INFLUENCE OF CLIMATE CHANGE INDICATORS ON AGRIBUSINESS GROWTH INDEX IN NIGERIA

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ABSTRACT

Climate change is intensifying the challenges faced by the agricultural sector in Nigeria. The indicators of climate change (rainfall, temperature and land degradation) have assumed unpredicted trends in recent years. This has adversely affected the productivity of the sector and posed a serious threat to the realization of the self-food sufficiency drive of the federal government. Premised on this fact, the study established the empirical relationship between agribusiness growth index and indicators of climate change in Nigeria. Secondary data were used and its covers the period from 1960 to 2016. The unit root test revealed that, specified series had mixed stationarity issues in level and in first difference. Autoregressive – distributed lag model was used to estimate the causal relationship between agribusiness growth index and indicators of climate change. The exponential trend analyses showed that, annual temperature, percentage of agricultural land, and agribusiness growth index grew positively at the rate of 0.07%, 0.63% and 3.31% respectively. However, annual rainfall had accumulative negative growth rate of -0.14%. The empirical results revealed that, temperature, rainfall and percentage of agricultural land available affected agribusiness growth index both in the long and short run periods. It is recommended that, the authority should formulate and implement supporting programmes that would assist agribusiness entrepreneurs to adapt and mitigate the adverse effect of climate variability. Also, government should create a mechanism for catering climate change information on continuous basis to adequately prepare for uncertainties in trends.

KEYWORDS: Agribusiness, climate change, rainfall, temperature, Nigeria

INTRODUCTION

Agricultural sector plays an important role in the economy development of Nigeria. The sector's contributes significantly to the gross domestic product (GDP) and employed more than 50% of the rural households in the country. It is increasingly obvious that sustainable improvement in agricultural activities can offer a reliable pathway to overcome rural poverty, but until very recently, the sector had not performed as well as it should have, because of several decades of neglect mostly accredited to unhealthy economic and political policies in the country (Akpan *et al.,* 2012). Apart from the poor synergy between agricultural development and policy environment, climate change is another fundamental factor that dampens the productivity of the sector. Agriculture, rural livelihoods, sustainable management of natural resources and food security are inextricably linked within the development and climate change challenges of the twenty-first century (Tubiello, 2012).

Climate change determine most activities in the physical environment, hence it played a dominant role in the development of agriculture. Since agriculture is practiced in the physical

environment, its successes are depended on the resilience of the physical environment to climatic shock. For instance, climate change is known to affect all stages of agricultural production; ranging from cultivation, harvesting, processing and distribution (Rudolf and Hermann, 2009; Mesike and Esekhade, 2014). The sector is highly vulnerable to the variability of climatic factors and the magnitude of the effect possess significant threats to the achievement of the Millennium Development Goals especially those related to eliminating rural poverty and hunger and promoting environmental sustainability (Enete, 2014). The need to study the causal relationship between indicators of climate change and agribusiness growth stems from the fact that, agricultural sector employs majority of Nigerian who dwell in rural areas. It is noted that rural poverty incidence in Nigeria is among the highest in the World. Hence, a study which focuses on a critical issue like this, translates to combating the menace of rural poverty. Also, issues of price volatility and different ecological zones call for more current information in order to formulate sustainable agricultural policy in the country.

