International Journal of Weather, Climate Change and Conservation Research
Vol.2, No.1, pp.47-56, March 2015
Published by European Centre for Research Training and Development UK (www.eajournals.org)

EFFECT OF CLIMATE CHANGE ON FOOD CROP PRODUCTION IN SOUTHEAST, NIGERIA: A CO-INTEGRATION MODEL APPROACH

Chikezie C[1], Ibekwe U. C[1], Ohajianya D. O[1], Orebiyi J. S[1], Ehirim N. C[1], Henri-Ukoha A[1], Nwaiwu I.U.O[1], Ajah E. A[2], Essien U. A[1], Anthony G[1] and Oshaji I.O[1]

[1]Department of Agricultural Economics, Federal University of Technology, Owerri Imo State
[2]Department of Agricultural Economics, University of Calabar Cross River State

ABSTRACT: *This paper studied the effect of climate change on selected food crop production in Southeast, Nigeria. The data were sourced from National Root Crops Research Institute, Umudike, National Bureau of Statistics and the Central Bank of Nigeria (CBN) bulletin. Data on crop yield and climate variables from 1984 to 2014 were collected. Descriptive Statistics, Co-integration analysis and Error Correction Model were adopted. The finding reveals unsteady climatic pattern with peak points across the period under review. The Augmented Dickey-Fuller test for unit root reveals that yam; maize and cassava outputs were non stationary but became stationary after the differencing. All climate variables showed stationary at first level. Result shows the existence of one co-integrating vector in the three models. The results shows that the coefficients of ECM(-1) which indicates speed of adjustment of the crop outputs to the equilibrium when a disturbance has occurred are -0.365 ($p<0.01$), -0.211 ($p<0.05$) and -0.599 ($p<0.001$) for yam, maize and cassava output models respectively. The coefficients of multiple determination (R^2) for yam, maize and cassava were 0.611, 0.440 and 0.2669 respectively. In yam model, the coefficients show that all variables except lagged yam output and temperature have positive relationship with the yam output; the coefficients of lagged maize output, rain days and temperature are negative while rainfall volume, humidity and sunshine are positive in maize model and in cassava model, coefficients of rainfall volume, rain days, sunshine and lagged cassava output are positive while temperature and humidity are negative. Results show that climate change impacted yam and maize output. It is recommended that adequate mitigation and adaptive measures be put in place to reduce the effect of climate change in order to achieve an appreciable agricultural productivity.*

KEYWORDS: Climate Variables, Food Crops, Co-integration, Error Correction, Southeast Nigeria

INTRODUCTION

Agriculture is the most important sector and extremely relevant to Nigeria's economy. This is because of its importance in sustaining livelihoods and poverty reduction. It also secures food, fuel and contributes to economic development. As a key sector in the Nigerian economy agriculture employs over 70% of labour force and contributes over 40% to the Gross Domestic Product (Adejuwon, 2004). Regrettably, food production in Nigeria has not kept the pace with the growing population in decades and it is susceptible to further decrease. This decline in production is attributed to some intertwining factors including climate change. Undoubtedly, Climate change is a global phenomenon, the impact however, is spatially heterogeneous and the risk is generally believed to be more acute in developing countries considering the region's limited human, institutional and financial capacity (United Nations Framework Convention on Climate Change, 2007).

Climate change is marked with increased intensity and frequency of storms, drought and flooding, altered hydrological cycles and precipitation variance and these have implications for future food availability (Food and Agricultural Organization, 2007). According to Jimoh and Adeoye, climate variability is rapidly becoming the most important environmental challenge facing mankind. Relevant literature shows that there is variability in Nigerian rainfall and temperature (Nwaiwu et al., 2014, Nwajiuba and Onyeneke 2010 and Odjugo (2010)). Unsteady temperature and rainfall pattern could be due to effects of climatic change in the area and according to Arnell (1992) climatic variability could result in changes in rainfall distribution. The study further shows that change climatic factors have significant effect on agricultural productivity. Food and Agricultural Organization (2004) estimated 25% loss of cereals, 37% loss of root and tubers and 53% loss of fruits in developing world as a result of factors ranging from weather conditions, production practices to harvesting, handling to processing . It is projected that crop yield in Africa may fall by 10-20% by 2050 or even up to 50% due to climate change (FAO, 2006).

