CONTRIBUTION OF CEREAL CROPS PRODUCTION TO AGRICULTURAL OUTPUT IN NIGERIA (1981-2020): AN ECONOMETRICS ANALYSIS

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ABSTRACT

The study assessed the contribution of cereal crops production to agricultural output in Nigeria (1981-2020). Time series data obtained from the archives of Food and Agriculture Organization and Central Bank of Nigeria for a period of thirty-nine years were used in the study. The data collected were analyzed using descriptive statistics, growth models, Vector Autoregression (VAR) and impulse response function. The result revealed that the trend of cereal production has been increasing considerably over the years but has experienced a downward trend in the last few years. Similarly, agricultural output has been experiencing an appreciable level of increase over the years. The growth rate of cereal production was 7.3% while that of agricultural output was 4.4%. The result of the Vector Auto-regression showed that cereal production had an R^2 value of 0.88. The result further showed that the coefficient of cereal crop production (0.834) in the previous year is positive and significant while the coefficient of agricultural output (0.236) is positive but not significant. The result of impulse response analysis indicates agricultural output responds positively to itself both in the short and long run over the period. Furthermore, the result indicates that cereal production responds positively to a unit shock of agricultural output both in the short and long run over the period. The study therefore concludes that the cereal sub-sector needs to be further strengthened in order to enhance the quantity and quality of cereal production in Nigeria, thus, boosting agricultural output and the national economy as a whole.

Keywords: Cereals, Output, VAR, Impulse Response, Econometrics

INTRODUCTION

Agriculture is the economic mainstay of the majority of households in Nigeria and is a significant sector in the Nigeria economy. The important benefits of the agriculture sector to the Nigeria`s economy include; the provision of food, contribution to the gross domestic product, provision of employment, provision of raw materials for agro-allied industries, and generation of foreign earnings labour agricultural exports were the main source of foreign exchange earnings (Udoh, 2000).

Agriculture, in the 1960s, was both the mainstay of the Nigerian economy and the chief foreign exchange earner (Chigbu, 2005); and accounted for well over 80 percent of the export earnings and employment; about 65 percent of the GDP and about 50 percent of the government revenue (FGN, 2008). As noted by the Vision 20: 2020, National Technical Working Group (NTWG) on agriculture and food security, agriculture has always played a key role in the nation's economy, currently contributing about 42% of Gross Domestic Product (GDP) as against 13% for Oil & Gas; and employing two thirds of the entire labour force, but, over the past 20 years, value added per capita in agriculture has risen by less than one (1) percent annually (NTWG, 2009).

The agricultural sector comprises crop production, fishery, livestock and forestry. Crop production is the dominant activity accounting for 87.6%, relative to livestock (8.1%), fishery (3.2%) and forestry (1.1%) (NBS, 2020). According to National Agricultural Extension Research and Liaison Services [NEARLS] (1996), the major cereal crops in Nigeria are rice, maize, sorghum, wheat, pearl, millet, sugar cane and fonio millet with rice ranking as the sixth major crop in terms of the land area while sorghum account for 50% of the total cereal production and occupies about 45% of the total land area devoted to cereal production in Nigeria. Cereals are a major contributor to agriculture and food security in Nigeria; consist of between 55 - 60% of subsistent farmers output, and provide incomes as well as form the basis of many a households' diets both in the rural and urban areas (Balami *et al*., 2011).

Today, cereal grains are the single most important source of calories to a majority of the world population. Developing countries depend more on cereal grains for their nutritional needs than the developed world. Close to 60% of calories in developing countries are derived directly from cereals, with values exceeding 80% in the poorest countries (Isah *et al*., 2015). The three most important food crops in the world are rice, wheat, and maize (corn). The three cereal grains directly contribute more than half of all calories consumed by human beings. In addition, other minor grains like sorghum and millet are particularly major contributors of overall calorie intake in certain regions of the world, particularly semi-arid parts of Africa. A large part of cereal grain production (particularly corn, barley, sorghum, and oats) also go into livestock feed, thus indirectly contributing to human nutrition (FAO, 2014).

