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GENDER COMPONENTS AND AGGREGATE FOOD PRODUCTION NEXUS: A PATH WAY TO ATTAIN FOOD SELF-SUFFICIENCY IN NIGERIA

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ABSTRACT

The study examined the relationship between aggregate food production and contribution of gender variables (women) in Nigeria from 1980 to 2015. Bounds test (ARDL Model) was used to determine the level of co integrating relationships. Data for the study was sourced from National Bureau of statistics, Central bank of Nigeria and Food and Agricultural Organization database. Stationarity of the data was tested using ADF and KPSS unit root tests and variables were I(1) and I(0). Bounds test results indicated that there is a long run relationship between aggregate food production, percentage of women in agriculture, percentage of educated women in agriculture, women as head of household and weather. Positive relationship exists between aggregate food production and all the variables included in the model except women as head of household. To attain food self-sufficiency, the study suggests more productive resources to be given to women through gender responsive policies that will eliminate all kinds of bias with respect to asset acquisition, financial inclusion and education for women.

Keywords: Gender; ARDL; aggregate food production; Nigeria

INTRODUCTION

Women in Africa generally play an important role in small-scale traditional agricultural production, they have taken over the production and processing of arable crops. Estimate of women's contribution to the production of food crops in sub-Saharan African (SSA) countries ranges from 30% to 80% revealing that women are actively more involved in agricultural activities than men (Afolabi, 2008). The National Bureau of Statistics (NBS, 2011) reported that as much as 73% of women in Nigeria were involved in cash crops, arable and vegetable gardening, 16 % in post-harvest activities and 15 % in agroforestry. Involvement of women in agriculture in Nigeria has attracted greater attention in recent years; the government of Nigeria adopted and enforced the national gender policy in 2007 as a substitution of the women's policy adopted in 2000. Its objective is to promote people's potential so society may boom despite gender and social class (JICA, 2012). In some states, rural women have virtually taken over the production and processing of arable crops responsible for as much as 80% of the staple food items (Odebode, 2012).

The role that women play and their position in meeting the challenges of agricultural production and development are quite dominant and prominent. Findings from a study financed by the United Nations Development Programme (UNDP) revealed that women make up some 60-80 percent of agricultural labour force in Nigeria (World Bank, 2003). Unfortunately, female farmers in the country are among the voiceless, especially with respect to agricultural policy design and implementation that are targeted at increasing food security and food production. The policies tend to either under estimate or ignore women's role in both production and the general decision-making process within the household (Ogunlela and Aisha, 2009).

Empirical studies have found that female farmers have lower yields than male farmers which are attributed to some constraints faced by them in every step of the production process (FAO, 2011). Women are likely to have less land to cultivate than men, and when they do, tenure security may be weaker, their access to technology, information, and agricultural extension tends to be more limited compared to men, they owned fewer of the working animals and fertilizers, they use less credit and often do not have control over it and have less education than men. The consequence was a yield gap between men and women which averages around 20-30%, and most research reveals that the gap is due to differences in resource use (FAO, 2011). Agricultural output in developing countries is said to increase between 2.5% and 4% when yields of crops by women farmers are up to the levels achieved by men (Oseni e*t al.*,2014; FAO, 2011).

In an attempt to bridge the gap between men and women farmers in Nigeria, various women groups and organizations have emerged such as women farmers advancement network (WOFAN) and other national and states cooperative societies with a view to encourage acquisition of farm lands for productivity. The formation of Women-In-Agriculture group (WIA) under the government Agricultural Development Programme (ADP) had facilitated acquisition of farm inputs, credits and extension education to women cooperative groups to support them in the area of agricultural production, processing and trainings on various aspect of life (Kotze, 2003; Odebode, 2012). In view of the recognition that women make crucial contributions to agriculture in Nigeria and the constraints they suffered due to gender gap resulting in low productivity compared to their counterpart (male). The study was aimed at analysing the relationship and the contribution of women in increasing aggregate food production in Nigeria using some attributable variables.