Given the above statistics, climate change has indeed become a global issue. It is very likely that climate change can aggravate such condition and slow the pace of progress along sustainable development pathways. Addressing sustainable development challenges in agricultural sector is therefore of paramount importance to Nigeria especially in southeast where agriculture is largely rain-fed.

METHODOLOGY AND ANALYTICAL FRAMEWORK

The study area was Southeast, Nigeria. The study employed time series data on temperature, rainfall volume, rainfall days, relative humidity, sunshine duration and crop yield data ranging from 1984 to 2014. The data were sourced from National Root Crops Research Institute, Umudike, National Bureau of Statistics and the Central Bank of Nigeria (CBN) bulletin. Data were analysed using descriptive statistics and Co-integration analysis. In using time series data, stationarity is usually assumed but this not always so since time series data is not constant but varying (Seddighi *et al.*, (2000) and Patterson (2000). It must be noted that regressing a non-stationary time series data over another non-stationary time series data gives a spurious or nonsense regression (Phillips, 1986; Olayemi, 1998; Ehirim *et al.,* 2007). Spurious regression occurs when the test statistics show a significant relationship between variables in the regression model even though no such relationship exists between them. According to Giles (2007) the "levels" of many economic time-series are integrated and if these data are used in a regression model then a high value for the coefficient of determination (R^2) is likely to arise, even when the series are actually independent of each other. Following Gujarati and porter (2009) a unit root test is performed using this equation

$Y_t = pY_{t-1} + u_t, \quad -1 \leq p \geq 1$ where u is the white noise error.

If the estimated p is statistically equal to 1 when Y_t is regressed on its lagged value of Y_{t-1} then Y_t exhibit a non-stationary process but if otherwise then Y_t is stationary. Following the statistical model specified by Ayinde et al., (2011), stationarity test was carried out using Augmented Dickey Fuller (ADF) formula:

$$\Delta Y_t = B_1 + B_{2t} + \delta Y_{t-1} + \sum_{t=1}^{n} \Delta \alpha Y_{t-1} + _{\varepsilon t} \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where $e_t = \Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$, $\Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$.

Once a unit root has been confirmed and the variables under examination are integrated of order 1, there is possibility for the existence of a long-run equilibrium relationship which implies that their stochastic trends must be linked among a given set of variables and a test for co-integration was a useful pre-test for this linkage. Co-integration is said to occur if the model produces stationary Residuals and eliminates the stochastic trends (Engle & Granger 1987). The null hypothesis of no co-integration was tested by performing a unit root test on the equilibrium error process. The Johansen procedure as suggested by Maddala (2001) was used to test for the number of co-integration vectors in the model. If non-stationary variables are co-integrated, the true equilibrium error process u_t must be I(0) **(**Phillips, 1986), they must obey an equilibrium relationship in the long-run and are expressed by Error Correction Model (ECM). If they are not co-integrated, then u_t must be I(1) (Ayinde, 2011). For this paper the co-integration model is shown below

$$Y_{it} = B_0 + B_1X_{1t} + B_2X_{2t} + B_3X_{3t} + B_4X_{4t} + B_5X_{5t} + U_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where

i= 1, 2, 3

Y_1, Y_2, Y_3 = mean of annual output of yam, cassava and maize measured in tons/Ha respectively
X_1 =Annual temperature (^{0}C)
X_2 =Annual rainfall (mm)
X_3 =Annual average of rain days (number)
X_4 =Annual average of relative humidity (%)
X_5 =Annual average of sunshine duration (hours)
U = error term

RESULTS AND DISCUSSION

Trends of Agricultural Products over a period of 30 Years

Yam, maize and cassava were selected to represent agricultural products in the study area. In figure 1, Yam recorded an unsteady trend with a highest average value of 23 thousand tons in 1985. The output trend of yam took a downward trend between 1986 and 2009 with the lowest value of 9 thousand tons in 2011. The period 1986-1994 was the Structural Adjustment Programme (SAP) period and findings by Ereagha *et al*., (2014) showed despite the programme agricultural sector contribution to GDP in the post SAP was a little above 40%. From figure 2, maize had its highest value of 3.5 thousand tons in 1985 and lowest value of 1.3 thousand tons in 2011. Other low output recorded (1.5, 1.4 and 1 .35 thousand tons) occurred in 2005, 2013 and 2014 respectively.