Based on the inexhaustible debates on this critical issue and its role on the sustainability of environment resources and human race; many researchers have conducted empirical studies on the relationship between climate change and the growth in agribusiness activities. For instance, Nwachukwu, *et al.,* (2012) examined the relative effect of climate change on the productivity of cocoa in Nigeria. They discovered that, the overall rainfall had significant negative relationship with cocoa production while temperature had positive effect. Still on the same issue, Mesike and Esekhade (2014) reported an inverse relationship between rubber production and rainfall in Nigeria. Similarly, Aondoakaa (2012) investigated the effects of climate change on agricultural productivity in the Federal Capital Territory of Nigeria. Their findings showed positive relationships between crop yield and rainfall as well temperature. Ayinde, *et al.,* (2013) analyzed the effect of relative humidity and minimum temperature trend on rice production in Niger State, Nigeria. They found variations in the trend of climatic factors and rice output. Their report also showed that, humidity and minimum temperature had negative and positive effect respectively on rice yield. In addition, Adamgbe and Fanan (2013) examined the impact of variability in rainfall characteristics on maize yield in Gboko, Nigeria. The result of the correlation analysis showed that rain days and rainfall amount had strong positive relationship with maize yield. It was also observed that the rainfall characteristics jointly contributed 67.4% in explaining the variations in the yield of maize per hectare. In the south eastern State of Enugu, Enete (2014) investigated the impacts of climate change on agricultural production. The study showed that all the traditional crops with the exception of cassava and pepper had a significant field decrease as rainfall continued to be more erratic.

The pool of literature available in Nigeria has given mixed results concerning the relationship between climate change and agribusiness growth; and these findings seem to be regional in nature. For instance, in Nigeria, most of these researches were carried out in the western and eastern regions; hence their findings might not be adequately applied to other regions of the country because of the ecological/environmental differences. Again, issue related to climate change is so dynamic that constant researches are required to keep track with the climatic development in a particular region. In order to provide current information on climate change and its relationship with agribusiness in a holistic manner, this research was designed to specifically establish an average relationship between climate change factors and agribusiness growth index in Nigeria.

RESEARCH METHODOLOGY

Data source: Secondary data were used for the study. These data were sourced from the statistical bulletins of the Central Bank of Nigeria (CBN), World Bank website and FAOSTAT data website. Data covered the period from 1960 to 2016.

Analytical Technique

The study utilized the trend and regression analyses to explore the behavior of the specified variables.

The trend Analysis of Climatic factor and Agribusiness Growth Index in Nigeria

The study investigated the nature of movement over time and growth rate in annual rainfall, temperature and percentage of agricultural land as well as the measure of agribusiness growth index in Nigeria. An exponential trend equation was specified as thus:

$$log_e APP_t = b_0 + b_1 T + U_t \dots\dots\dots\dots (1)$$

Where 'T' is the time expressed in year; APP is agricultural production index (2004-2006) = 100) as a proxy of agribusiness growth index in Nigeria. The exponential growth rate is given as:

(r) $=(e^{b1} - 1) * 100 \dots\dots\dots (2)$

Auto regressive – Distributed lag Model

The study also applied time dependent econometric model to investigate the long run relationship among specified variables. Autoregressive – Distributed Lag Model was used to analyze data collected. The model was used to correct the problem of serial correlation among explanatory variables used in the study. The ARDL model was also preferred over other time series models because the explanatory variables were strictly exogenous to the dependent variable. In addition, the climate change factors are long run factors and their effects would best be described in a long run single equation such as ARDL model. The lag length used in the model was determined by the used of information criteria and lag I was appropriate for the estimation of the specified model. The ARDL model is shown as:

$$LnAPP_t = \delta_0 + + \delta_1 \sum_{i=1}^{n} LnAPP_{t-1} + \delta_2 \sum_{i=1}^{n} LnTEM_t + \delta_3 \sum_{i=1}^{n} LnTEM_{t-1} + \delta_4 \sum_{i=1}^{n} LnRAI_t + \delta_5 \sum_{i=1}^{n} LnRAI_{t-1}$$
$$+\delta_6 \sum_{i=1}^{n} LnALN_t + \delta_7 \sum_{i=1}^{n} LnALN_{t-1} + U_t \dots\dots\dots\dots (3)$$

Where;

APP_t = Agricultural production index (2004-2006) = 100) as a proxy of agribusiness growth index

TEM_t = Annual temperature in Nigeria measured in decree Celsius

RAI_t = Annual rainfall in Nigeria measured in mm

ALA_t = Annual percentage of agricultural land out of the total land area in Nigeria as a proxy of accumulative effect of climate change on land availability (%)

U_t= Stochastic error term and $U_t \sim$ IID (0, δ^2_U) and Ln = Natural logarithm .

