AGRICMECH)_{t-1} + \varepsilon_t \quad (4)$$

Where Δ is the first-difference operator and ε_t is a white-noise disturbance term. Y = index of food production in the economy also represented by FOODINDX (food production index), while hypothesized drivers of food production include: X_1 = Agricultural expenditure in millions of naira . ARABLAND (X_2) = area under arable crop production in millions of hectares; RAINF (X_3)= climate change (mean annual precipitation in Nigeria in mm); and AGRICMECH , (X_4) = Farm technology proxy – number of tractors in millions in the economy; while ε_t = stochastic error term. β_0 … β_{10} are coefficients of the respective variables.

Equation (4) also can be viewed as an ARDL of order (p, *q*, *r*, *s*, *t*, *u*). Equation (4) indicates that food production performance tends to be influenced and explained by its past values. The structural lags are established by using minimum Akaike's information criteria (AIC). From the estimation of unrestricted error correction mechanisms (UECMs), the long-run elasticities are the coefficient of one lagged explanatory variable (multiplied by a negative sign) divided by the coefficient of one lagged dependent variable (Bardsen, 1989). For example, in equation (4), the long-run agricultural expenditure and arable land areas' elasticities are (β_2 / β_1) and (β_3 / β_1) respectively. The short-run effects are captured by the coefficients of the first-differenced variables in equation (4).

RESULTS

The results of the standard Augmented Dickey-Fuller (ADF) and Philips Perron (PP) unit root test exercised to

Table 1. Results of Unit Root Tests using Augmented Dickey Fuller and Philips Perron Tests.

VARIABLE OR SERIES	ADF STATISTICS AT LEVELS	ADF 1st DIFFERENCE STATISTICS	PP LEVELS STATISTICS	PP 1st DIFFERENCE STATISTICS	REMARK
Food production index	1.0383(NS)	-6.3409 ***	1.038301 (NS)	-6.296662	I(1)
Agricultural expenditure	-3.7039***	NA	-3.6887***	NA	I(0)
Agricultural mechanization	-1.9528(NS)	-4.6786***	-1.9528(NS)	-14.6969***	I(1)
Arable Land under crop cultivation	-1.7714(NS)	-2.7742*	-0.7674(NS)	-2.5597(NS)	I(1)
Rainfall	-3.5235**	NA	0 -3.4892**	NA	1(0)

Note: The null hypothesis is that the series is non-stationary, or contains a unit root. The rejection of the null hypothesis is based on MacKinnon (1996) critical values. The lag length are selected based on SIC criteria, this ranges from lag zero to lag two. *, ** and *** indicate the rejection of the null hypothesis of non-stationary at 1%, 5% and 10% significant level, respectively.

Table 2. Results of the ARDL Estimates.

Variable	Coefficient	Std. Error	t-Statistic	Probability
INTERCEPT	-80.999	21.607	-3.748***	0.001
FOODINDX(-1)	-0.485	0.124	-3.920***	0.001
AGRICEXP(-1)	0.000	0.000	-3.008***	0.007
ARABLAND(-1)	0.000	0.000	3.937***	0.001
RAINF(-1)	0.060	0.027	2.225**	0.038
AGRICMECH(-1)	9.542	2.076	4.597***	0.000
Δ (FOODINDX(-1))	-0.253	0.136	-1.862*	0.078
Δ (AGRICEXP(-1))	0.000	0.000	2.853**	0.010
Δ (ARABLAND(-1))	0.000	0.000	-3.093***	0.006
Δ (RAINF(-1))	-0.033	0.022	-1.522	0.144
Δ(AGRICMECH(-1))	-26.161	7.221	-3.623***	0.002
R-squared	0.71	Mean dependent var		3.367
Adjusted R-squared	0.56	S.D. dependent var		3.146
S.E. of regression	2.081	Akaike info criterion		4.581
F-statistic	4.722	Schwarz criterion		5.094
Prob(F-statistic)	0.001			

Dependent Variable: FOODINDX.

check the order of integration of the time series in the study are presented in Table 1. It was found that out of five variables, three have unit root that is, the dependent variable, food production index and two independent variables, i.e. arable land area under cultivation and agricultural mechanization. On ther hand aggregate agricultural expenditure and mean annual rainfall are I(0) variables. Noticeably, the mixture of both I(0) and I(1) variables would not be possible under the Johansen procedure. This gives a good justification for using the bounds test approach, or

Table 3. Diagnostic Checking Results

Test Type	Statistic (and P values)	Remarks
Jarque Bera normality test	0.94 [0.62]^{NS}	Normally distributed Residual
LM test: Breusch-Godfrey Serial Correlation test	2.54 [0.11]^{NS}	No presence of serial correlation
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.90 [0.55]^{NS}	No significant presence of heteroscedaticity in the model
Ramsey RESET (Ramsey Regression Specification Error Test)	0.73 [0.47]^{NS}	Specification error is not detected

*, ** and *** indicate significance at 0.01, 0.05 and 0.10 level respectively. Probability values are quoted in square brackets. “NS” indicates not significant at the stated three alpha levels. LM= Breusch-Godfrey Serial Correlation test statistic to test for the presence of serial correlation ; JB and RESET stand for Jarque-Bera Normality Test and Ramsey Regression Specification Error Test, respectively.