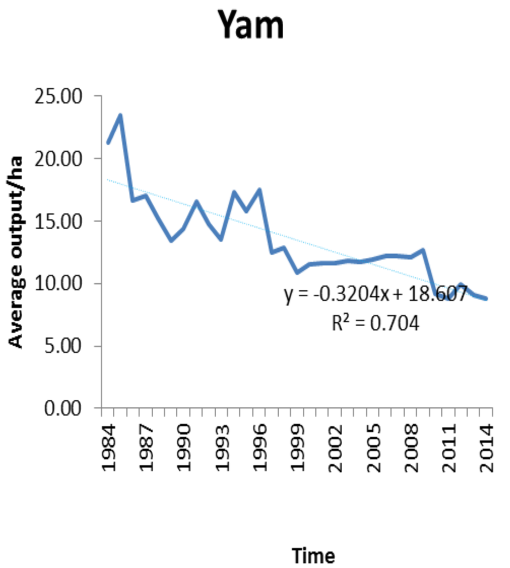

Fig 1: Distribution of yam production (tons/ha)

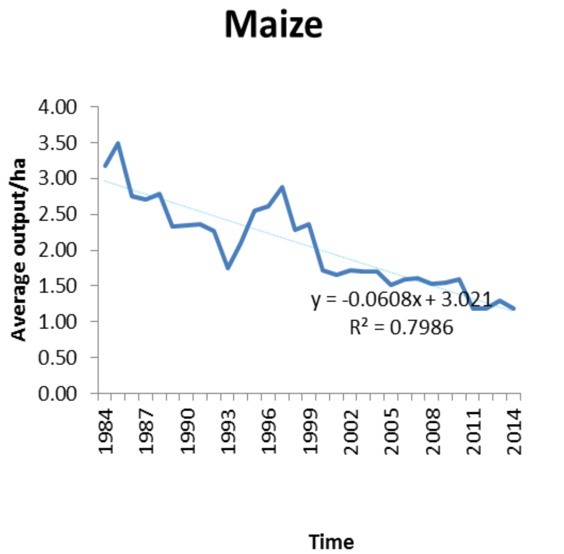

Fig 2: Distribution of maize production (tons/ha)

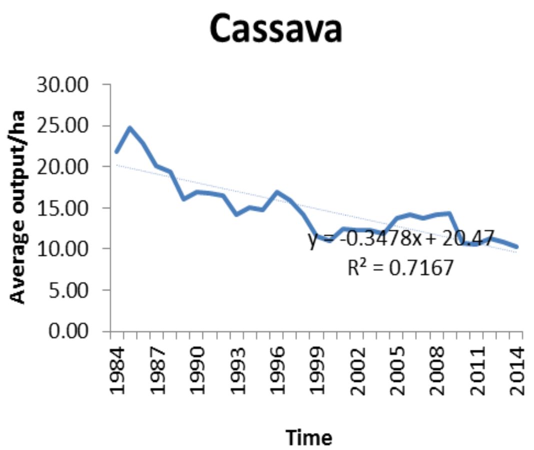

Fig 3: Distribution of cassava production (tons/ha)