RESULTS AND DISCUSSION

Descriptive Statistics

The summary of descriptive statistics of series used in the study is presented in Table 1. The result revealed that, the specified climatic factors showed varied degrees of variability and

Skewness. However, the degree of variability was high in agribusiness growth index and percentage of agricultural land; but low in annual temperature and rainfall. For instance, about 56.23% and 1.53% variations were recorded in agribusiness growth index and rainfall from respectively from 1960 to 2016. This means that, these variables were highly inconsistent and time variant within the study period.

Table 1: Summary Statistics, using the observations from 1960 - 2016

Variable	Mean	Median	Min.	Max.	Std. Dev.	C.V.	Skewness
APP	56.934	42.120	22.570	116.21	32.016	0.5623	0.4999
TEM	26.974	26.979	26.177	27.832	0.4123	0.0153	0.0189
RAI	94.529	95.129	72.974	111.780	8.554	0.0905	-0.2672
ALA	68.293	67.176	51.845	80.921	8.944	0.1309	-0.2028

Source: Computed by authors and variables are as defined in equation 3.

The behavior of the climatic factors and agribusiness growth index as shown in the descriptive analysis implies that, the specified variables vary greatly with time and also exhibited various degrees of variability in the study period.

The trend Analysis of rainfall, temperature, percentage of agricultural land and agribusiness growth index from 1960 to 2016

Estimates of the exponential trend equation for temperature, rainfall, percentage of agricultural land and agribusiness growth index are presented in Table 2. The result for the trend analysis in agribusiness growth index revealed a positive significant relationship of agribusiness growth index and time in Nigeria. This implies that, agribusiness growth index had witness annual increment at an exponential rate of 3.30% in the study period. Similarly, the trend analysis in annual temperature also revealed positive significant relationship with time. The result shows that, the average temperature increased marginally at an exponential rate of 0.07%. In a similar vein, the percentage of agricultural land has a positive significant correlation with time. Increase in time increases the percentage of agricultural land available to farmers in the country. This means that, the proportion of the total land area converted to agricultural land increases on annual basis.

Table 2: Exponential Trend Analysis of Agricultural intensification index in Nigeria

Variables	*APP*	*TEM*	*RAI*	ALA
Constant	2.921 (68.84)***	3.276(1139)***	4.584(188.7)***	4.032 (177.0)***
Time	0.033 (26.05)***	0.0007(7.68)***	-0.0014(-1.876)*	0.0063 (9.23)***
F- cal.	678.526***	58.921***	3.5194*	85.153***
R-square	0.9250	0.517	0.060	0.608
Exp. GR (%)	3.31	**0.07**	**-0.14**	**0.63**

Note: Values in bracket represent t-values. The asterisks ***, ** and * represent 1%, 5% and 10% significance level respectively.

An accumulated exponential growth rate of 0.63% was discovered for agricultural land available in the study frame. On the contrary, the annual rainfall exhibited negative relationship with time. Thus on average, rainfall decreases as time increase in the study period. The result revealed that, about 0.14% reduction in the total rainfall occurs annually due to climate change.

Unit Root test of Variables used in the Analysis

The ADF-GLS test result presented in Table 3 revealed that at level, temperature and rainfall were stationary at the level of lag 0. However when variables were expressed in lag 1, a mixed result was obtained. Specified variables generally have shown stability in their first difference. The result of the ADF-GLS unit root test implies that, the analysis of the specified variables at their levels could result in spurious regression estimates.