MATERIAL AND METHODS

The study employed time series data spanning a period of thirty six(36) years, from 1980 to 2015.To achieve the objective of the research data on gender such as percentage of women in agriculture in Nigeria, percentage of women as head of household, percentage of educated women represented by percentage of enrolment of women in secondary school, access to productive resources by women using dummy variable. Aggregate output production of food crops and rainfall as weather variable were also obtained. The entire data for the study were drawn from the following sources; National Bureau of Statistics (NBS) - various edition of annual abstract of statistics, Central Bank of Nigeria (CBN) annual reports and Food and Agricultural Organization Database (FAOSTAT). Aggregate output production was the only variable converted to natural logarithm form to enable interpretation of relationships.

Analytical Tools and Model Specification

The study employed Autoregressive Distributed Lag model (ARDL) also known as Bounds test approach to co-integration developed by Pesaran *et al*., (2001). The technique has some unique advantages over Engle-Granger procedure and Johansen co-integration techniques, for instance (i) it is valid even in small data series of sample less than 80 observations like the present study (ii) it does not require that all series be integrated of the same order (iii) it gives unique co-integration vector rather than assuming only on eco integration relation, and (iv) this technique provides more choices like decision about number of endogenous and exogenous variables to be included in the model treatment of deterministic element, optimal number of lags to be used, and order of the vector autoregressive (VAR) (Ogundari and Nenseki, 2013; Sajid *et al.*, 2014).

Following Pesaran *et al*. (2001), the vector auto regression (VAR) of order *p,* denoted VAR (*p*) was assembled for the function satisfying all conditions as follows;

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

Where, $\boldsymbol{Z_t}$is the vector of both $\boldsymbol{y_t}$ and $\boldsymbol{x_t}$ and $\boldsymbol{y_t}$ is the dependent variable defined as aggregate output production, $\boldsymbol{x_t}$ is vector matrix which represents a set of explanatory variables i.e. gender variables, t is the time trend. Error correction model (ECM) is also developed as follows;

$$\Delta Z_t = \mu + \alpha t + \pi Z_{t-1} + \sum_{i=1}^{p-i} \gamma_i \, \Delta y_{t-i} + \sum_{i=1}^{p-i} \gamma_i \, \Delta x_{t-i} + \varepsilon_t \qquad (2)$$

The Bounds testing approach begins with testing of Null hypothesis of no co integration against the Alternative hypothesis using the F-test or Wald test statistics with critical values tabulated by Pesaran *et al* (2001) and Narayan, (2005). The null hypothesis of no co integration will be rejected if the calculated F-statistic is greater than the upper Bounds critical value, otherwise it is accepted. According to these authors, the lower Bounds critical values assumed that the explanatory variables are integrated of order zero, or I(0), while the upper Bounds critical values assumed that they are integrated of order one, or I(1). Therefore, if the computed *F*-statistic is smaller than the lower Bounds value, then the null hypothesis is accepted and we conclude that there is no long-run relationship between the variables.

The ARDL model developed as per above is specified as follows;

$$\begin{aligned} \Delta lnAGAO_{t-j} = \beta_0 + \sum_{j=1}^{k} \alpha \, \Delta lnAGAO_{t-j} + \sum \theta \Delta WIA_{t-j} + \sum \delta \Delta WHH_{t-j} + \sum \gamma \Delta EDWA_{t-j} \\ + \sum \vartheta \Delta Weather_{t-j} + \psi_1 lnAGAO_{t-1} + \psi_2 WIA_{t-1} + \psi_3 WHH_{t-1} \\ + \psi_4 EDWA_{t-1} + \psi_5 Weather_{t-1} + \psi_6 Dummy + \emptyset ECT_{t-1} \qquad (3) \end{aligned}$$

Where, Δ = lag operator, ln is natural logarithm, ECT is the error correction term which is the lagged value of error from the long run equation, k is the number of lags automatically determine by Akaike Information Criteria. $\beta_0, \alpha, \theta, \delta, \gamma, \vartheta, \psi_{1-6}$ *and* $\emptyset$ are coefficients of short, long run and speed of adjustment to be estimated. $lnAGAO$ = Natural log of aggregate agricultural output in million metric tons from 1980 to 2015

WIA= Percentage of women employed in agriculture

WHH= Percentage of women as head of house hold

$Weather\ Variable$= Average annual rainfall (mm) as proxy

$EDWA$ = Percentage of educated women represented by percentage of enrolment of women in secondary school

$Dummy$= Represent access to productive resources, if 1 from 1999 to 2015,0 otherwise