The extraordinary growth in cereal crop productivity, aptly termed the Green Revolution, according to Prabhu and Hesey (1999), resulted from an increase in land productivity and occurred in areas of growing land scarcity and/or areas with high land values. It was always associated with strong market infrastructure and supportive government policies.

However, in the recent past, indicators show a decrease in the growth rate of productivity of cereal crops, especially in the intensively cultivated lands. This reduction in productivity growth, according to Prabhu and Hesey (1999) can be attributed to degradation of the land resource base due to intensive cultivation, declining infrastructure and research investment; and the increasing opportunity cost of labor.

Prabhu and Hesey (1999) further noted that cereal crop output and productivity growth rates had been particularly low in sub-Saharan Africa over the last few decades. Balami *et al.* (2011) asserted that factors militating against the realization of potentials of cereal growth in productivity in sub-Saharan Africa include: failure to modernize agriculture on a large scale, poor access to credit, high cost of farm inputs, low adoption of research findings, outdated land tenure system, weakened extension services, over emphasis on inefficient fertilizer procurement and distribution and poor and inadequate access to markets. In many parts of the region, rapid population growth has outstripped more modest gains in food crop production. The changing global trends pose food security threats to countries such as Nigeria, which are food import dependent.

Because of the increased demand for such cereal crops resulting from an increase in population density and income growth, relative to the low productivity of some cereal crops by farms; Nigeria has become Nigeria has become a net importer of some cereal crops with about 5.6 million tonnes total cereal import in 2019 (International Grains Council, 2020). Thus, Nigeria first goal is to meet the domestic demand and then if possible seek to become competitive of such cereal crops with other countries. Nigeria cereal crops production is potentially competitive in the domestic market if the crops industry would enhance the overall economic development through the income and employment effects in the rural and urban economics.

Other researchers have worked on cereal crops in Nigeria such as Maikasuwa (2013) who assessed factors affecting cereal crops in Nigeria; Tahir (2014) focused on trend analysis of productivity of some selected cereal crops in Nigeria amongst others. However, studies on the contribution of cereal crops production to agricultural output in Nigeria are few, hence, the need for this study to fill this research gap.

METHODOLOGY

The study was carried out in Nigeria. Nigeria has a total geographical area of 923, 768 square kilometers constituting land area of 910768 square kilometers and water area of 13000 square kilometers, respectively. It is one of the eight most populous countries in the world with a population of about 140 million (NPC, 2006). With a population growth rate of 2.6%, Nigeria has a projected population of about 206 million in 2020. Nigeria is located between 4^o16 and 13^o53 north latitude and between 2^o40 and 14^o41 east longitude (Central Intelligence Agency [CIA] Fact Book, 2009). Nigeria has a highly diversified agro-ecological climatic condition and hence, agriculture constitutes one of the most important sectors of the Nigeria economy. The climate varies with Equatorial in South, Tropical in Centre and in the North. There are two seasons – the wet season (April-October) and the dry season (November-March). The type of vegetation is grassland savannah in the North and forest in the south. This vegetation has made agriculture the major employer of labour in the country.

Methods of Data Collection

The study relied basically on secondary data. Annual time series data spanning from 1981 to 2020 was sourced from Central Bank of Nigeria (CBN) and Food and Agriculture Organization (FAO) database. Specifically, data on agricultural output were collected from the statistics of Central Bank of Nigeria (CBN) while data on cereal crops production was collected from the archives of the Food and Agriculture Organization (FAO).

Analytical Techniques

The data collected were analyzed using both descriptive statistics (mean, maximum and minimum with graphs) and inferential statistics (trend model, Vector Autoregression (VAR), impulse response function and t-test.

The trend model is given as:

$$Yt = Y_0(1+r)^t \quad \ldots\ldots(1)$$

Where;

Y_t = Cereal crops production and agricultural output in year t.

Y_0 = Cereal crops production and agricultural output in the base year.

r = compound rate of growth of Y,

t = time in chronological years.