Table 3: ADF-GLS Unit Root test Results for Variables Used in the Analysis

Logged Variable	Lag length	Level	First Difference	Order of Integration	Lag length	Level	First Difference	Order of Integration
APP	0	-1.4149	-7.6318***	1(1)	1	-1.0519	-3.0779***	1(1)
TEM	0	-6.0922***	-	1(0)	1	-3.0647*	-	1(0)
RAI	0	-5.9506***	-	1(0)	1	-2.1605	-3.5042***	1(1)
ALA	0	-1.6535	-8.0614***	1(1)	1	-1.6221	-2.7290***	1(1)
				Critical Values				
CV (1%)	0	-3.7472	-3.7510***			-3.7586	-3.7548	
CV (5%)	0	-3.1708	-3.1740***			-3.1804	-3.1772	
CV (10%)	0	-0.8720	-2.8750***			-2.8810	-2.8780	

Note: OT means order of integration. Critical values (CV) are defined at 1% significant level and asterisks *** represents 1% significance level. Variables are as defined previously in equation 3.

The log run model of agribusiness performance in Nigeria

The estimates of the long run model of agribusiness growth index are shown in Table 4. The diagnostic tests for the long run model of agribusiness growth index in Nigeria showed that, the model has goodness of fit. The F-cal. is statistically significant at 1% level, implying that, the estimated R^2 is significant. The result revealed that, about 78.36% of variation in agribusiness growth index is caused by the specified explanatory variables. Serial correlation was not a serious problem, while the normality test (7.1809**) justified the use of OLS method of estimation. The significant of the RESET test means that, the model has structural rigidity. The stability of the long run model was also tested using CUSUM square plot with 95% confidence band as shown in figure 1. The result revealed that, the plot stays with the boundaries of the band. This further suggests that, the estimated model has stability and rigidity.

Table 4: Long run estimates of agribusiness performance in Nigeria

Variable	Coefficient	Standard error	t-value	Probability
Constant	−6.1285	2.7685	−2.2137**	0.0316
$LnAPP_{t-1}$	0.9449	0.0335	28.1946***	<0.0001
LnTEMt	−0.1041	0.6509	−0.1599	0.8736
$LnTEM_{t-1}$	1.8375	0.6278	2.9267***	0.0052
$LnRAI_t$	0.1665	0.0773	2.1535**	0.0363
$LnRAI_{t-1}$	−0.1285	0.0757	−1.6984*	0.0959
LnALAt	0.5892	0.1984	2.9692***	0.0046
$LnALA_{t-1}$	−0.4742	0.2107	−2.2511**	0.0290
		Diagnostic statistics		
R-squared	0.78364	Adjusted R-squared	0.76271	
F(7, 48)	1070.878***	Normality test	7.1809**	
Durbin Watson	2.05844	RESET Test	4.5544**	

Note: Asterisks * and ** represent 10% and 5% significance levels respectively. Variables are as defined in equation (3).

The empirical result revealed that, the previous index of agribusiness growth has a significant positive impact on the current index. This means that, as the previous agribusiness growth index increases, the current index also increases. This connotes that, the previous year activities in agribusiness sector is very important in the current year activities. This result is as expected, because most agribusinesses have time lag and might not yield immediate benefits in the current year but in subsequent years.

The coefficient of temperature in the current year did not show any significant long run impact on the agribusiness growth index, but the previous year temperature impacted positively on the agribusiness growth rate. This means that, if the previous year temperature is high, it would increase agribusiness growth index; and this would call for adoption of mitigation and adaptation strategies to reduce its effect in the current year. As the result of the attempt to reduce the effect of temperature on agro businesses, the output of the sector would shrink in response to these attempts. Alṣo, the opposing sign in the current and previous year of annual temperature isa clear indication of the mixed effect of global weather change on climatic factors in this region.

The coefficient of the current year rainfall has a positive significant relationship with agribusiness growth index. This means that, as the current year rainfall increases, the agribusiness activities received a boost. However, increase in the previous year rainfall lower the productivity of agribusiness sector.Enete, (2014) has reported similar result.This result could be explained by the fact that, previous experience with rainfall would trigger adoption of adaptation and mitigation strategies by farmers and agro entrepreneurs in the current year. As the result of these safety nets, productivity in agribusiness will increase in the current year. The following researchers have reported similar results; Nwachukwu, *et al.*, (2012); Mesike and Esekhade (2014);Aondoakaa (2012);Adamgbe and Fanan (2013).