The short-run dynamics in the ARDL specification can be obtained by the following error correction model:

$$\Delta lnAGAO_{t-j} = \beta_0 + \sum_{j=1}^{k} \alpha\, \Delta lnAGAO_{t-j} + \sum \theta \Delta lnWIA_{t-j} + \sum \delta \Delta lnWHH_{t-j} + \sum \gamma \Delta lnEDWA_{t-j} + \sum \vartheta \Delta lnWeather_{t-j} + \emptyset ECT_{t-1} \quad (4)$$

The long run equation is specified as;

$$\Delta lnAGAO_t = \psi_1 lnAGAO_{t-1} + \psi_2 WIA_{t-1} + \psi_3 WHH_{t-1} + \psi_4 EDWA_{t-1} + \psi_5 Weather_{t-1} + \psi_6 Dummy + \varepsilon_t \quad (5)$$

Unit root Test

Augmented Dickey Fuller (ADF) Test

The presence of serial correlation in the residuals of the Dickey- Fuller (DF) test biases the results. For that reason, the ADF test was developed as an extension of the DF. The idea is to include enough lagged dependant variables to get rid of serial correlation. The ADF test is based on the following model;

$$\Delta Y_t = \alpha + \varphi t + \theta Y_{t-1} + \sum_{i=1}^{n} \omega_i\, \Delta Y_{t-i} + v_t \quad (6)$$

In the above model equation (6) the null hypothesis is that,$Y_t = Y_{t-1} + v_t$,where$\boldsymbol{v_t}$~NID (0, σ^2). Under the null (π) will be negatively biased in a limited sample, thus only a one sided test is necessary for determining H_0 :$\theta = 0$ [$Y_t \sim I(1)$] againstHa : $\theta = 0$ [$Y_t \sim I(0)$].The critical values are originally tabulated in Fuller (1976). $H_0$is rejected if the t- statistics is smaller than the relevant critical value. H_0:$\theta = 0$ signifies series $Y_t$has a unit root and is non- stationary, whereas it is regarded as stationary if the null hypothesis is rejected.

Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Unit Root Test

Kwiatkowski *et al.* (1992) developed test that is intended to complement unit root tests, such as the Dickey-Fuller test. The procedure examined both the unit root hypothesis and the stationarity hypothesis, and distinguish series that appear to be stationary, series that appear to have a unit root, and series for which the data (or the tests) are not sufficiently informative to be sure whether they are stationary or integrated. The innovation has technically made allowance for error autocorrelation. Correspondingly the autocorrelation correction is similar to the Phillips-Perron corrections for unit root tests.

The test point of difference between other tests is that, series Y_t is assumed to be stationary under the null hypothesis (both trend and level-stationary), the KPSS statistics is also based on the residuals from the OLS regression of Y_t on the exogenous variables X_t;

$$Y_t = X_t\delta + \mu_t \tag{7}$$

The LM statistic for the stationarity hypothesis is define as

$$LM = \sum_{i=1}^{T} S_t^2 \Big/ \hat{u}_\varepsilon^2 \tag{8}$$

Where, $\hat{u}_\varepsilon^2$ =estimator of the residual spectrum at frequency zero and S_t^2 is a cumulative residuals function. H_0:$\theta = 0$ signifies series Y_t is stationary, whereas it is regarded as non stationary if the null hypothesis is accepted. The t- statistics are compared with the reported LM critical values based upon asymptotic results contained in Kwiatkowski *et al*. (1992).

Description of Variables

Percentage of women employed in agriculture- (WIA) as a variable represents the population of women employed in agricultural sector with emphasis on crop production. It depicted both family unpaid worker and the proportion of those women being paid as employee in agricultural production. The variable evidently portrays the extent of women contribution in the overall agricultural production within the period of study (1980 – 2015).
Women as head of household (WHH)– The choice of this variable is based on the notion that women who heads a house hold have a decision-making power regarding her activities and is equal in rank to the men in terms of accessibility of inputs and other inalienable rights. FAO, (2011) reported two types of female-headed households (i) *de facto*- are those in which an adult male partner is working away from the household but remains involved through remittances and other economic and social ties and (ii) *de jure*-are. those which have no male partner, such as women who are widowed, divorced or never married. This study uses both due to unavailability of data.
Ratio of female to male enrolment in secondary school-This was taken to provide insight on the level of educated women in agriculture during the period of study. Level of education and access to extension services were believed to increase agricultural productivity as it imparts skills, knowledge and competences that are pivotal to human development (NBS, 2012).
Weather variable (Average annual rainfall)- the important of weather cannot be emphasized in agricultural production, average annual rainfall was factored in the model to represent influence of weather and climate and the expectation is that a positive relationship should exists between the variables.
Dummy variable- was included to measure the impact of access to productive resources by women. Access to productive resources such as land, modern inputs, technology, education