Taking the natural log of equation (1) to make it linear, it is stated thus

$InYt = In\ Y_0 + tIn(1+r)$ ...……(2)

Substituting in InY_0 with β_1 and $In(1+r)$ with β_2, equation (2) is rewritten as

$InYt = \beta_1 + \beta_2 t$……..…… (3)

Adding the disturbance or error term to equation (3), we obtain

$InYt = \beta_1 + \beta_2 t + Ut$……..…… (4)

Equation (4) is the growth rate model developed for this study. A semi-log growth model was developed for this study instead of a linear trend model because the point of interest in this study is both absolute and relative in the parameters of interest. The most important parameter in equation (4) is the coefficient of β_2 which is the slope and measures the constant proportion or relative change in Y for a given absolute change in the value of the regressor t. multiplying β_2 by 100 gives the instantaneous growth rate at a point in time.

$IGR = b_2 \times 100$……..…….…….. (5)

Where IGR = Instantaneous growth rate.

b_2 is the least square estimate of the coefficient of β_2, then taking the anti-log of b_2 and subtracting it 1 and then multiplying the difference by 100 will give the compound growth rate (CGR) over a period of time.

$CGR = [antilog\ b_2 - 1] \times 100$…….…… (6)

If the coefficient of b_2 is positive and statistically significant or negative and statistically significant, there is acceleration or deceleration in the growth respectively. However, if the coefficient of b_2 is not statistically significant, then there is stagnation in the growth process.

The linear trend analysis model with the form $Q = b_0 + b_1T + e$ and the quadratic model with the form $Q = b_0 + b_1T + b_2T^2 + e$ were also tested to determine the best fit.

RESULTS AND DISCUSSION

Trends of Total Cereal Production in Nigeria (1981-2020)

Figure 1 presents the trend of total cereal production in Nigeria. The result shows that the trend of total cereal production in Nigeria ranges between 8053000 tonnes and 32145703 tonnes with a mean of 20770209 during the period under study. This can be attributed to the fact that in the recent past, indicators show a decrease in the growth rate of productivity of cereal crops, especially in the intensively cultivated lands, however, output of cereal crops is on the increase. Specifically, from 1981 to 1990 there was a steady increase in total cereal production in Nigeria and continued to increase till 1999. Between 1999 and 2001 there was a decline in total cereal production but increased yet again from 2001 to 2006. From 2006 to 2008 total cereal production decreased slightly. Total cereal production fluctuated between 2008 and 2016 when it reached an all-time high but has continued to decrease recently till 2018. This agrees with the findings of Prabhu and Hesey (1999) who observed that reduction in the productivity growth can be attributed to degradation of the land resource base due to intensive cultivation, declining infrastructure and research investment; and the increasing opportunity cost of labour.

