International Journal of Advanced Studies in Economics and Public Sector Management | IJASEPSM
p-ISSN: 2354-421X | e-ISSN: 2354-4228
Volume 11, Number 2 May, 2023

Investigating the Determinants of Cereal Production in Nigeria

[1]Innocent Chile Nzeh, [2]Uzoechina, Benedict I., [3]Chika P. Imoagwu & [4]Ogwuru, Hycenth O. R.
[1]Department of Cooperative and Rural Development,
University of Agriculture and Environmental Sciences, Umuagwo, Imo State
[2&3]Department of Economics, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria.
[4]Department of Economics, Novena University, Ogume, Delta State, Nigeria

Article DOI: 10.48028/iiprds/ijasepsm.v11.i2.04

Abstract

This study examined the factors that determine cereal production in Nigeria in two different periods; namely from 1970-2006 and from 1986-2021 using the autoregressive distributed lag (ARDL) bounds test. Findings revealed that in the two periods, cereal production was mainly influenced positively by land under cereal production and agricultural raw materials import. Also, while arable land impacted positively on cereal production in the second period, both food importation and rural population growth adversely impacted on its production. The study therefore contends that for cereal production to improve in Nigeria, land under cereal cultivation should be improved. Furthermore, while there is need to encourage the importation of more agricultural inputs in the short-run, the long-run target should be geared towards sourcing the inputs locally. It is equally the view of the study that while it is pertinent to modernize agricultural practice so that the rural inhabitants can embrace farming, excessive cereal importation should be checked to encourage local production.

Keywords: *Cereal production, Food importation, Rural population, ARDL*

Corresponding Author: **Innocent Chile Nzeh**

Background to the Study

The achievement of food security has been the preoccupation of successive governments in Nigeria. This is as a result of the understanding that adequate food supply has a direct bearing on the welfare of the people (Nzeh, 2023). Of all the crop types, cereal is very necessary in many respects and its importance formed the motivation for this study. As observed by Ismaila, Gana, Tswanya and Dogara (2010), **c**ereals are the major dietary energy suppliers that provide vital amount of minerals (potassium and calcium), protein and vitamins (vitamin A and C). The study further observed that cereals can be consumed in a number of forms, such as noodles, cakes, pastes, drinks and breads, among others. Furthermore, the husk, bran, plant parts and other residues after processing are relevant as feeds for animals and can as well be used in the culture of micro-organism. Some extract from cereal such as gum and wax syrup also serve as industrial raw materials. In Nigeria, the major cereals produced are rice, maize, pearl millet, wheat and sorghum. As noted by Idem and Showemimo (2004) cited in Ismaila *et al.* (2010), cereal production in Nigeria takes place in the savannah ecology of the country which accounts for about 67 million hectares, representing about 70% of the geographical area. The rise in population in Nigeria coupled with the neglect of the agricultural sector has led to low domestic supply of cereals, leading to high importation. As observed by Ogundiran (2019), Nigeria has been spending so much on food imports, mainly grains and livestock products.

Cereal production in Nigeria has been beset with numerous challenges such as the frequent occurrence of drought occasioned by erratic rainfall especially in the Northern region of the country where cereals are mainly produced (Olaoye, 1999). Also, smallholder producers dominate the agrarian sector in the country that uses traditional farm inputs, resulting in low productivity. In another respect, reports from the 2023 Miller Magazine observed that banditry and kidnapping activities in the primary wheat cultivation Northwest region of Nigeria mostly Borno, Bauchi, Yobe, Kano, Jigawa and Zamfara have adversely affected wheat production in recent times. This threat has also affected corn production as the corn belt comprising Kaduna, Nasarawa and Katsina states has been hard hit by kidnapping for ransom. The report also noted that the recent hike in electricity tariff and petrol (gasoline) add to the cost of rice production which leads to rise in the local rice prices beyond the prices of imported rice. To boost agricultural productivity, report by the Food and Agricultural Organization (FAO, 2023) noted that the government has implemented some initiatives and programmes such as the Nigeria–Africa Trade and Investment Promotion Programme, Economic and Export Promotion Incentives and the Zero Reject Initiative, Agriculture Promotion Policy (APP), Reducing Emission from Deforestation and Forest Degradation (REDD+), Presidential Economic Diversification Initiative, Nigeria Erosion and Watershed Management Project (NEWMAP), among others.

The importance of cereal has led to some studies that have examined the factors that influence its production. It is pertinent to point out that many factors affect cereal production. Empirical studies have included factors such as education level, credit, household size, extension contact, improved seed and off-farm income (Mukhtar, Mohamed, Shamsuddin, Sharifuddin, & Muktar, 2018) as the variables that influence cereal production. Others included farm size, fertilizer, age, irrigation, arable land and land used for cereal production (Ayele & Melaku, 2019; Asfew & Bedemo, 2022; Garba, Akanni, Yahya, Kareem & Afolayan, 2020). This paper joins the ongoing debate by including factors such as rural population growth, food import and agricultural raw materials import in addition to some other variables that have been used previously such as arable land, land under cereal production and fertilizer consumption. Since cereals are mainly cultivated in the rural areas, the study deemed it necessary to examine the impact of rural population growth on cereal production. This is because most rural agricultural lands have been converted into other uses as a result of rural population pressure. Also, the likely displacement impact of food importation on local food production compelled the study to examine the impact of food import on cereal production. It is mainly owing to this fact that the federal government of Nigeria in recent times placed a ban on the importation of rice and other food items. The inclusion of agricultural raw materials import in the study is based on the fact that some of the inputs used in cultivating food in Nigeria are imported such as fertilizers, pesticides, de-stoning machines for rice production, among others. The contribution of these imported agricultural inputs to cereal production need to be examined.