and financial services are critical determinants of agricultural productivity. Agriculture is important to women, but female farmers have less access to the productive resources and services required by agricultural producers. Women are less likely than men to own land or livestock, adopt new technologies, use credit and other financial services, or receive education or extension services. Dummy variable takes the form of 1 for access to productive resources from 1999 to 2015 and 0 otherwise.

RESULTS AND DISCUSSION

Unit Root Test

The test of co integration started with knowing the characteristics of the univariate time series data, unlike other co integration approach ARDL does not imposed on series to be of the same order. However, they should not be I(2) as such data would invalidate the methodology. Stationarity test was conducted using Augmented Dickey Fuller (1979)–ADF test and Kwiatkowski *et al.* (1992) KPSS test. ADF test the null hypothesis that variable has unit root (not stationary) while KPSS assert the null hypothesis that data is stationary. The 2 tests were run with intercept only and test statistics were compared with critical values while lag length selection was automatic using Schawarz Information Criterion (SIC).

Table 1: Results of Augmented Dickey Fuller (ADF) and Kwiatkowski-Phillip-Schmidt-Shin (KPSS) unit root tests

Variables	Exogenous: Intercept only			
	Ho= series is non stationary ADF t stat values		Ho= series is stationary KPSS t stat values	
	Level	1st Diff	Level	1st Diff
LnAGAO	-2.4058	-7.8141***	0.6116	0.1251***
WIA	-2.7078	-9.225***	0.5826	0.1975***
WHH	-3.4961*	-6.5984***	0.4168*	0.4013***
EDW	-2.6098	-5.7806***	0.1331*	0.1674***
Weather	-3.8631*	-5.5473***	0.0669*	0.0675***

Note: Critical values at 1%, 5% and 10% for ADF are -3.7114, -2.9810and -2.6299 and for KPSS CV are 0.7390, 0.4630 and 0.3470 respectively. Appropriate optimum lag length was automatically determined by Schwarz Information Criterion (SIC)

The results in Table 1 indicated that some of the variables were stationary at level while others at first difference. Test statistics under ADF failed to reject the null hypothesis at level for lnAGAO, WIA and EDW variables because t values; -2.4058, -2.7078 and -2.6098 were less than the critical value at 5% probability level (2.981).Those variables have unit root at level, but the null hypothesis was rejected for WHH and Weather variables showing that, they were stationary at level. However after first difference all the variables were converted into stationary at order I(1). Similarly, the KPSS test showed that lnAGAO and WIA were not stationary at level at 5% significant level due to rejection of null hypothesis, meaning that their computed t statistics at level were greater than the critical value at 5%. Similarly, WHH, EDW and Weather were stationary at level. The overall result indicated that condition for estimation of Bounds test was met.

Bounds Test Result between Aggregate Output and Components of Gender

Table 2 revealed that there is co integration between aggregate production output and the explanatory variables included in the model. Using OLS and automatic lag length selection by AIC, the bound test showed that computed F statistics (4.54) is higher than the upper bound critical values for unrestricted intercept at 5 percent probability level (4.01). This necessitated the rejection of the null hypothesis of no co integration, implying that the variables; aggregate cereals output production, percentage of women in agriculture, women as head of house hold, percentage of educated women and weather variable move together in the long run. Since, existence of co integration was confirmed the next step was determination of long and short run relationships.