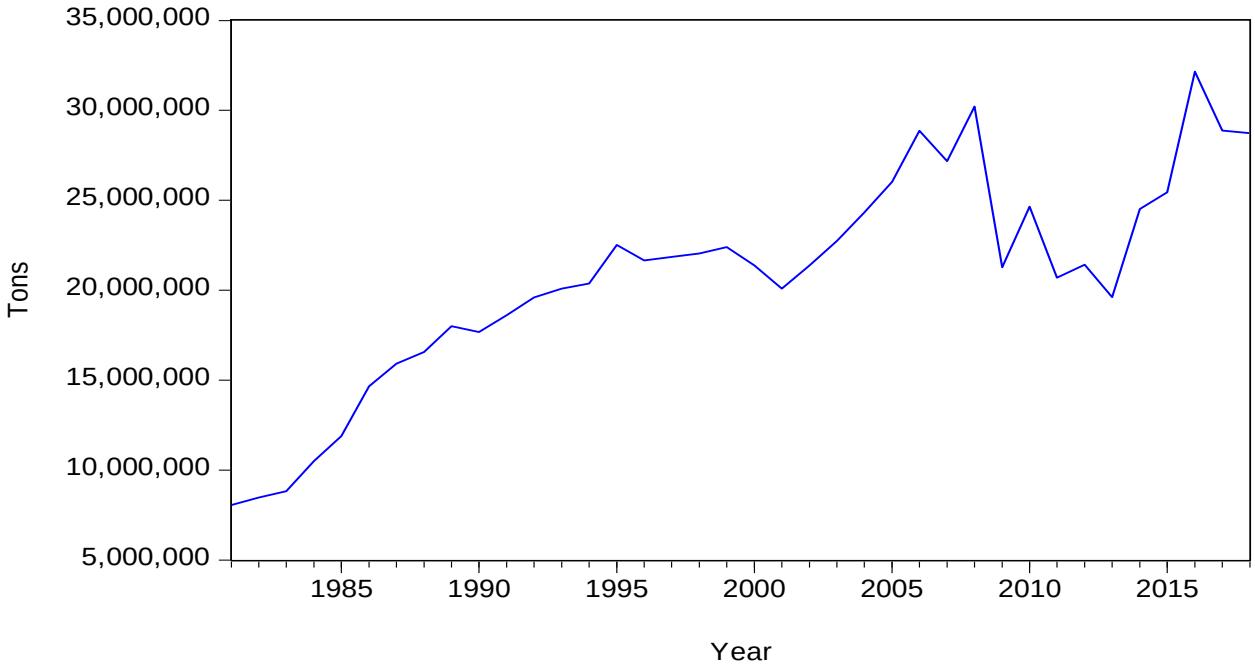

Figure 1: Trends of cereal production in Nigeria (1981-2020)
Source: Data analysis, 2020

Figure 2 presents the trend of agricultural output in Nigeria. The result shows that the trend of agricultural output in Nigeria ranges between ₦2303510 to ₦17544147 with a mean of ₦7671357 during the period under study.

This can be attributed to political instability, lack of focused and visionary leadership, economic mismanagement and corruption (Adekanye, 1993). Specifically, from 1981 to 1982 agricultural output was fairly constant but decreased from 1982 to 1984. Between 1984 and 1990 agricultural output increased at a steady rate but became constant from 1990 to 1991. Agricultural output continued to increase from 1991 to 1998 and became constant yet again from 1998 to 1999. From 1999 to 2001 there was a slight increase in agricultural output but from 2001 to 2015 there was a rapid increase in agricultural output. However, agricultural output declined from 2015 to 2016 but has continued to increase from 2016 till 2018. This is in line the findings of Kalikume (2015) who asserted that agricultural output in Nigeria has risen substantially over the years, with annual average of 7.4 per cent in the last decade. But the growth has not been inclusive, broad-based and transformational.