Improving domestic cereal production is key to achieving food security in Nigeria. However, this cannot be possible if the factors that influence cereal production are not examined, especially the factors that have not been considered by previous related studies in Nigeria. Government policies to boost cereal production could be ineffective if these factors are neglected as this has been among the reasons for weak implementation of agricultural policies in Nigeria. Therefore, this present study is of the view that by investigating the factors that influence cereal production which have been incorporated in the study, policies to improve cereal production could be effective.

Empirical Literature

The importance of food on the economy of a country has led to many empirical studies that sought to examine the factors that influence cereal production. In Nigeria, Mukhtar *et al.* (2018) employed the descriptive statistics along with the multiple regressions to reveal that cooperative membership, education level, credit, household size, extension contact, improved seed and off-farm income had a positive and significant relationship with pearl millet output. However, household size and age were shown to have negative association with total output. In Ethiopia, Ayele and Melaku (2019) examined the determinants of cereal crop production of small household farmers in southern region of Kecha Birra woreda. The study revealed that farm size, improved seed, education, fertilizer, age, irrigation and family size influenced cereal crops production positively, while the impact of sex and access to credit was negative. In another study for Nigeria, Garba *et al.* (2020) revealed that the major determinants of cereal yield are cereal production and land used for cereals production. Also, in another study for Ethiopia, Ketema (2020) revealed that fertilizer input import, rainfall, inflation rate and trade openness impacted agricultural output positively and significantly in the long run, while the effect of drought negatively and significantly impacted on it. Akanni, Garba, Banjoko and Afolayan (2020) revealed that cereal production in Nigeria was Granger-caused by the size of farmland used for the planting of cereal.

In a study in Kecha Birra district of Ethiopia, Ayele and Tamirat (2020), found that the variables that significantly influenced cereal crop production are access to credit, use of fertilizer, education level, household head, family size of household head, access to extension service, improved seed and use of recommended agricultural inputs. For wheat production in the Libyan economy, Faraj, Ismail and Ab-Rahim (2020) revealed that while rainfall had a positive but non-significant impact on wheat production, the effect of temperature was negative but non-significant. In a study for Bangladesh, Chandio, Jiang, Fatima, Ahmad and Ahmad (2021) used the ARDL to show that rainfall impacted positively on cereal production in both the short-and long-term. Also, while temperature had an adverse effect on cereal production, energy consumption, financial development and rural labor force improved it. In another study for Ethiopia, Asfew and Bedemo (2022) used the ARDL to reveal that in both the long and short runs, precipitation had a positive and significant effect on cereal crops production, while temperature change adversely affected it. Also, in the long run fertilizer consumption, arable land and carbon dioxide emissions improved cereal production. In Nigeria, Enilolobo, Nnoli, Olowo, Aderemi, Adewole, Olapade and Esedeke (2022) used the ARDL to reveal that domestic capital and bank lending had a positive impact on food security. However, a study in Ghana by Tsiboe, Asravor, Owusu and Mensah-Bonsu (2022) revealed that the major contributors of cereal production are land, seed and agro-ecology of cereal farms.

Methodology

Owing to the periods the study sample covered, the study suspected that there may be some structural breaks in the parameters of the model for the study. This could be due to policy issues, natural events, political events or other events that may influence the variables of the study within the period. The study conducted two tests to determine the existence of structural breaks. First, the study plotted the CUSUM and CUSUM of Squares of the model to identify possible outliers in the model. This is based on the stability tests by Brown, Durbin and Ewans (1975) that is based on the recursive regression residuals. The decision rule was to reject the null hypothesis of no structural break if the two plots fall outside the critical bands of the 5% confidence interval. Second, the study conducted the stability test using the Bai-Perron multiple breakpoint tests and the test indicated two break periods: 1986 and 2006. Consequently, the study introduced dummy variables to adjust for the outliers. Thus, the sample was split into two sub-samples: giving room for the estimation of two models. Stationarity test to ascertain the order of integration was carried out by employing both the augmented Dickey-Fuller (ADF) and the Phillip-Perron (PP) tests. The test for the cointegrating relationship among the series was conducted using the autoregressive distributed lag (ARDL) bounds. Since the study used annual series, lag 2 was chosen following Pesaran and Shin (1999) which recommend a maximum of 2 lags for annual data.