Table 2: Bounds test result for gender component: ARDL (1, 0, 3, 0, 3)

Variables	F Statistics	DF
Null Hypothesis $H_0 = \varphi_1 = \varphi_2 = \varphi_3 = \varphi_4 = 0$	4.54	K=4, N=27
Critical/Bounds value:	Lower Bound	Upper Bound
(Unrestricted intercept only)	I(0)	I(1)
1%	3.74	5.06
5%	2.86	4.01
10%	2.45	3.52

Note: 10%, 5%and 1% are level of significance and I(0) , I(1) are lower and upper values indicating order of integration. Critical values are obtained automatically from Narayan (2005) case III for 40 observations. K is number of regressors and N is number of observations. Automatic model lag selection based on AIC

Long Run Relationship

The results of long run relationship between the variables were reported in Table 3. Percentage of women participating in agriculture as a ratio of male counterpart (WIA) was found to be positively significant at 1 percent level. The coefficient indicated that as women participation in agriculture increases by a unit, food crops production increased by 0.14 percent. The variable as noted earlier constitutes women as farmers, women as unpaid workers on family farms and paid/unpaid as labourers in agricultural enterprises. Available data showed that on the average, percentage of women in agriculture constituted about 40.4% in Nigeria. Similarly, FAO (2011) reported that women comprised on the average 43 percent of the agricultural labour force in developing countries. In Nigeria females are involve in all kind of farm activities although participation varied according to region, culture and religion.

Coefficient of women as head of household (WHH) was significant at 10 percent and was found to be negative in the long run, indicating that, as percentage of women who heads the house increase by a unit, production of food crops decreased by 0.15%. The finding implied that there is the likelihood of women diversifying into other non-farm businesses due to extra burden and responsibilities. Another reason that supported this finding as reported by FAO (2011) was that, female-headed households faced more severe labour constraints because they have fewer members but more dependants in the family and have lower yields than men headed household. NBS (2011) also reported that 56.5% of women as head of household in Nigeria are non-poor ostensibly due to engagement of farming and nonfarm businesses. These findings therefore suggest that production increases so long as women continue to remain under the male household or at best as a *de facto* household.

Dummy variable was found to be positive and significant at 10 percent level, meaning that access to productive resources by women from the period 1999 to 2015 had impacted positively on output of food crops. The result indicated that an increase in one unit of productive assets by women raised production of food crops by 0.3 percent in the long run. Nigeria has within this period of study formulated sound national policy frameworks (National Gender Policy, 2007) and programmes on gender to expose women to better education, health and access to productive resources etc. some of these programmes include Better Life for Rural Women, National Poverty Eradication Programme, Family Support Programme, Family Economic Advancement Programme, National Economic Empowerment Development Strategy (NEEDS) etc. The Food and Agriculture Organization of the United Nations (FAO) reported that if women, who are 43 percent of agricultural labour in developing countries, had the same access to productive resources as men, they could increase yields on their farms by 20-30 %. This increase could raise total agricultural output in developing countries by 2.5 to 4 percent and reduce the number of hungry people in the world by 12-17 percent, (FAO, 2011)

Weather was another variable in the model that was positively significant at 5 percent level. Average annual rainfall was used as proxy and it showed very low relationship indicating an increase of about 0.001% of output when current rainfall increases by a unit. Coefficient of education for women was not significantly different from zero at 5% probability level however it had revealed the expected positive relationship with agricultural production implying that educated women adopted and understood new technology and other extension messages. Some of the national education policies which are concerned with gender issues during the study period were; the national policy on gender in basic education, the universal basic education policy on education, an integrated early child care and education policy, and the national policy on women. Nonetheless average percentage of women enrolment in secondary school remained 46.9% and this however decreases to less than 40% at tertiary level (NBS, 2011). It could be seen from the result that significant relationship existed between aggregate crop production and the gender variables except percentage of educated women. Similarly, access to productive resources was found to have the highest positive contribution indicating that any policy thrust toward that direction could likely produce a tremendous impact on production. The result indicated that from 1999 to 2015 access to resources by women increased output by 0.29 percent.

$$ECT = lnAGOP - (0.1403WIA - 0.1533WHH + 0.0010ED + 0.0009Weather \\ + 0.2697Dummy + 15.0958C$$

Table3: Results showing long run relationship ARDL (1, 0, 3, 0, 3)

Variables	Coefficient	Std error	T statistics
WIA	0.1403	0.0463	3.0286***
WHH	-0.1533	0.0860	-1.7819*
EDW	0.0010	0.0055	0.8691 ^{NS}
Weather	0.0009	0.0003	2.7916**
Dummy	0.2967	0.1452	2.0437*
Constant	15.0958	0.7395	20.4125***

Note: *, **, *** and NS denotes significant at 10, 5and 1 percent probability level while, NS denotes not significant respectively

Short Run Relationship

Short run dynamic relationship was captured in Table 4. Optimum lag length as already noted was automatically selected by the AIC and the error correction term was found to be significant at1% level with the expected negative sign. The coefficient of the error correction term (ETC-1) showed that about 58% proportion of disequilibrium in aggregate agricultural output due to shocks from the gender variables in one period is corrected in the next period, thus suggesting a relatively moderate speed of adjustment.