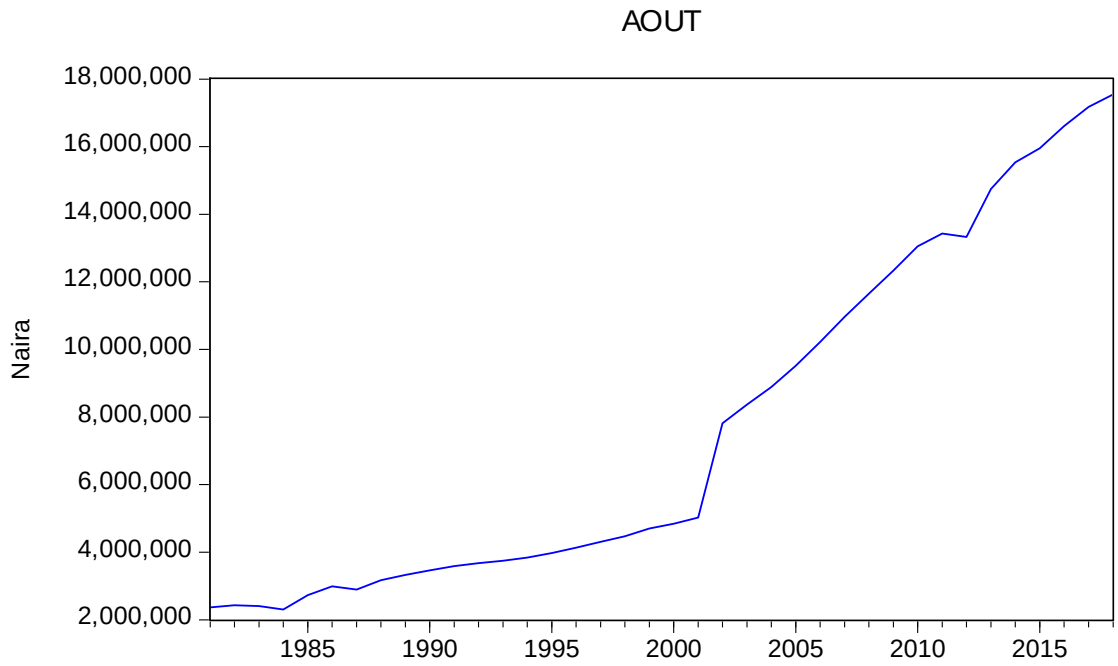

Figure 2: Trends of agricultural output in Nigeria (1981-2020)
Source: Data analysis, 2020.

Growth Rates and Direction of Total Cereal Production in Nigeria

The result of the trend analysis of total cereal production is shown in Table 1. The trend equation revealed that the coefficient for estimating the growth (0.073) was positive and significant at 1% which implies a positive growth rate. The instantaneous growth rate (growth at a point) of cereal production is 7.3% while the compound growth rate is 11.8%. The direction of growth of total cereal production shows that there was deceleration in total cereal production. The coefficient of multiple determination (R^2) shows that 85% of the variations in the trend of cereal production are explained by time. This agrees with the findings of Prabhu and Hesey (1999) who noted that cereal crop output and productivity growth rates had been particularly low in sub-Saharan Africa over the last few decades.

Table 1. Trend Analysis of Total Cereal Production

Variables	Coefficient	t-statistics
Constant	16.042	250.81
@ trend	0.073	9.13***
@ trend^2	-0.0012	-6.15***
R^2	0.85	
F-statistics	96.2	

*** Significant at 1%

Source: Data analysis, 2020.

Growth Rates and Direction of Agricultural Output in Nigeria

The result of the trend analysis of agricultural output in Nigeria is shown in Table 2. The trend equation revealed that the growth rate of agricultural output in Nigeria was positive which implies a positive growth rate. The coefficient for estimating the growth (0.044) was positive and significant at 1%. The instantaneous growth rate (growth at a point) of agricultural output is 4.4% while the compound growth rate is 11.06%. The direction of growth of agricultural output in Nigeria shows that there was acceleration in agricultural output. The coefficient of multiple determination (R^2) shows that 97% of the variations in the trend of agricultural output in Nigeria are explained by time. This is similar to the findings of Soyibo and Olayiwola (2000) who observed that agricultural output in Nigeria has been good relative to annual GDP growth rate.

Table 2. Trend Analysis of Agricultural output

Variables	Coefficient	t-statistics
Constant	14.59709	265.3317
@ trend	0.043810	6.368046***
@ trend^2	0.000469	2.611086**
R^2	0.970363	
F-statistics	606.7469	

*** Significant at 1%, ** significant at 5%
Source: Data analysis, 2020.

Unit Root test

The Augmented Dickey Fuller (ADF) test for unit root was employed to test whether or not a variable is stationary and also determine the order of integration of the variable. The result indicated that total cereal production was integrated of order zero. However, agricultural output was found to be integrated of order one and became stationary on first differencing. This indicates that the variable exhibit random walk (unit roots) or the future values of these variables do not converge from their past values or their mean are unpredictable.

Table 3. Result of Augmented Dickey-Fuller (ADF) Test

Variable	Level				First Difference				
	ADF	1%	5%	10%	ADF	5%	1%	10%	Inference
AGO	0.257	-3.621	-2.943	-2.610	-5.885*	-3.636	-2.946	-2.611	I (1)
TCP	-4.489*	-3.670	-2.964	-2.621	-	-	-	-	I (0)

* Significant at 1% AGO = Agricultural Output; TCP = Total Cereal Production
Source: Data analysis, 2020.