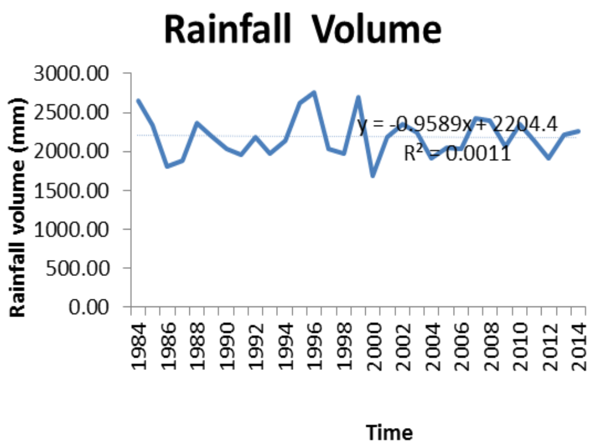

Fig 4: Trend of Rainfall volume

The trend of cassava in figure 3 shows a fluctuating movement along the line, with a highest value of 25 thousand tons in 1985 and lowest output value of 10 thousand tons in 2010 and 2011. The figure 4 shows that rainfall volume was about 2800mm in 1984, dropped to about 1800mm in 1985 rose to about 2200mm in 1987, with several interruptions of declining patterns in 1998, 2001, 2004 and 2013; this fluctuating trend implies an indication of climate change especially since 1985 and this impacted on the food crop output in the area.

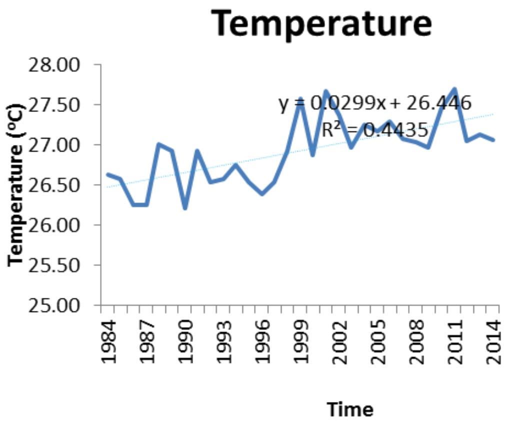

Fig 6: Trend of Temperature variation

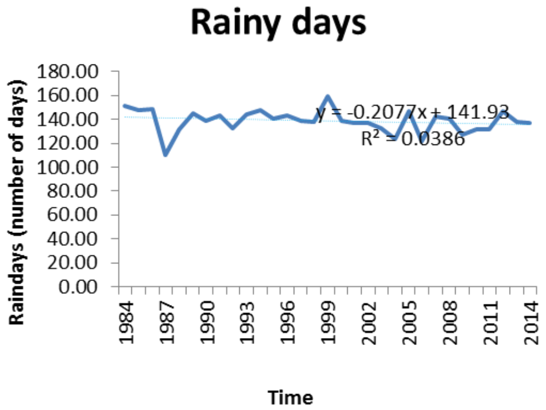

Fig 5: Trend of Rainy days variation

In figure 5, the rainy day was about 150 days in 1984, but dropped to about 110 days in 1987, only to rise to again to 145 days in 1989. The unsteady movements of rise and fall characterized rain day patterns, with the highest rain day period in 1999 and lowest in 1987. This drop in rain days might have a negative toll on yam (fig.1), maize (fig.2) and cassava (fig.3) as indicated by sharp fall in output between 1985 and 1987. This suggests some mitigation measures like irrigation to meet up with food production. Temperature distribution as shown in figure 6 was averaged about 26.7^{o}c in 1984, rises to 27^{o}c in 1988, 27.5^{o}c in 1999 and 2001, and 27^{o}c in 2011. This increasing trend might have had detrimental effect on agricultural production as indicated in figure 1, 2 and 3. The period of low temperature values were experienced in 1990, 1996 and 2009 with average temperature not falling below 26^{o}c. This figure shows that temperature is not relatively constant.