Women in agriculture variable at current period was found to be significant at 1 percent level and has a positive impact on production of food crops in the short run. The coefficient showed that level of output is raised to 0.08 percent as percentage of WIA increases by one unit. This calls for more effort from policy perspective towards encouraging women into agricultural production. Unlike in the long run women as head of household (WHH) lagged by two years was found positively significant in the short run, this showed that as more women- headed household increases output of food crops also increases. It actually indicated that access to more productive resources and other opportunities do not cause a shift and neglect of food production. The coefficient revealed an increase in aggregate food crops output by 0.06 percent when WHH lag two increases by one unit. However, though not significant, WHH lag one showed negative relationship with production output. Weather variable had similarly exhibited positive relationship in the short run, the coefficient was very low (0.0009) and statistically significant at 5% level of significance. There was also just as in the long run, a positive relation between access to productive resources represented by dummy variable and the dependent variable in the short run. The coefficient indicated a response of 0.17 percent increase in output as access to productive resources is increase by one unit. Educated women in agriculture variable in the short run was found to be non significant but maintained a positive relationship meaning that level of education may increase production but does not matter most in model during the study period.

It was however noticed that, response of the gender variables as determinants of food crops production were very low and access to productive resources and percentage of women in agriculture contributed more to aggregate food crops output and that the long run responses were a bit higher than during the short run. Policy effort should focus effectively on the entire gender gap (variables included in the model) if sustainable food crops production is to be attained.

Diagnostic Checking

Lower segment of Table 4 further revealed diagnostic checks to confirm the robustness of the model. The goodness of fit for the estimated equation measured by coefficient of determination (R^2) and combine significance of the explanatory variables (F stat.) are reasonably good, 91 percent of the variation in aggregate food production is explained by the variables included in the model. Adjusted R squared is 83% and F statistics is significant at 1 percent level. Errors of residuals also seemed uncorrelated as both DW and Breusch-Godfrey LM rejected the null hypothesis with probability values > 0.05%. While DW detects first order serial correlation [AR (1)], the LM test foresee autocorrelation of any maximum length of lag (Ogundari, 2016). Jarque-Berra and Breusch-Pagan tests also rejected the null hypotheses and ascertained the normality and absence of Heteroscedasticity in the errors.

Furthermore, an inspection of the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) graphs (Figure 1) from the recursive estimation of the model reveals that coefficients are stable and there is no systematic change detected over the sample period as coefficients under CUSUM are within the critical bound of 5% significant level, albeit the CUSUMSQ portrayed a little deviation at some point.

Table 4: Results of ARDL (1, 0, 3, 0, 3) model showing Short run relationship

Variables	Coefficient	Std error	T statistics	Probability
ETC_{t-1}	-0.58	0.1432	-4.0704	0.0011
ΔWIA_t	0.0817	0.0242	3.3761	0.0045
ΔWHH_t	0.0126	0.0164	0.7684	0.4550
ΔWHH_{t-1}	-0.0095	0.0171	-0.5586	0.5853
ΔWHH_{t-2}	0.0683	0.0146	4.6720	0.0004
ΔEDW_t	0.0005	0.0032	0.1675	0.8693
$\Delta Weather_{t-1}$	0.0002	0.0001	2.7381	0.0160
$\Delta Weather_{t-2}$	0.0001	0.00009	1.2347	0.2373
Δ*Dummy-for access to res.*	0.1729	0.0743	2.3261	0.0355

Diagnostic checking
R^2 = 0.91
R^2 Adjusted = 0.83
F stat. = 12.2 prob. = 0.000
DW Stat. = 2.23
Serial corr. LM test =3.683 prob. = 0.158 (Breusch-Pagan)
Breusch-Pagan-Godfrey test (Heteros) =10.71 prob. = 0.5540
Normality –Jarque-Bera = 0.937 prob. = 0.6256