Model Specification

With some modifications from Chandio *et al.* (2021), the functional link between cereal production and its determinants is specified as follows:

$$CP_t = f(LUCP_t, ARMIMPT_t, FC_t, FIMPT_t, AL_t, RPG_t) \quad (1)$$

where: *CP*= cereal production, *LUCP* = land under cereal production, *ARMIPT*= agricultural raw materials import, *FC* = fertilizer consumption, *FIMPT* = food import, *AL* = arable land, *RPG*= rural population growth. The ARDL model for period one is specified as follows:

$$\Delta CP_i = \varpi_0 + \sum_{i-1}^{p} \varpi_1 \Delta CP_{t-1} + \sum_{t-0}^{p} \varpi_2 \Delta LUCP_{t-1} + \sum_{t-0}^{p} \varpi_3 \Delta ARMIMPT_{t-1} + \sum_{t-0}^{P} \varpi_4 \Delta FC_{t-1}$$
$$+ \sum_{t-0}^{p} \varpi_5 \Delta FIMPT_{e-1} + \sum_{t-0}^{p} \varpi_6 \Delta AL_{t-1} + \sum_{t-0}^{p} \varpi_7 RPG_{i-1} + \varpi_8 CP_{t-1} + \varpi_9 LUCP_{t-1} +$$
$$\varpi_{10} ARMIMPT_{t-1} + \varpi_{11} FC_{t-1} + \varpi_{12} FIMPT_{t-1} + \varpi_{13} AL_{t-1} + \varpi_{14} RPG_{t-1} + DUM1 + \varepsilon_t \text{.........(2)}$$

The ECM form of model one is specified as:

$$\Delta CP_i = \varpi_0 + \sum_{i-1}^{p} \varpi_1 \Delta CP_{t-1} + \sum_{t-0}^{p} \varpi_2 \Delta LUCP_{t-1} + \sum_{t-0}^{p} \varpi_3 \Delta ARMIMPT_{t-1} + \sum_{t-0}^{P} \varpi_4 \Delta FC_{t-1}$$
$$+ \sum_{t-0}^{p} \varpi_5 \Delta FIMPT_{e-1} + \sum_{t-0}^{p} \varpi_6 \Delta AL_{t-1} + \sum_{t-0}^{p} \varpi_7 RPG_{i-1} + \eta ECM_{t-1} + DUM1 + \varepsilon_t \text{.........(3)}$$

where: η = coefficient of the ECM, ε = the error term, ϖ_1, ϖ_2, ϖ_3, ϖ_4, ϖ_5, ϖ_6 and ϖ_7 are the short-run parameters and ϖ_8, ϖ_9, ϖ_{10}, ϖ_{11}, ϖ_{12}, ϖ_{13} and ϖ_{14} are the long-run parameters. $DUM1$ = dummy variable for model one which takes zero (0) values for before 1986 and one (1) after 1986 till 2006.

The ARDL model for period two is specified as follows:

$$\Delta CP_i = \gamma_0 + \sum_{i-1}^{p} \gamma_1 \Delta CP_{t-1} + \sum_{t-0}^{p} \gamma_2 \Delta LUCP_{t-1} + \sum_{t-0}^{p} \gamma_3 \Delta ARMIMPT_{t-1} + \sum_{t-0}^{P} \gamma_4 \Delta FC_{t-1}$$
$$+ \sum_{t-0}^{p} \gamma_5 \Delta FIMPT_{e-1} + \sum_{t-0}^{p} \gamma_6 \Delta AL_{t-1} + \sum_{t-0}^{p} \gamma_7 RPG_{i-1} + \gamma_8 CP_{t-1} + \lambda_9 LUCP_{t-1} +$$
$$\gamma_{10} ARMIMPT_{t-1} + \gamma_{11} FC_{t-1} + \gamma_{12} FIMPT_{t-1} + \gamma_{13} AL_{t-1} + \gamma_{14} RPG_{t-1} + DUM2 + \varepsilon_t \text{.........(4)}$$

The ECM form of model two is specified as:

$$\Delta CP_i = \gamma_0 + \sum_{i-1}^{p} \gamma_1 \Delta CP_{t-1} + \sum_{t-0}^{p} \gamma_2 \Delta LUCP_{t-1} + \sum_{t-0}^{p} \gamma_3 \Delta ARMIMPT_{t-1} + \sum_{t-0}^{P} \gamma_4 \Delta FC_{t-1}$$
$$+ \sum_{t-0}^{p} \gamma_5 \Delta FIMPT_{e-1} + \sum_{t-0}^{p} \gamma_6 \Delta AL_{t-1} + \sum_{t-0}^{p} \gamma_7 RPG_{i-1} + \delta ECM_{t-1} + DUM2 + \varepsilon_t \text{.........(5)}$$

Where: δ = the coefficient of the ECM for model two, γ_1, γ_2, γ_3, γ_4, γ_5, γ_6 and γ_7 are the short-run parameters for model two and γ_8, γ_9, γ_{10}, γ_{11}, γ_{12}, γ_{13} and γ_{14} are the long-run parameters. $DUM2$ = dummy variable for model two which takes zero (0) values for periods before 2006 and one (1) after till 2021. In order to test for the existence of co-integration in the two models, the study compared the computed F-statistic with the upper critical bound *I(1)* and the lower critical bound *I(0)*. If the computed F-statistic is greater than the upper critical bound, it proves that there is the existence of cointegration. However, the series are not co-integrated if the computed F-statistic falls below the lower critical bound.