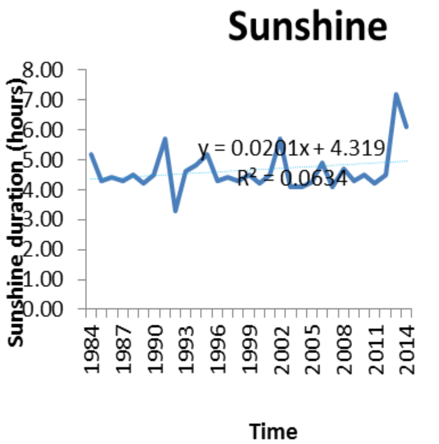

Fig 8: Trend of Sunshine duration variation

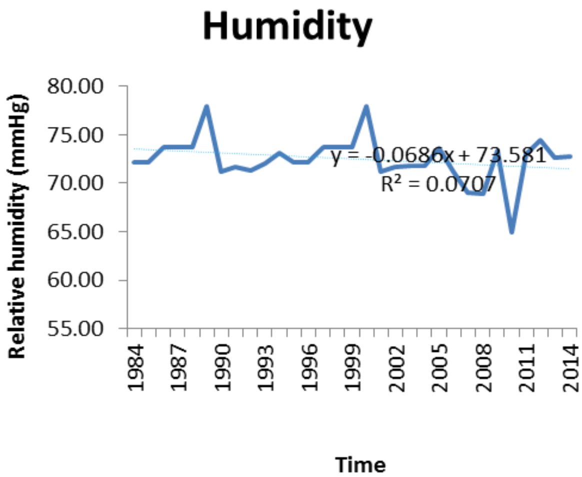

Fig 7: Trend of Relative humidity variation

The figure 7 indicates the relative humidity variation in the area over three decade period. There is a substantial fluctuation of the high humidity of about 78mmHg in 1989 followed by unsteady movements over the three decades, and a record low humidity of 65mmHg in 2010. The figure 8 shows an unsteady change in the movements of the sunshine levels, it was almost 5 hours sunshine duration per day in 1984, which rose slightly to 6 hours/day in 1991, 2002 and about 7.5 hours/day in 2013.

Estimation of Long run equilibrium relationship existing in the model

Stationarity Test Result

Augmented Dickey-Fuller test (ADF) for stationarity is presented in Table.1. According to Gujarati (2003) by simply differencing a non-stationary time series data become stationary

Table 1: Result of Unit root tests

Variables	ADF value@ level	ADF value@ 1st diff.	order	Decision
Yam	-2.335	--7.888***	I(1)	Non Stationary
Cassava	-1.609	-5.350***	I(1)	Non Stationary
Maize	-1.622	-6.751***	I(1)	Non Stationary
Rainfall Vol.	-5.742***	-7.384***	I(0)	Stationary
Rain days	-5.635***	-9.060***	I(0)	Stationary
Temp.	-3.040**	-8.094***	I(0)	Stationary
R. Humidity	-4.931***	-9.386***	I(0)	Stationary
Sunshine D.	-4.296***	-8.495***	I(0)	Stationary

***, **, * = significance at 1%, 5%, 10%

ADF tab @ 10%, 5%, 1% = -2.624, -2.986, -3.716

Table 1 reveals that the output of yam, maize and cassava were not stationary at level while rainfall volume, rain days, temperature, relative humidity and sunshine duration were stationary at the level I (0). However, when the unit roots tests were conducted at their first difference, they became stationary and this presumes that this is a long-run relationship between them.

Co-integration Analysis Result

Johansen co-integration test was conducted and the result is shown in table 2. In order to test for the co-integrating relationship between the variables under study, all the lag selection criteria such as Akaike information criteria (AIC), Hannan-Quinn Information Criteria (HQIC), Schwartz information criteria (SIC) were used to select the number of lag length required in the co-integration test and a lag length of l = 4 is suggested for the yam, maize and cassava output models based on these criteria.

The Table 2 shows the trace and maximum statistics of the yam, maize and cassava models, The null hypothesis is that the number of co-integrating vectors is less than or equal to r, where r is 0, 1, 2, 3, 4, 5 or 6. Accordingly, the null hypothesis is rejected if the calculated trace and/or maximum statistics are greater than their corresponding tabulated values, otherwise they are accepted (Johansen, 1995). In the output model, the calculated trace and maximum statistics at null hypothesis of $r \leq 1$ were 66.6428* and 29.5837* for yam, 71.5339* and 32.996* for maize and 65.7875* and 32.996* for cassava with corresponding tabulated values of 76.07 and 38.77 at 5% level of significance. The null hypothesis was accepted at this stance which implies that there are at least one co-integrating vectors at 0.05% critical level. This suggests the existence of one co-integrating vector in the three models, we can conclude that the climate and agricultural outputs variables were co-integrated and followed long-run equilibrium relationship (Johansen, 1995). According to Akintunde *et al.*, (2013), the evidence of co-integration rules out spurious correlation and hence suggests the Error Correction Model.