The slope coefficient of the percentage of agricultural land in the current also impacted positively on the agribusiness sector. This means as the percentage of agricultural land in the current year increases, the agribusiness growth index increases too. However, the relationship was reverse with the previous value of percentage of agricultural land. Following the

experience of the previous year, farmers and agro entrepreneurs adjusted to avoid the adverse effect of land deterioration in the current year.

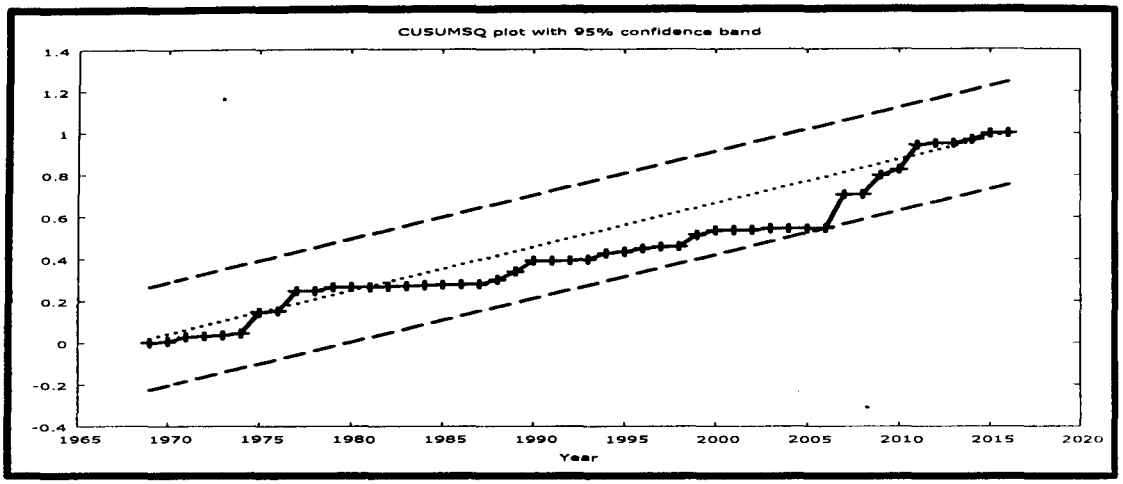

Figure 7: Stability Test of the Long run Model

Short run effect of climate change indicator on agribusiness growth index

The relationship was also tested using the first difference of the specified variables. The essence was to investigate the relationship with the underlining assumption of the short run effect between climatic factors and agribusiness growth index. The result is presented in Table 5. The diagnostic statistics were satisfactory; hence the estimated model has a good explanatory power. The CUMSUM square plot shown in figure 2 further confirms the relevance the specified model at 95% confidence band.

Table 5: long run estimates of agribusiness performance in Nigeria

Variable	Coefficient	Standard error	t-value	Probability
Constant	0.0279	0.0067	4.1652***	0.0001
$\Delta LnAPP_{t-1}$	−0.0485	0.1555	−0.3121	0.7562
$\Delta LnTEMt$	−1.1515	0.4865	−2.3667**	0.0219
$\Delta LnRAI_t$	0.1336	0.0651	2.0504**	0.0456
ΔLnALAt	0.7024	0.1418	4.9530***	<0.0001
		Diagnostic statistics		
R-squared	0.349745	Adjusted R-squared	0.29773	
F(4, 50)	8.1997***	Normality test	Chi-square(2) = 8.23459**	
Durbin Watson	2.13172	RESET Test	4.7843**	

Note: Asterisks * and ** represent 10% and 5% significance levels respectively. Variables are as defined in equation (1).