Vector Autogression (VAR) Model Result for Effect of Cereal Crop Production on Agricultural Output in Nigeria in the Short and Long run

Consequent upon the existence of stationarity of both variables at different levels, the Vector Autoregressive (VAR) model was estimated as both variables became endogenous. There was no further need for co-integration test because of the levels of stationarity of the variables. The result of the Vector Autoregressive (VAR) as shown in Table 4 indicates that both variables become endogenous and therefore have effect on each other. The result of the total cereal production model showed that the coefficient of determination (R^2) is 0.88. This implies that 88% of the total variation in agricultural output was explained by total cereal production in the previous year and cereal output in the previous year. The result also showed that the F-statistics (118.8) was positive and significant at 1% indicating the overall significance of the model. The result further showed that the coefficient of total cereal crop production (0.834) in the previous year is positive and significant at 1% level of probability as expected. Thus, this implies that a unit increase in total cereal crop production in the previous year will increase total cereal production by 0.834%. This agrees with the findings of Nkonya *et al.* (2010) who asserted that the increase in cereal output is large, due to increased cultivation of land area rather than productivity. Also, the coefficient of agricultural output (0.236) is positive but not significant.

The result of the total agricultural output model showed that the coefficient of determination (R^2) is 0.28. This implies that 28% of the total variation in agricultural output was explained by total cereal production in the previous year and cereal output in the previous year. The result also showed that the coefficients of agricultural output in the previous year (-0.016) is negative but not significant. This implies that a unit increase in agricultural output in the previous year will decrease agricultural production by 0.01% which rightly points out that agricultural output does not have a significant effect on total cereal crop production in Nigeria. In addition, the coefficient of total cereal production in the previous year (0.013) is positive but not significant.

Response of Cereal Crops Production to Shocks of Agricultural Output

The result of impulse response analysis (Fig. 3) indicates that agricultural output responds positively to itself both in the short run and in the long run over the period. The effect of this shock was higher in the short run specifically in the first year where it was about 0.08% and declined henceforth. Furthermore, agricultural output responds positively to a unit shock of total cereal crop production both in the short run and in the long run over the period.

Table 4. Effect of Cereal Crop Production on Agricultural Output in Nigeria

Regressors	**ΔAOUT**	**ΔTCP**
Constant	-0.159 (-0.221)	2.817 (3.050)***
$\Delta AOUT_{t-1}$	-0.016 (0.091)	0.236 (1.049)
ΔTCP_{t-1}	0.013 (0.298)	0.834 (15.161)***
R^2	0.28	0.88
Adjusted R^2	0.26	0.87
F statistics	0.05	118.8
Akaike Info. Criteria	-2.174	--1.672
Schwarz Criteria	-2.042	-1.539
Log Likelihood	42.134	33.086

Figures in parentheses are t-values,***significant at 1%
Note: AOUT = Agricultural output; TCP = Total cereal production
Source: Data analysis, 2020.

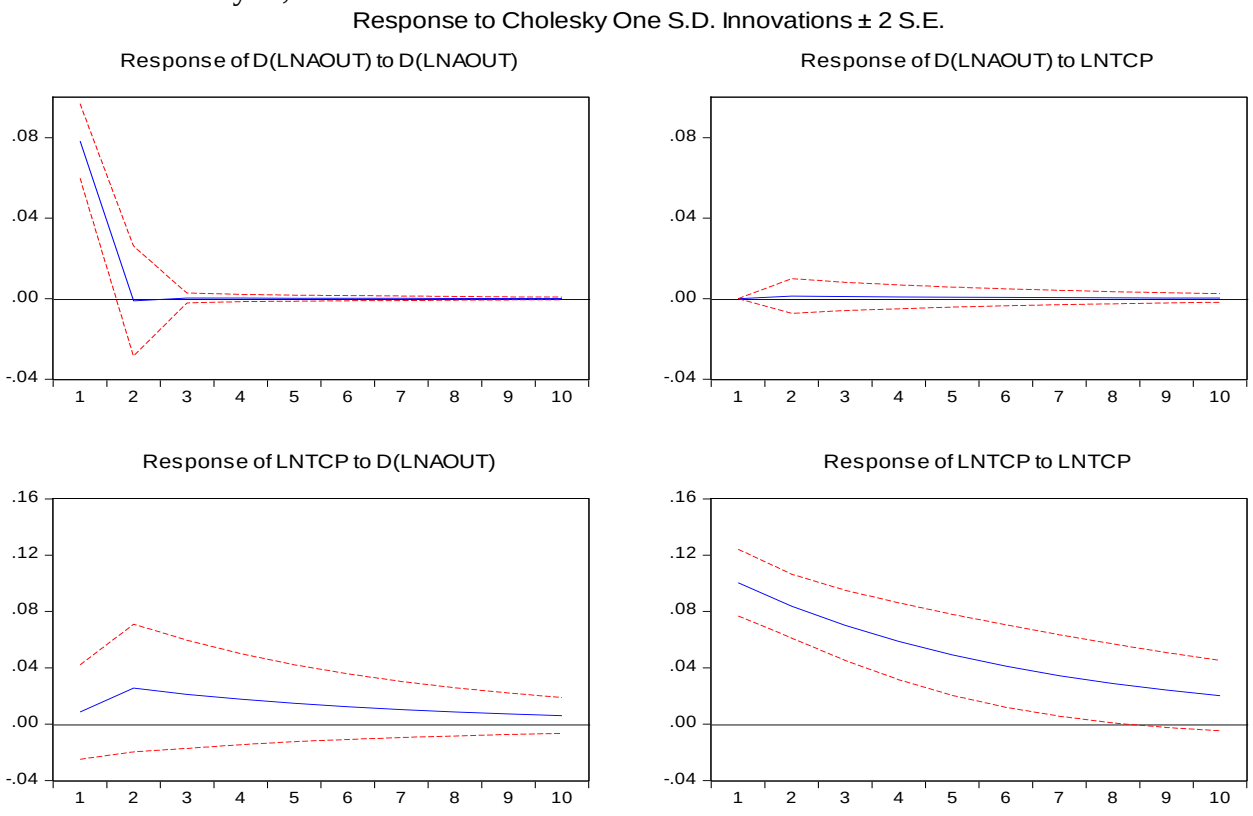

Figure 3. Impulse Response of Cereal Crops Production and Agricultural Output
Source: Data Analysis, 2020.

The effect of this shock was however minimal as it around 0.001% throughout the study period hovers. The effect of the shock was therefore positive but not significant in both the short run and in the long run. The result further indicates that total cereal crop production responds positively to itself both in the short run and in the long run over the period. The effect of this shock was higher in the short run than in the long run. Shocks rising from total cereal crop production have the tendency to first increase total cereal crop production by 0.010% during the first year and then decreases consistently to 0.002% in the 10^{th} year. More also, the result indicates that total cereal crop production responds positively to a unit shock of agricultural output both in the short run and in the long run over the period. Specifically, shocks rising from total cereal crop production have the tendency to increase agricultural output by 0.002% during the second year. The effect of the shocks decreased to 0.001% during the 3^{rd} year and continues even after the 10^{th} year. The effect of this shock was higher in the short run than in the long run. This could be explained by the robust performance of cereal crop production over the years in Nigeria as there has been a geometric rise in cereal crop production over the years. This is consistent with the findings of Soules *et al.* (2016) who observed that while cereal crop production has leaped considerably over the past twenty-five years, demand has also risen, accentuating the Federation's dependency on foreign cereal products and making it vulnerable to internal and external shocks.

CONCLUSION AND RECOMMENDATIONS

In Nigeria, cereals are the only crops that are grown throughout the country in all the agro-ecology zones. The study revealed that, cereal production has a positive and significant relationship with agricultural output in Nigeria both in the short run and in the long run. This implies that the more cereal crop is been produced in Nigeria, the more the improvements in the performance of agricultural output in Nigeria. The study therefore recommended that:

i. Cereal crop sub-sector in Nigeria needs to be further strengthened in terms of increased financing, policy enactment and government commitment in order to enhance the quantity and quality of cereal production in Nigeria.
ii. Government should encourage the use of modern mechanized farm tools, and subsidize the prices of agro-chemical and fertilizer for farmers in order to improve cereal crop production in the country and to encourage soil conservation methods.
iii. All hands should be on deck to increase the availability of good quality seed of improved high-yielding cereal crop varieties to farmers; scaling-up and delivering improved multiple stress tolerant, nutrient-use efficient and nutritious cereal crops varieties.

REFERENCES

Adekanye, D.O. (1993). Public Enterprises Reforms in West Africa: Issues and Research Agenda". *Res. Dev.* 11(1&2):13-24.

Balami, D. H., Ogboru, I. and Talba, D. M, (2011). The Cereal Economy in Nigeria and the Sub- Regional Dimension. SSSG Series 1 (29). Benue State University. Destiny Ventures. Makurdi.

Central Intelligence Agency [CIA] (2009). *The World Fact Book*. Available online at http:www.cia.gov/library/publications/the-world-factbook/goes/ni.html.

Chigbu, U.E. (2005). Agriculture as the only saviour to Nigeria dyeing economy. http://www.nigerianvillagesquare.com/articles/guest/2005/03/agric-as-only-saviour-to.html.

FGN (2008). National Investment Brief. High Level Conference on Water for Agriculture and Energy in Africa: The Challenges of Climate Change, Sirte, Libyan Arab Jamahiriya, December 15-17.

Food and Agricultural Organisation (FAO) (2014). FAO Statistical Data Base, http://apps.fao.org/,

International Grains Council (2020). Increase productivity and efficiency of existing grain plant: Focus on Nigeria. Available online at www.world-grain.com

Isah, M. A., Samuel, E., Makama, S.A. and Kiresur, V. R. (2015). Trend of Area, Production and Productivity of major cereals: India and Nigeria Scenario. *Research Journal of Agriculture and Forestry Sciences.* 3(2), 10-15.

Kalikume, A. I. (2015). The role of agriculture in economic development. *Nigeria Economic Review.* 51(4): 556-593

MaiKasuwam, M. A. (2013). Trend Analysis of Area and Productivity of Sorghum in Sokoto State, Nigeria, 1993-2012., *European Scientific J.* 9(16): 69-75

National Bureau of Statistics (2019). Annual Abstract of Statistics. Available online at www.nigerianstat.gov.ng

National Bureau of Statistics (2020). "LSMS: Integrated Surveys on Agriculture: General Household Survey Panel." General Household Survey Panel, Microdata Library.

National Agricultural Extension Research and Liaison Services [NEARLS] (1996). Prospects and problems of the 1996 Cropping season. (*Res. Report*). National Agricultural Extension Research and Liaison Services (NEARLS) and Agricultural planning Monitoring and Evaluation Unit (APMEU). A.B.U. Zaria.

Nkonya, E., Pender, J., Kato, E., Omobowale, O., Philip, D. and Ehui, S. (2010). Enhancing Agricultural Productivity and Profitability in Nigeria. (NSSP Brief No 19). IFPRI

National Population Commission [NPC] (2006). *National Population Commission Census.* National Economic Census Board, 2006, Abuja, Nigeria.

National Technical Working Group on Agriculture and Food Security [NTWG] (2009). Report of the Vision 2020 National technical working group on agriculture and food security. Federal Government of Nigeria, Abuja.

Prabhu, L. P, and Hesey, W. (1999). Cereal Crop Productivity in developing countries: Past trends and future prospects. (Econ. working paper 99-03). CIMMYT.

Soyibo, A. and Olayiwola, K. (2000). 'Interest rate Policy and the Promotion of Savings Investment and Resource Mobilisation in Nigeria', Research Report 24, Development Policy Centre, Ibadan.

Tahir, H.M. (2014). Trend Analysis of Productivity of Some Selected Cereal Crops in Nigeria: 1983-2008. *Research on Humanities and Social Sciences.* 4(8): 110-116.

Udoh, E.J. (2000). Land Management Resource Use Efficiency among Farmers in South Eastern Nigeria. Unpublished Ph.D Thesis, Department of Agricultural Economics University of Ibadan, Nigeria.