Causality Test (Wald test statistics) for Gender Assessment

Short run causality which showed the significance of lagged coefficient of the independent variables jointly influencing aggregate output of food crops indicated that causality runs from women in agriculture to output production, the F statistics rejected the null hypothesis at 5% significant level. Similarly, women as head of household to production output rejected the null hypothesis of no causality at 10 percent significant level and weather variable is significant at 5percent. The long run causality indicated rejection of null hypothesis at 5 percent significant level (Table 5**)**

Table 5: Gender causality test (Wald test)

Test	Direction	F statistics	Prob. value
Short run causality	$WIA \rightarrow ACOP$	4.5905	0.0455
	$WHH \rightarrow ACOP$	4.0778	0.0630
	$Weather \rightarrow ACOP$	8.6281	0.0281
Long run causality	*Based on coefficient of ECT*	0.421**	0.04742
Strong causality	*Short run and long run causality*	nil	nil

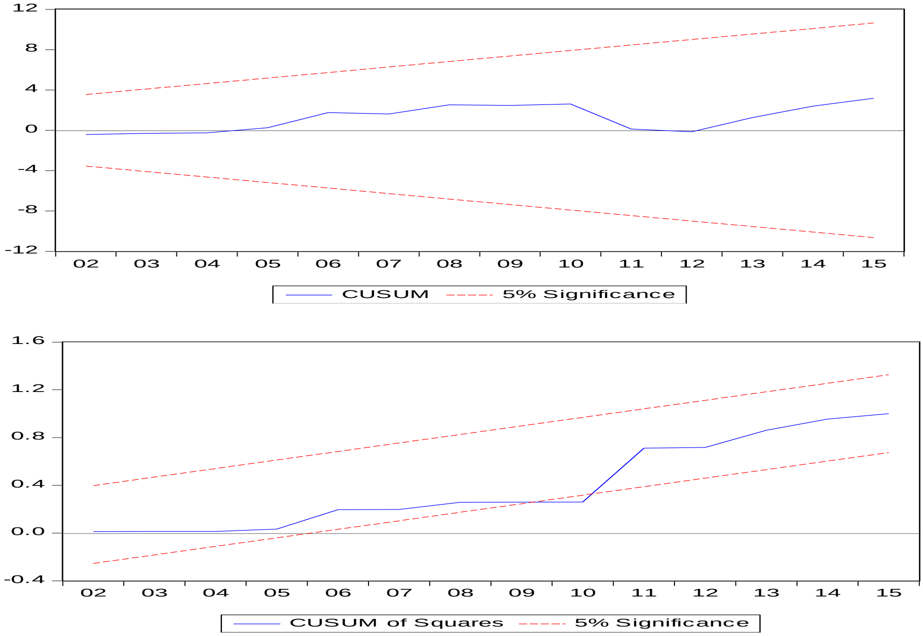

Fig. 1: CUSUM and CUSUMSQ showing level of stability of the model's residuals.

CONCLUSION

The study has attempted to empirically determine the relationships between aggregate agricultural production and contribution of women in Nigeria from 1980 to 2015 using ARDL Bounds test approach to co integration. ADF and KPSS unit root test were employed to assess the stationarity of the variables and the results had shown that no series was I(2). Bounds test results indicated that there was existence of co integration between aggregate crop production and the gender variables. The findings further revealed that in the long run positive relationships existed between aggregate production and all the variables except women as head of household (WHH). Access to productive resources represented by dummy variables had contributed more in raising production compared to other variables whereas the negative relationship exhibited by WHH may ostensibly be linked to diversification to nonfarm businesses as responsibilities of women increased. Short run impact was generally found lower than the long and the speed of adjustment as indicated by the coefficient of error correction term (ECT) was relatively moderate in converging back to equilibrium position aftershocks.

Increased food self-sufficiency and overall agricultural development could therefore be attained by increasing the access to productive resources by women through gender responsive policies that will eliminate all kind of gender bias and enable women to participate in production and rural development. Investment in education for women and access to extension education could be a panacea for increased output, similarly availability of machine powered equipment (mechanization) may help to lower the difficulties encountered in farm labour by women household head whereas, irrigation structures may complement the impact of rainfall (weather) in boosting aggregate production.

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