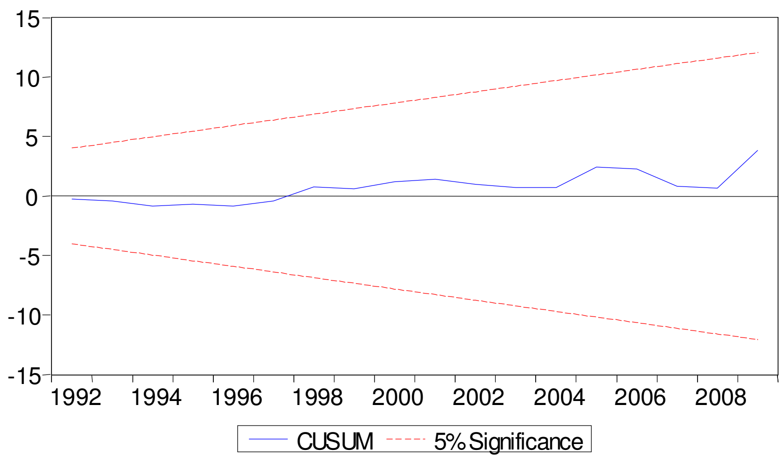

Figure 1. Result of Test for Stability of the model (CUSUM Test).

ARDL model, which was proposed by Pesaran *et al.* (2001).The estimates of Equation (4) using the ARDL model is reported in Table 2. Using Hendry’s general-to-specific method, the goodness of fit of the specification, that is, *R*-squared is 0.71. The implication of these is that the 71 per cent of variation in food output in the country over the period in review were accounted for by variations in the climate factors, agricultural expenditure by the government and other independent variables included in the model. This is a fairly good fitting.

The robustness of the model has been validated by several diagnostic tests such as Breusch-Godfrey serial correlation LM test, ARCH test, Jacque-Bera normality test and Ramsey RESET specification test ((Table 3). All the tests disclosed that the model has the desirable econometric properties; it has a correct functional form and the model’s residuals are serially uncorrelated, normally distributed and homoscedastic. . Hence, the results reported are valid for reliable interpretations and policy recommendations.

The CUSUM test of squares was carried out on the squares of the residuals. Similar to the CUSUM, this test measures the parameter instability of the estimated model. If the line representing the squares of the model’s residuals fall within range (the upper and lower bound lines) then the residuals variance is stable, otherwise it is not. Figure 1 shows that the cumulative sum of squares is within the range. Thus it passes the second stability test.

In Table 4, the results of the bounds co-integration test demonstrate that the null hypothesis of no co-integration against its alternative is rejected at the 1 percent significance level. The computed *F*-statistic of 4.722 is greater than the lower critical bound value of 3.74, thus indicating the existence of a steady-state long-run relationship among the series.The estimated coefficients of the long-run relationship between FOODINDX, AGRICEXP, ARABLAND, RAINF and AGRICMECH are expected to be significant, that is:$D(FOODINDX)_t$ = -80.99*** - 0.004***AGRICEXP + 1.00E+00***ARABLAND + 0.124 **RAINF + 19.661***AGRICMECH (5)

Table 4. Bounds Test for Cointegration Analysis

Critical value	Lower Bound Value	Upper Bound Value
1%	3.74	5.06
5%	2.86	4.01
10%	2.45	3.52

Note: Computed F-statistic: 5.508 (Significant at 0.05 marginal values).Critical Values are cited from Pesaran et al. (2001), Table CI (iii), Case 111: Unrestricted intercept and no trend.

Table 5. Normalized Cointegrating Vectors.

Variables	Normalized Coefficients	Remarks
FOODINDEX(1)		
AGRICEXP(-1)	-0.004	***
ARABLAND(-1)	1.00E+00	***
RAINF(-1)	0.124	**
AGRICMECH(-1)	19.661	***

State the meaning of the ***,***,**

Equation (5) and Table 5 indicated that arable land intensification, rainfall and agricultural technology (agricultural mechanization) have a positive effects on food production in Nigeria over the period in review. However, the result indicates that agricultural expenditure during this period have been contributing negatively to food production. This may not be unrelated to corruption and diversion of money meant for agricultural production to unintended beneficiaries. If there is a unit increase in agricultural expenditure, food production decreases by 0.004 percent. On the other hand a unit increase in the arable land area, mean rainfall level and agricultural mechanization increases food production level by 1.00E+00%, 0.124%t and 19.66% respectively. This analysis demonstrates that, in the long-run, agricultural expenses, climate variable (rainfall), agricultural mechanization level, arable land intensification positively influence food production level in Nigeria. The above findings agree with the earlier findings of Nzeh and Eboh (2010) who observed that farm technology, land area under arable crop cultivation, climate variability and level of agricultural investment combine to influence the level of agricultural (food) production. The undesirable effects of agricultural expenditure (negative returns, possibly as a result of wastage of resources) can combine with climate variability to worsen the food crisis. Such scenario reiterates the fear of Homer-Dixon in their environmental crisis theory earlier discussed in our theoretical framework.

DISCUSSION

This study focused on long-run relationship between climate variability, agricultural expenditure at the macro-economic level, arable land intensification and farm technology (specifically use of farm machineries) on the level of food output performance in Nigeria over 32 years period.

The study applied the relatively recent econometric approach to modeling cointegration (with ARDL also known as bound testing approach). From the results the model demonstrated good econometric attributes by passing all the required diagnostic tests. Thus, giving the confidence to recommend for policy makers which will not be based on less agreed findings. In summary, it was found that on the long-term basis, climate variability (rainfall), level of aggregate farm mechanization and arable land expansion exerted significant positive impacts on food production level in the country. However, its influence was negative when it was assessed on long-term basis. It was thus recommended that Nigerian government should work on ensuring the efficiency of agricultural expenditure through prudence and proper accountability. In addition, put in place programmes of agricultural transformation based on improved agricultural mechanization and building capacities of farmers to adopt climate resilient technologies such as investment in irrigation facilities especially in the semi-arid regions of the country. Access to land should also be made easy for the small-scale crop farmers who dominate Nigerian food production industry by reviewing the Land Use Act (1978).

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