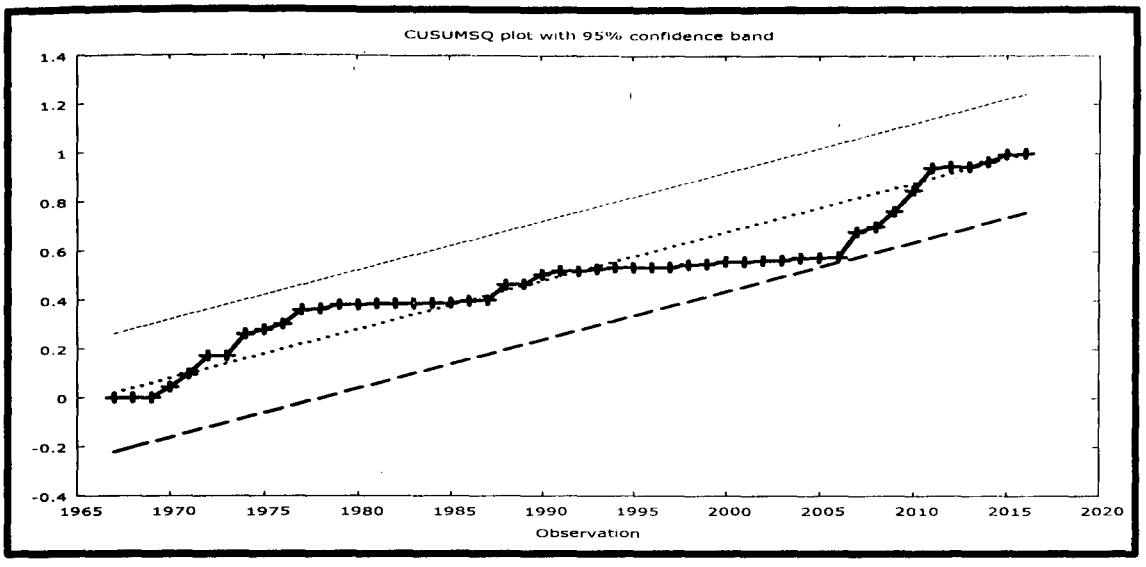

Figure 8: Stability Test for the Short run Model

The empirical result was similar to the previous result presented. The finding revealed that, in the short run; rainfall and percentage of agricultural land have accumulative positive effect on the agribusiness growth index in Nigeria. This means that, increase in these variables, increases the index of agribusiness growth. On the contrary, temperature influence agribusiness growth index negatively.

CONCLUSION AND RECOMMENDATIONS

Indicators of climate change have shown diverse variability marked with high degree of uncertainty in recent years in Nigeria. These changes in the climatic factors are inseparably linked with activities in the agricultural sector. Climate change has both positive and negative effect on agricultural activities. It has diverse and location specific impact on agro business activities in the country. One of the prominent adverse effects of climate change on agribusiness activities is increased in incidence of poverty in rural areas given thehigh dependency on the agricultural sector forrural livelihood opportunities. The menace of climate change on agricultural sector has also resulted in the alteration of the natural flow of price system of some agro products in country. Planting seasons has been altered due to climate change. The overall profitability of agribusiness to an extent is determined by the rolling ball of climate change.It is imperative that all tiers of governments should recognize the impeding threats of climate change on our agricultural sector. Quantum of scientific research results abound on the likely impacts of climate change on agribusiness. This call for increase advocacy activities especially among the vulnerable; increase political awareness on the issue and a sound legislative framework to back implementation of policies. It is indispensable that. government should enunciate programmes to help farming households to cope with both the threat of climate change and challenges pose on the future investment in the sector. Again, authority should formulate and implement supporting programmes that would assist agribusiness entrepreneurs to adapt and mitigate the devastating effect of climate variability.Furthermore, it is also recommended that. the government should create a mechanism for collating climate change information on a continuous basis to checkmate uncertainties in trends. A policy pack that contains climate change adaptation and mitigation strategies should be enshrine in the development map for agribusiness entrepreneurs in the country. It is expected that authority should mainstream climate change policies into

agricultural main policy. Adoption of sustainable management of agricultural resources in the face of climate change is absolutely inevitably.

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