Table 3 presented the Least Square Estimates of the ECM models. The results shows that the coefficients of ECM(-1) which indicates speed of adjustment of the crop outputs to the equilibrium when a disturbance has occurred were -0.365 ($p<0.01$), -0.211 ($p<0.05$) and -0.599 ($p<0.001$) for yam, maize and cassava output models respectively, this implies that stochastic error (residuals) processes generated and their movements with time in the yam, maize and cassava models can be corrected and the speed of adjustments back to equilibrium in the long run were given as 0.365, 0.211 and 0.599 respectively.

In yam model, the coefficients of variables showed that all variables except lagged yam output and temperature had positive relationship with the yam output. With a negative coefficient (-0.860), it indicates that decreasing temperature engenders increase in yam output per hectare in the short run. The coefficients of lagged maize output, rain days and temperature were negative while rainfall volume, humidity and sunshine were positive in maize model and in cassava model, coefficients of rainfall volume, rain days, sunshine and lagged cassava output were positive while temperature and humidity were negative.

Table 2: Co-integration rank of a VECM model

			yam			maize			cassava			
Hypo thesis Null	Alter native	Eigen-value	Trace statistics	Max. statistics	Eigen-value	Trace statistics	Max. statistics	Eigen-value	Trace statistics	Max. statistics	5% crit. value (trace)	5% crit. value (max.)
r = 0	r =1		131.201	64.5582		115.0443	43.5104		113.573	43.5104	103.18	45.10
r ≤ 1	r = 2	0.89206	66.6428*	29.5837*	0.77695	71.5339*	32.996*	0.80752	65.7875*	32.996*	76.07	38.77
r ≤ 2	r = 3	0.63945	37.059	15.5446	0.67947	38.5378	16.1057	0.61787	37.89	16.1057	54.46	32.24
r ≤ 3	r = 4	0.41493	21.5144	13.6069	0.42614	22.4322	13.1688	0.46344	19.8354	13.1688	35.65	25.52
r ≤ 4	r = 5	0.3745	7.9075	6.9459	0.36498	9.2634	7.3852	0.33328	8.0792	7.3852	20.04	18.63
r ≤ 5	r = 6	0.21299	0.9616	0.9616	0.22482	1.8782	1.8782	0.16297	2.9203	1.8782	6.65	6.65

Table 3: Result of the Vector Error Correlation Model (VECM) Yam, Maize, Cassava

Variables	Coeff.	Std. Err.	z	P>|z|	Coeff.	Std. Err.	z	P>|z|	Coeff.	Std. Err.	z	P>|z|
ECM(-1)	0.365 ***	0.106	-3.430	0.001	-0.211**	0.105	-2.010	0.045	0.599***	0.081	-7.420	0.000
Lagged Output	-0.201	0.152	-1.320	0.185	-0.080	0.221	-0.360	0.719	0.056	0.204	0.280	0.783
Rainfall vol.	0.002*	0.001	1.890	0.059	3.60e-4*	1.86e-4	1.940	0.053	0.001	0.001	0.920	0.358
Rain days	0.002	0.023	0.070	0.946	-0.004	0.004	-0.980	0.329	0.005	0.022	0.220	0.825
Temperature	-0.860	0.857	-1.000	0.316	-0.126	0.156	-0.810	0.418	-0.811	0.840	-0.970	0.334
Humidity	0.004	0.105	0.040	0.968	0.002	0.019	0.120	0.906	-0.001	0.102	-0.010	0.996
Sunshine	1.716 ***	0.403	4.260	0.000	0.124**	0.055	2.230	0.026	0.771*	0.409	1.890	0.059
Constant	-0.653	0.294	-2.220	0.026	-0.079	0.050	-1.570	0.116	-0.472	0.292	-1.620	0.106
AIC	33.471				30.210				33.671			
R^2 /Chi^2	0.611 /32.939			0.000	0.440/ 16.497			0.036	0.2669/ 7.6453			0.469
LM	29.115			0.785	39.067			0.334	27.680			0.838
Jarque-Bera	1.460			0.482	0.324			0.851	0.706			0.703