Variables and Data Sources

This study used annual data that spanned the periods from 1970 to 2006 and from 1986 to 2021 to investigate the determinants of cereal production in Nigeria. The dependent variable is cereal production, while the explanatory variables are land under cereal production, agricultural raw materials import, arable land, food imports, rural population growth and fertilizer consumption. As defined by the World Bank Development Indicators, cereals comprise of crops harvested for dry grain only. Cereals include rice, maize, wheat, millet, sorghum, barley and oats, among others. Cereal production is measured in metric tons, agricultural raw materials imports is measured as percentage of merchandise imports and land under cereal production is measured in hectares. Also, arable land is measured as a percentage of land area, food imports is measured as a percentage of merchandise imports, rural population growth is measured in annual percentage and fertilizer consumption is measured as a percentage of fertilizer production. Data on all the variables were obtained from the data bank of the World Bank Development Indicators. For normalization, cereal production, land under cereal production and arable land were logged.

Results Presentation and Discussion of Findings

The study first considered the results of some preliminary tests which were meant to investigate the behaviour of the variables used in the study. The results of the descriptive statistics in Table 1 indicated that the mean and the median of all the variables are close which implies that the variables are symmetric. It is also revealed that the variable with the highest mean is food import with a mean of 10.56330, while the variable with the least mean is agricultural raw materials import with a mean of 0.701013. The implication of the results is that the country spends more on food importation than on agricultural inputs. The variable with the highest range within the period is food importation which implies that it exhibited the highest volatility. Arable land, on the other hand exhibited the least volatility as it has the least range.

Table 1: Descriptive Statistics

	CP	LUCP	ARMIPT	FC	FIMP	AL	RPG
Mean	7.138	31.006	0.701	7.348	10.563	7.439	1.781
Median	7.219	32.939	0.604	6.141	10.816	7.477	1.780
Maximum	7.460	40.405	2.613	15.315	27.023	7.565	2.486
Minimum	6.764	18.079	0.000	0.216	0.000	7.216	1.259
Std. Dev.	0.216	6.643	0.689	4.662	8.473	0.103	0.350
Skewness	-0.293	-0.570	0.908	0.190	-0.053	-0.846	0.509
Kurtosis	1.536	2.145	3.285	1.863	1.676	2.485	2.465
Jarque-Bera	3.833	3.133	5.211	2.216	2.718	4.826	2.042
Probability	0.147	0.208	0.073	0.330	0.256	0.089	0.360
Sum	264.106	1147.229	25.937	271.883	390.842	275.271	65.911
Sum Sq. Dev.	1.690	1588.952	17.139	782.542	2585.012	0.381	4.417

The stationarity results in Table 2 revealed that at level, agricultural raw materials import, and food import achieved stationary under the ADF and PP, while others were not stationary. That is, both variables were *I01).* However, after first differencing, all the variables became stationary. That is, they all became *I(1).* The stationarity results thus indicated that the series have an admixture of order of integration which suggests that the ARDL is suitable for the investigation of the cointegrating relationship among the variables.

Table 2: Stationarity Results

	ADF		PP	
Variables	Level	First Diff.	Level	First Diff.
CP	-2.94(0.92)	-2.94(0.00)	-2.94(0.93)	-2.94(0.00)
LUCP	-2.94(0.83)	-2.94(0.00)	-2.94(0.76)	-2.94(0.00)
ARMIMPT	-2.94(0.01)	-2.94(0.00)	-2.94(0.01)	-2.94(0.00)
FC	-2.94(0.25)	-2.94(0.00)	-2.94(0.33)	-2.94(0.00)
FIMPT	-2.94(0.03)	-2.94(0.00)	-2.94(0.03)	-2.94(0.00)
AL	-2.94(0.78)	-2.95(0.02)	-2.94(0.70)	-2.94(0.00)
RPG	-2.94(0.76)	-2.94(0.00)	-2.94(0.63)	-2.94(0.00)

Next the study investigated the stability of the model parameters using the plots of CUSUM and CUSUM of squares. Figures 1 and 2 revealed that the two plots fall outside the critical bands of the 5% confidence interval. This indicates that the model parameters exhibited outliers within the study period. Since these plots cannot determine the breakpoint dates and the number of breaks, the study carried out the Bai-Perron multiple breakpoint tests and the results in Table 3 revealed two break periods, namely: 1986 and 2006.

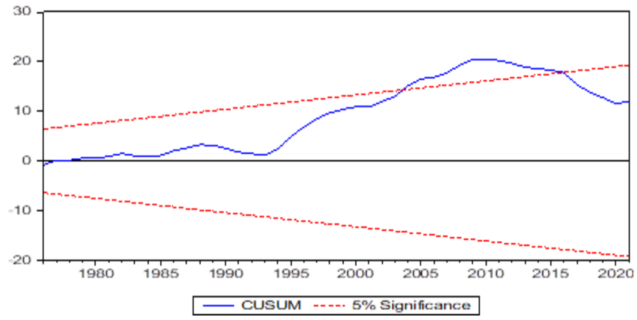


Fig 1: Plot of CUSUM

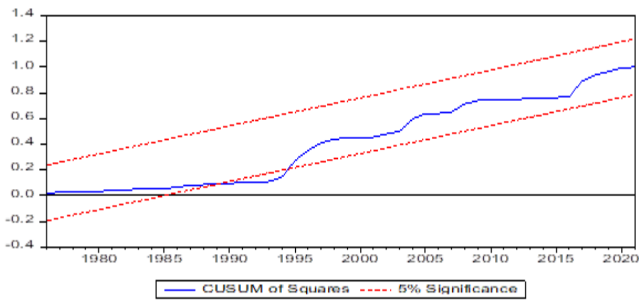


Fig. 2: Plot of CUSUM of Squares

Table 3: Bai-Perron Multiple breakpoint tests

Sequential F-statistic determined breaks:			2
Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	38.30631	229.8378	20.08
1 vs. 2 *	4.740777	28.44466	22.11
2 vs. 3	3.352676	20.11606	23.04
Break dates:			
	Sequential	Repartition	
1	1986	1982	
2	2006	2006	

* Significant at the 0.05 level.