Based on the significance of the variables in table 3, the coefficients of rainfall volume and sunshine for yam model were 0.002 ($p<0.05$) and 1.716 ($p<0.01$) respectively and this implies that they have positive significance short run effects on the yam output and 100% increases in rainfall and sunshine significantly increases the yam output by 0.2% and 171.6% respectively. Similarly, the coefficients of rainfall volume and sunshine for maize model were 3.602e-4 ($p<0.05$) and 0.124 ($p<0.05$). It indicates positive significance of these variables at short run and 100% increase in rainfall volume and sunshine, would significantly increase the maize output by 3.602e-2% and 12.4%, However, the coefficient of sunshine for cassava model was 0.771 ($p<0.1$) which indicates a positive short run effect of sunshine on the cassava output and 100% increase in sunshine, would increase the cassava output by 77.1%. This implies that annual rainfall volume contributes significantly and positively to maize production in the study area and climate change has not significantly altered the pattern of rainfall in the study area in such a way as to affect maize production. Ayinde *et al.*, (2011) adopted co-integration technique and revealed that temperature had negative effect on agricultural productivity. This result is consistent with the outcomes of Ammani *et al.*, (2012).

The coefficients of multiple determination (R^2) for yam, maize and cassava were 0.611, 0.440 and 0.2669 respectively, this implies that the climatic factors such as rainfall, rain days, humidity, temperature and sunshine accounts for about 61.1%, 44% and 26.7% variations in yam, maize and cassava respectively with the period under review. The chi-square for yam, maize and cassava were 32.9391 ($p> \varkappa^2=0.0001$), 16.4973 ($p> \varkappa^2=0.0358$) and 7.6453 ($p> \varkappa^2=0.4689$). For yam model the relationship was statistically significant at 1% level, showing that climate actually impacted yam output. For maize model, the relationship was statistically significant at 5% level. This also signifies an effect of climate change on maize output. The yam output relationship was statistically insignificant and this may be attributed to Nigerian government intervention in cassava production. Also, cassava is a drought resistant crop and thrives favourably in harsh climatic conditions (International Institute of Tropical Agriculture, 1990). The Langragian Multipliers (LM) auto-correlation values were 29.115 ($p> \varkappa^2 = 0.785$), 39.067 ($p> \varkappa^2 =0.334$) and 27.680 ($p> \varkappa^2 =0.838$) which indicates that the residuals of the yam, maize and cassava output models do not exhibit serial correlation and the Jarque Bera normality values were 1.460 (p> $\varkappa^2$ =0.482), 0.324 (p> $\varkappa^2$ =0.851) and 0.706 (p> $\varkappa^2$ =0.703) which indicates that the residual is normally distributed.

CONCLUSION AND RECOMMENDATIONS

Agriculture in southeast Nigeria is largely rain-fed, it therefore follows that any unfavourable change in climate is likely to impact negatively on its productivity. The could be in terms of effects on crop growth, availability of soil water, soil erosion, incident of pest and diseases and decrease in soil fertility. This study examined the effect of climate change on food crop production in southeast, Nigeria for the period 1984-2014. The result shows a substantial fluctuation in volume of rainfall, temperature, relative humidity, sunshine duration and number of rain days from 1984 to 2014. It also shows a positive and significant trend at 1% level of probability for temperature. The Augmented Dickey-Fuller test for unit root revealed that yam; maize and cassava outputs were non stationary but became stationary after the differencing. All climate variables showed stationary at first level. The study employed an error correction technique of analysis and showed the existence of one co-integrating vector in the three models. The study also revealed that the effect of climatic variables on selected crop varies depending on the type of crop. In general, climate change was found to affect crop output (particularly yam and maize) based on the significance of chi-square in yam and maize output models. This paper suggests the need for programmes and seminars to intimate farmers with modern adaptation strategies especially the use of irrigation facilities to supplement rainfall in the study area. Sensitization of farmers on the importance of weather forecast is also advocated.