Having confirmed the stationarity of the series, the study carried out the test of cointegration among the variables. For model one, the result of ARDL in Table 4 indicated that at the 5% level, the value of F-statistic at 3.729 is higher than the upper critical bound at 3.5. Thus, the study concludes that the variables are cointegrated or have a long-run relationship.

Table 4: ARDL Result of Cointegration for Model One

Test Statistic	Value	K
F-statistic	3.729	7
	Critical Value Bounds	
Significance	*I(0)* Bound	*I(1)* Bound
10%	2.03	3.13
5%	2.32	3.5
2.5%	2.6	3.84
1%	2.96	4.26

The results in Table 5 reveal that in the short-run, land under cereal production had a positive and significant impact on cereal production both in the current period and in lag one period. This result finds support in Garba *et al.* (2020) in a study for Nigeria. In the current period also, agricultural raw materials import impacted on cereal production positively and significantly. While fertilizer consumption had a positive but non-significant impact on cereal production, the impact of food import was negative and significant. Also, while arable land was found to have a negative and significant impact on cereal production, rural population growth had a negative but non-significant impact. The coefficient of the ECM is negative and significant which supports the cointegration result and it implies that the system adjusts to equilibrium after a shock at a speed of 57%. The long-run results reveal that both land under cereal production and agricultural raw materials import had positive and significant impact on cereal production. However, both arable land and food importation adversely impacted on cereal production significantly, while the impact of rural population growth though was negative but insignificant. The coefficient of the dummy variable was positive and significant indicating the relevance of the variable in the long-run.

Table 5: Short and Long-run Results for Model One ARDL(1, 2, 2, 0, 0, 2, 0, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Short-run Results				
D(LUCP)	0.074	0.016	4.511	0.000
D(LUCP(-1))	0.044	0.016	2.596	0.018
D(ARMIMPT)	0.032	0.016	1.935	0.068
D(ARMIMPT(-1))	0.013	0.009	1.524	0.144
D(FC)	0.001	0.002	0.641	0.529
D(FIMPT)	-0.002	0.001	-2.375	0.028
D(AL)	-3.659	1.038	-3.523	0.002
D(AL(-1))	-1.818	1.065	-1.706	0.105
D(RPG)	-0.043	0.029	-1.494	0.152
D(DUM1)	0.013	0.040	0.330	0.745
D(DUM1(-1))	-0.049	0.037	-1.312	0.205
ECM(-1)	-0.573	0.111	-5.138	0.000
Long-run Results				
LUCP	0.044	0.022	2.005	0.060
ARMIMPT	0.078	0.037	2.096	0.050
FC	0.003	0.004	0.657	0.518
FIMPIMPT	-0.004	0.002	-2.113	0.048
AL	-2.493	1.347	-1.850	0.080
RPG	-0.076	0.051	-1.492	0.152
DUM1	0.235	0.055	4.223	0.000
C	24.293	9.310	2.609	0.017

The ARLD cointegration result for model two in Table 6 indicated that at the 5% level, the value of F-statistic at 6.114 is higher than the upper critical bound at 3.5. Thus, the study concludes that the variables are cointegrated or have a long-run relationship

Table 6: ARDL Result of Cointegration for Model One

Test Statistic	Value	K
F-statistic	6.114	7
	Critical Value Bounds	
Significance	*I(0)* Bound	*I(1)* Bound
10%	2.03	3.13
5%	2.32	3.5
2.5%	2.6	3.84
1%	2.96	4.26

The results in Table 7 for model two reveal that in the short-run, while land under cereal production had a positive but non-significant impact on cereal production, the impact of agricultural raw materials import was positive and significant after one period lag. While food import had a positive and significant impact in the current period, the impact was negative after one period lag even though it was not significant. In the short-run also, while arable land had a positive and significant impact on cereal production, rural population growth had a negative and significant impact. It was also found that the coefficients of the dummy variable in both the current period and one period lag are significant, indicating that the inclusion of the dummy in the model is relevant. The coefficient of the ECM is negative and significant which conforms to the result of cointegration. The system adjusts to equilibrium after a shock at a speed of 97%. The long-run results reveal that both land under cereal production and agricultural raw materials import had negative and significant impact on cereal production. Also, while food import and arable land had a positive and significant impact on cereal production, the impact of rural population growth was negative and significant.

Table 7: Short and Long-run Results for Model Two ARDL (2, 1, 2, 1, 2, 1, 0, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Short-run Results				
D(LUCP)	0.001	0.003	0.495	0.627
D(ARMIMPT(-1))	0.020	0.005	3.559	0.002
D(FC)	-0.000	0.001	-0.717	0.484
D(FIMPT)	0.002	0.000	3.074	0.007
D(FIMPT(-1))	-0.000	0.000	-1.325	0.204
D(AL)	0.985	0.016	59.456	0.000
D(RPG)	-0.107	0.019	-5.442	0.000
D(DUM2)	0.002	0.023	0.113	0.910
D(DUM2(-1))	0.098	0.022	4.405	0.000
ECM(-1)	-0.966	0.114	-8.405	0.000
Long-run Results				
LUCP	-0.094	0.042	-2.235	0.041
ARMIMPT	-0.095	0.014	-6.647	0.000
FC	0.001	0.000	1.178	0.256
FIMPT	0.003	0.001	2.988	0.009
AL	8.848	3.377	2.620	0.019
RPG	-0.111	0.022	-4.973	0.000
DUM2	0.006	0.012	0.478	0.639
C	-55.551	23.841	-2.330	0.034

Discussion of Findings

The study found that in the first period spanning from1970 to 2006, land under cereal production and agricultural raw materials import played significant positive role in cereal production in Nigeria both in the long-run and in the short-run. This reveals that around the seventies and eighties when the sub-sample covered, these variables were very relevant to cereal production. The positive contribution of land under cereal production to cereal production found support in Garba *et al.* (2020) in a study for Nigeria. In another vein, food import was found to impact negatively on cereal production in both the time horizons. This is evidence of the displacement impact of food import on domestic food production in Nigeria. What the study found confusing is the negative impact of arable land within the study period which contradicts the positive impact reported by Asfew and Bedemo (2022), for Ethiopia. Fertilizer consumption had a positive impact on cereal production which finds support in Ayele and Melaku (2019) in a study for Ethiopia. However, the non-significance of the result implies that the application of fertilizer may not have been embraced fully within the period coupled with the cost of its procurement.

In the second period that spanned from 1986 to 2021, the study also found that both land under cereal production and agricultural raw materials import had significant positive impact in cereal production in the short-run which proves the importance of these variables to cereal production in Nigeria. As expected, arable land had a positive and significant impact on cereal production both in the long-run and in the short-run which could be attributed to improvement in the fertility of land. The negative and significant impact of rural population growth on cereal production is an indication that population growth in the rural area retards cereal production instead of providing the needed manpower for cereal cultivation. A direct consequence of a growing rural population is that there is much pressure on land available for agricultural cultivation. This result is similar to the finding by Mukhtar *et al.* (2018) which found household size to impact negatively on cereal production in Nigeria. However, what the study found curious is the negative and significant impact of land under cereal production and agricultural raw materials import in the long-run within this period. One plausible reason could the negative impacts of banditry, kidnapping and other hostilities visited on farmers across the country which has stifled agricultural activities. The results of the post-diagnostic tests indicated that in model one as shown in Appendix i, the model passed the tests for heteroskedasticity, serial correlation, normality, model specification and stability tests. In model two as shown in Appendix ii, the model also passed all the post-diagnostic tests except the normality test. All the tests were conducted at the 5% and 10% level of significance.

Conclusion

This study investigated the determinants of cereal production in Nigeria under two sub-sample periods. In both sample periods, the study found that cereal production was mainly influenced positively by land under cereal production and agricultural raw materials import. Another variable that influenced cereal production positively, especially in the second sample is arable land, while both food importation and rural population growth adversely impacted on cereal production. In all the models, the impact of fertilizer consumption on cereal production was not felt within the sample periods. The study is therefore of the view that for cereal production to improve in Nigeria, adequate provision should be made for land under cereal cultivation. Also, there is need to encourage the importation of more agricultural inputs in the short-run while the long-run target should be geared towards sourcing the inputs locally to conserve foreign exchange. The government should improve on fertilizer procurement and distribution while the use of inorganic fertilizers should be encouraged. It is equally the view of the study that while it is pertinent to modernize agricultural practice so that the rural inhabitants can embrace farming, excessive cereal importation should be checked to encourage local production.

References

Akanni, S. B., Garba, M. K., Banjoko, A. W. & Afolayan, R. B. (2020). Econometric analysis of the effects of land size on cereals production in Nigeria, *University Multidisciplinary Journal, 7(1), 252-258.*

Asfew, M., & Bedemo, A. (2022). Impact of climate change on cereal crops production in Ethiopia. *Hindawi Advances in Agriculture Volume 2022*. Retrived from https://doi.org/10.1155/2022/2208694

Ayele, T., & Melaku, T. (2019). Determinants of cereal crops productivity: In case of Kecha Birra Woreda, Snnpr, Ethiopia, *Journal of Economics and Sustainable Development, 10(17), 29-37* doi: 10.7176/JESD

Ayele, T., & Tamirat, N. (2020). Determinants of cereal crops productivity of rural Ethiopia: A case study of rural smallholder farmers of Kecha Birra Woreda in Kambata Zone, Ethiopia, *Journal of Poverty, Investment and Development, 52, 35-40.* doi: 10.7176/JPID/52-04

Brown, R, Durbin, J. & Ewans, J. M. (1975). Techniques for testing the Constance of regression relations overtime, *Journal of Royal Statistical Society 37, 149-172.*

Chandio, A. A., Jiang, Y., Fatima, T., Ahmad, F., Ahmad, N. & Li, J. (2021). Assessing the impacts of climate change on cereal production in Bangladesh: evidence from ARDL modeling approach, *International Journal of Climate Change Strategies and Management 14(2), 125-147.*

Enilolobo, O. S., Nnoli, T. I., Olowo, S. O., Aderemi, T. A., Adewole, A. O., Olapade, V. O. & Esedeke, J. F. (2022). Determinants of food security in Nigeria, ACTA *Universitatis Danubius, 18(3), 193-209.*

Faraj, F. S., Ismail, F., & Ab-Rahim, R. (2020). Determinants of wheat production in Libya. *International Journal of Academic Research in Business and Social Sciences, 10(12), 178–191.*

Food and Agricultural Organization (2023). *Nigeria Agriculture at a Glance,* Retrieved from https://www.fao.org/nigeria/fao-in-nigeria/nigeria-at-a-glance/en/

Garba, M. K., Akanni, S. B., Yahya, W. B., Kareem, K. Y. & Afolayan, R. B. (2020). Modelling effects
of some factors that contribute to cereals yields in Nigeria using Toda-Yamamoto Techniques, *Sule Lamido University Journal of Science and Technology, 1(1), 50-56.*

Grain Market in Nigeria: Miller Magazine (2023). *Retrieved from* https://millermagazine.com/blog/gran-market-n-ngera-4056

Ismaila, U., Gana, A. S., Tswanya, N. M. & Dogara, D. (2010). Cereals production in Nigeria: Problems, constraints and opportunities for betterment, *African Journal of Agricultural Research, 5(12), 1341-1350.*

Ketema, A. M. (2020). Determinants of agricultural output in Ethiopia: ARDL approach to co-integration, *International Journal of Business and Social Research, 10 03), 01-10.*

Mukhtar, U., Mohamed, Z., Shamsuddin, M. N., Sharifuddin, J. & Muktar, B. G. (*2018*). An assessment of socio-economic determinants of pearl millet production in Northwestern Nigeria: An ordinary least square analysis. *Asian Journal of Social Sciences and Humanities, 7(1), 48-57*

Nzeh, I. C. (2023). Does domestic food production contribute to improved life expectancy? Evidence from low-income food-deficit countries (LIFDC) in Africa. *International Journal of food and agricultural economics, 11(1). 51-63.*

Ogundiran, A. (2019). Food security, food sovereignty, and indigenous knowledge. *African. Archaeological. Review, 36, 343–346.*

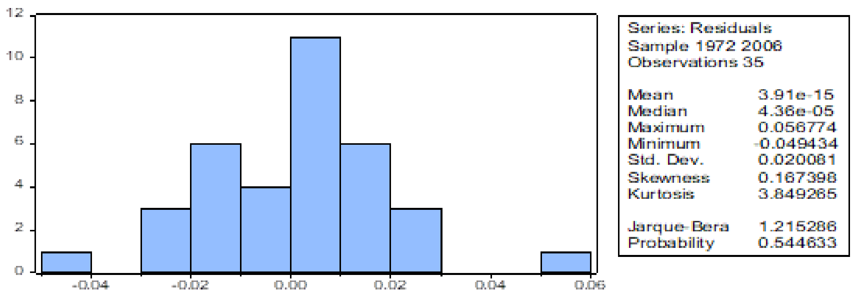
Olaoye, O. (1999). *Developing drought tolerant varieties for the savannah agro-ecologies of Nigeria in 25th year commemorative publication of Genetic Society of Nigeria*, 173-182.

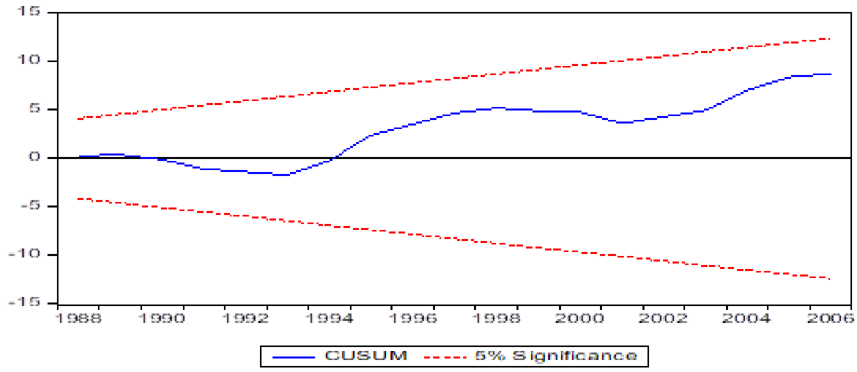
Pesaran, M. & Shin, Y. (1999). *An autoregressive distributed-lag modelling approach to co- integration analysis,* Cambridge: Cambridge University Press.

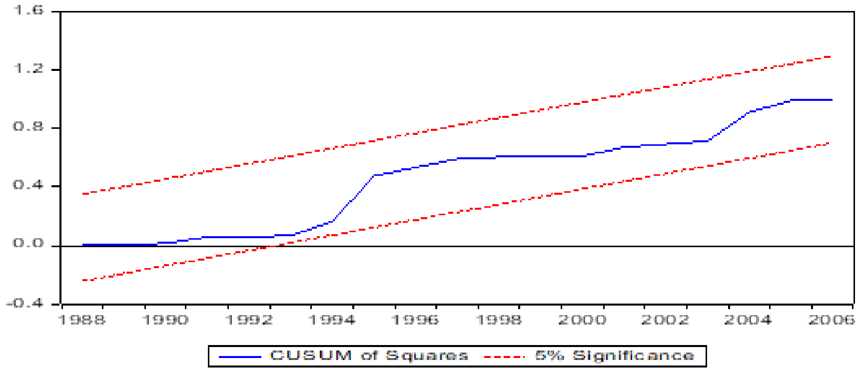
Tsiboe, F., Asravor, J., Owusu, V. & Mensah-Bonsu, A. (2022). Production technology, efficiency, and productivity of cereal farms: Prospects for enhancing farm performance in Ghana, *Agricultural and Resource Economics Review, 51, 579–609.* doi:10.1017/age.2022.16

Appendix i: Post-diagnostic Results of Model One

Test	P-value	Null Hypothesis	Conclusion
Heteroskedasticity Test: ARCH	0.9424	Ho: No Homoscedasticity	Cannot reject Ho
Serial Correlation: Breusch-Godfrey LM Test	0.3173	Ho: No Serial Correlation	Cannot reject Ho
Jarque-Bera (Normality Test)	0.544633	Ho: Normally Distributed	Cannot reject Ho
Model Specification (Ramsey RESET Test)	0.3857	Ho: Correctly Specified	Cannot reject Ho

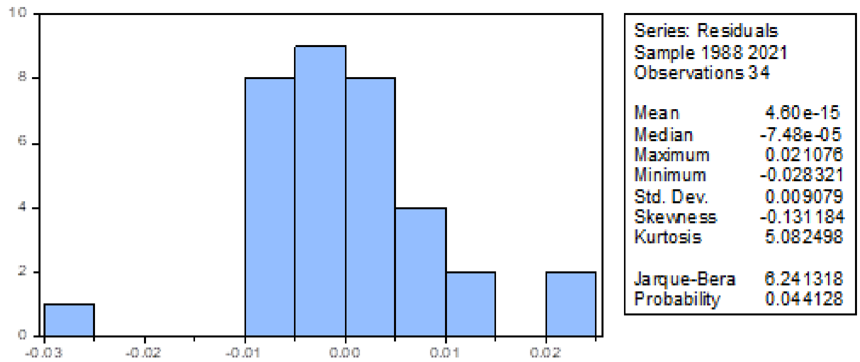


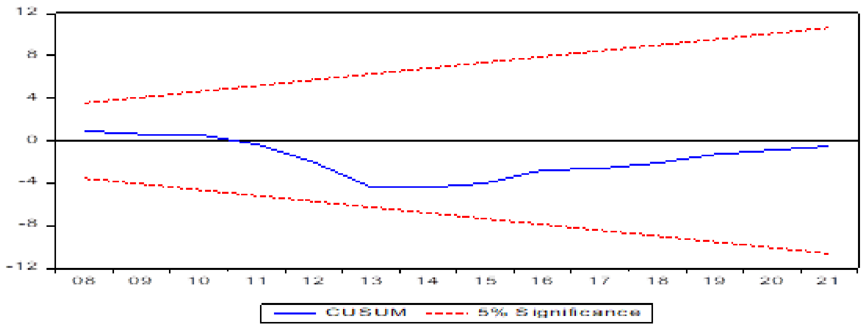


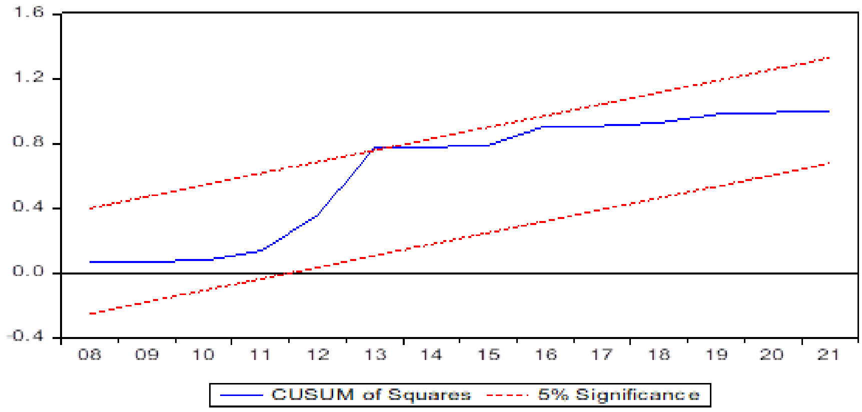


Appendix ii: Post-diagnostic Results of Model Two

Test	P-value	Null Hypothesis	Conclusion
Heteroskedasticity Test: Arch	0.6200	Ho: No Homoscedasticity	Cannot reject Ho
Serial Correlation: Breusch-Godfrey LM Test	0.1730	Ho: No Serial Correlation	Cannot reject Ho
Jarque-Bera (Normality Test)	00.44128	Ho: Normally Distributed	Reject Ho
Model Specification (Ramsey RESET Test)	0.0868	Ho: Correctly Specified	Cannot reject Ho




12
8
4
0
-4
-8
-12
08 09 10 11 12 13 14 15 16 17 18 19 20 21
CUSUM
5% Significance


1.6
1.2
0.8
0.4
0.0
-0.4
08 09 10 11 12 13 14 15 16 17 18 19 20 21
CUSUM of Squares
5% Significance