REFERENCES

Adewuyi, S. A., Okojie, L. O., Folorunso, B. and Bada, B. S. (2014). Effect of Climate Change on Yam and Cassava Production in Oyo state, Nigeria: A Co-integration Model Approach *International Journal of Agricultural Economics and Rural Development 6 (1): 2014*

Akintunde, O. K., Okoruwa, V. O and Adeoti, A. I (2013). The Effect of Agro-climatic Factors on Cash Crops Production in Nigeria. *Journal of Central European Agriculture 14(3): 52 - 74*

Ammani, A. A., Ja'afaru, A. K., Aliyu, J. A. and Arab, A. I. (2012) Climate Change and Maize Production: Empirical Evidence from Kaduna State, *Nigeria Journal of Agricultural Extension 16 (1): 1-8.*

Arnell, N.W. (1992). Impacts of Climatic Change on River Flow Regimes in the UK *Water and Environmental Management **6**: 432-442.*

Ayinde, O. E., Muchie M. and Olatunji, G. B. (2011). Effect of Climate Change on Agricultural Productivity in Nigeria: A Co-integration Model Approach Kamla-Raj *Journal of Human Ecology, 35(3): 189-194*

Ehirim, N. C., Rahji M. A.Y. and Donstop-Nguezet P. M. (2007). Determinants of Groundnut Supply in Nigeria 1960-2003: An Error Correction Model Approach *Int.J.Agric. Rural Dev. 10: 46-52*

Engle, R.F. and Granger C.W.J. (1987). Co- integration and Error Correction:

Representation, Estimation and Testing, Econometrics, 55, 251-276

Eregha, P. B., Babatolu, J. S. and Akinnubi R. T. (2014). Climate Change and Crop Production in Nigeria: An Error Correction Modelling Approach *International Journal of Energy Economics and Policy 4 (2):Pp 297-311*

Food and Agricultural Organisation (2006). The State of Food Insecurity in the World Rome.

Food and Agricultural Organization (2007). Adaptation to climate change in Agriculture, Forestry and Fisheries: Perspective, Framework and Priorities

Giles, D. E. A., 2007. Spurious regressions with time-series data: Further asymptotic results. *Communications in Statistics -Theory and Methods*, 36, 967-979.

International Institute of Tropical Agriculture (1990). Cassava in Tropical Africa Reference Manual, IITA, Ibadan, Nigeria.

Johansen, S. (1995). Likelihood Based Inference in Co-integrated Vector Error Correction Models, Oxford University Press, Oxford.

Maddala G. S. (2001). Introduction to Econometrics 3rd Edition England John Wiley and Sons Ltd

Nwaiwu, I. U. O., Ohajianya, D. O., Orebiyi, J. S., Ibekwe, U. C., and Eze, C. C. (2013a) Effects of Climate Change on Labour Time Allocation to Food Crop Production- A Case Study of Southeast Nigeria *Global Journal of Current Research. (GJCR) (CRDEEP) India Vol. 1 (4) Pp. 108-115*

Nwajiuba, C.U. and Onyeneke R. (2010). Effects of Climate Change on the Agriculture of Sub-Saharan Africa: Lessons from Southeast Rainforest Zone of Nigeria. Oxford Business and Economics Conference Program, June 28-29, 2010 St. Hugh's College Oxford University, Oxford, UK. Internet paper

Odjugo, P. A. O. (2010). General Overview of Climate Change Impacts in Nigeria *Kamla-Raj Journal of Human Ecology, 29(1): 47-55*

Olayemi, J. K. (1998). Elements of Applied Econometrics Department of Agricultural Economics, University of Ibadan Oyo State.

Patterson, K. (2000). An Introduction to Applied Econometrics: A Time Series Approach. New York: St. Martin's Press.

Phillips, P. C. B. (1986). Understanding Spurious Regressions in Econometrics *Journal of Econometrics*, 33, 311-340.

Seddighi, H. R., Lawler K. A. and Katos, A. V. (2000). *Econometrics: A Practical Approach* New York Routledge

United Nations Framework Convention on Climate Change (2007). Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries