EFFECT OF MAIZE PRODUCTION ON AGRICULTURAL OUTPUT IN NIGERIA (1981-2019): IMPLICATION FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT
The study assessed the effect of maize production on agricultural output in Nigeria (1981-2019) and its implication for sustainable development. Time series data obtained from archives of Food and Agriculture Organization (FAO) and Central Bank of Nigeria (CBN) for a period of (38) years were used in the study. The data collected were analyzed using descriptive statistics, trend models, and vector error correction model (VECM). The result of the study revealed that the trend of maize production has fluctuated considerably over the years which is not ideal for sustainable development while the trend of agricultural output in Nigeria has been experiencing an appreciable level of increase over the years. The growth rate and direction of maize production was 2.4% and decelerating while agricultural output was 4.4% and accelerating respectively during the period of study. The result of VECM indicated that in a long run, the coefficient of maize production is rightly signed with a coefficient of 9.876 as expected and statistically significant at 1% probability level. The result showed that the coefficient of determination (R^2) is 0.38. The result also showed that the F-statistics (6.223) was positive and significant at 1% indicating the overall significance of the model. The study therefore concluded that, effort must be made to increase the production/yield of maize and consequently agricultural output which is essential for sustainable development in Nigeria.

Keywords: Trend, Maize, Output, Vector Error Correction Model, Co-integration

INTRODUCTION

The role of agriculture in economic development of most countries can hardly be overemphasized (Timmer, 2003). Henao and Baanante (2006) posited that the economic development of Africa, more than any other region, depends on development of the agricultural and agro-industry sectors, which are fundamentally affected by productivity and land resources; particularly for Sub-Saharan Africa. Agriculture as a major contributor to Nigeria's economy, provides primary means of employment for Nigerians and accounts for about one quarter of total Gross Domestic Product (National Bureau of Statistics, 2020), with more than 50% of the working adult populations employed in the agricultural sector directly or indirectly (NBS, 2019).

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 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, food security and sustainable development 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).

FAO (2014) asserted that the three most important food crops in the world are rice, wheat, and maize. 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).

Sustainable development from an agricultural standpoint refers to an agricultural system which enhances environmental quality and the resource base on which agriculture depends, provides for basic human food and fiber needs, is economically viable, and enhances the quality of life of farmers and society as a whole (Office of International Studies and Programs, 1994). The development of the cereal crops such as maize, millet and guinea corn had continued to attract the attention of various administrations in Nigeria, since the colonial period till date. This is not unconnected with its economic importance as a very important source of edible and technical crops of a huge National revenue earning potential (Mgbeje, 2004) which translates in the long run to sustainable development and sustainability in the country.

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 a net importer of some cereal crops with about 5.6 million tonnes total cereal import in 2019 (International Grains Council, 2020). At the same time, the rapid devaluation of the Naira combined with high transportation costs from rural to urban markets has put imported crops in a competitively disadvantaged position. 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.

Maize (*Zea mays* L.) is the most widely-grown staple food crop in sub-Saharan Africa (SSA) occupying more than 36.9 million hectares (Santpoort, 2020). The crop covers nearly 17% of the estimated 200 million hectares cultivated land in SSA, and is produced in diverse production environments and consumed by people with varying food preferences and socio-economic backgrounds. More than 300 million people in SSA depend on maize as source of food and livelihood (FAOSTAT, 2015).

Maize (*Zea mays* L.) ranks third following wheat and rice in the world production (Kamara *et al*. 2005). In Nigeria, based on the area cropped and quantity produced, maize is the country's most important cereal crop followed by rice and sorghum (FAO/GIEWS, 2021). As a grain, maize yields more food per unit of land and labor than any other. Maize holds a unique position in the world agriculture as a food, feed and industrial crop par excellence. Maize is a major food for most households in Nigeria and the main source of income and employment for the majority of rural households.

In view of the overriding need to enhance the level of agricultural productivity, particularly of food grains, in the face of increasing population and declining agricultural output/yield in developing countries such as Nigeria, the importance of determining empirically quantitative relationships that provide estimates of changes in current and expected output and yield of maize and overall agricultural output cannot therefore be overemphasized.

Other researchers have worked on cereal crops in general and maize in particular in Nigeria such as Maikasuwa (2013) who assessed factors affecting cereal crops in Nigeria; Tahir (2014) who focused on trend analysis of productivity of some selected cereal crops in Nigeria amongst others. However, there is no known study on the effect of maize production on agricultural output in Nigeria 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°16 and 13°53 north latitude and between 2°40 and 14°41 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.

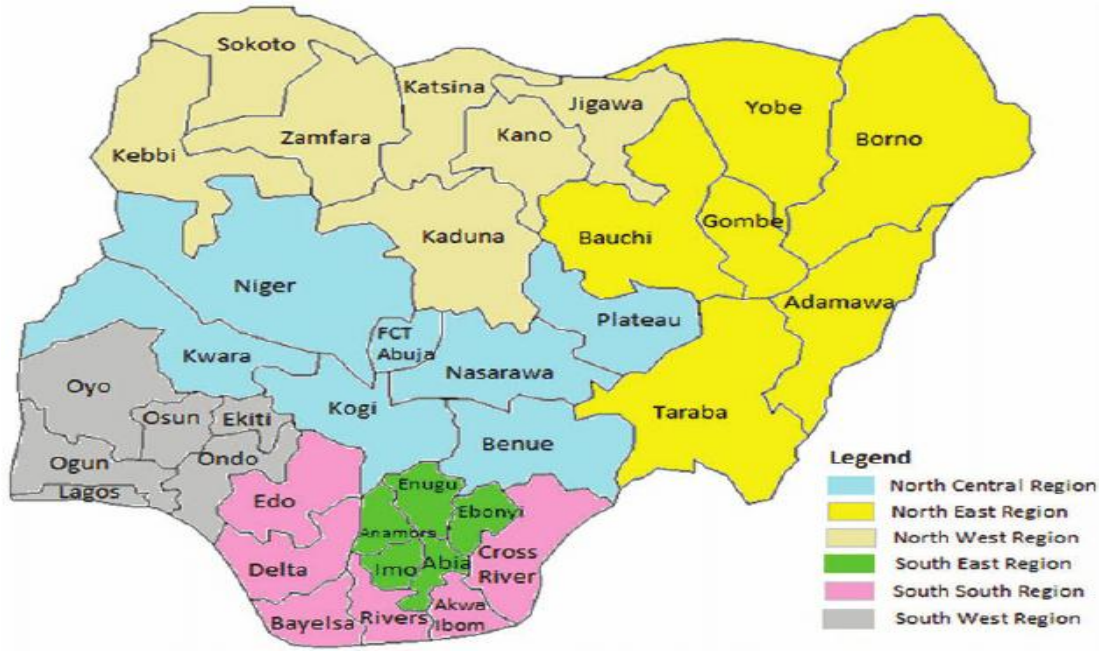

Figure 1: Map of Nigeria
Source: www.wikipedia.com/nigeria

Methods of Data Collection

The study relied basically on secondary data. Annual time series data spanning from 1981 to 2019 were 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 maize production were 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 error correction model [VECM] after testing for unit root and co-integration among the variables) and t-test.

The Trend Model is given as:

$Yt = Y_0(1+r)^t$……..……..…(1)

Where;

Y_t = Maize production and agricultural output in year t.

Y_0 = Maize 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. If b_2 is not statistically significant, there is stagnation in the growth process. However, if the coefficient of b_2 is not statistically significant, then there is stagnation in the growth.

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

RESULTS AND DISCUSSION

Trends of Maize Production in Nigeria (1981-2019)

Figure 2 presents the trend of maize production in Nigeria. The result shows that the trend of maize production in Nigeria ranges between 720000 tonnes and 11547980 tonnes with a mean of 6009520 during the period under study. This can be attributed to the fact that maize production in Nigeria has fluctuated considerably over the years. Specifically, from 1981 to 1985 there was a slight increase in maize production and the increase continued sharply till 1989. Between 1989 and 1990 there was a slight decrease in maize production but increased continuously till 1995. From 1995 to 2000 there was a sharp decline in maize production. Maize production however began to increase from 2000 to 2011 when it decreased slightly till 2012. Between 2012 and 2016 there was an increase in maize production but decreased sharply from 2016 to 2018. This is consistent with the reports of FAOSTAT (2015) who posited that the planted lands of maize and grain production have increased significantly across regions in SSA since 1961.

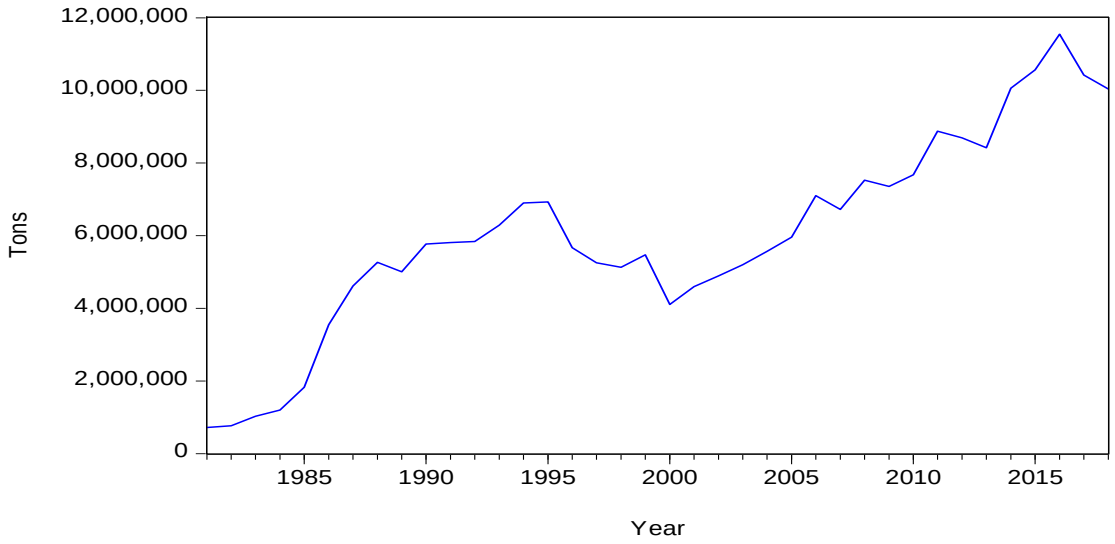

Figure 2: Trends of Maize Production (1981-2019)
Source: Data analysis, 2020.

Trends of Agricultural Output in Nigeria (1981-2019)

Figure 3 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.

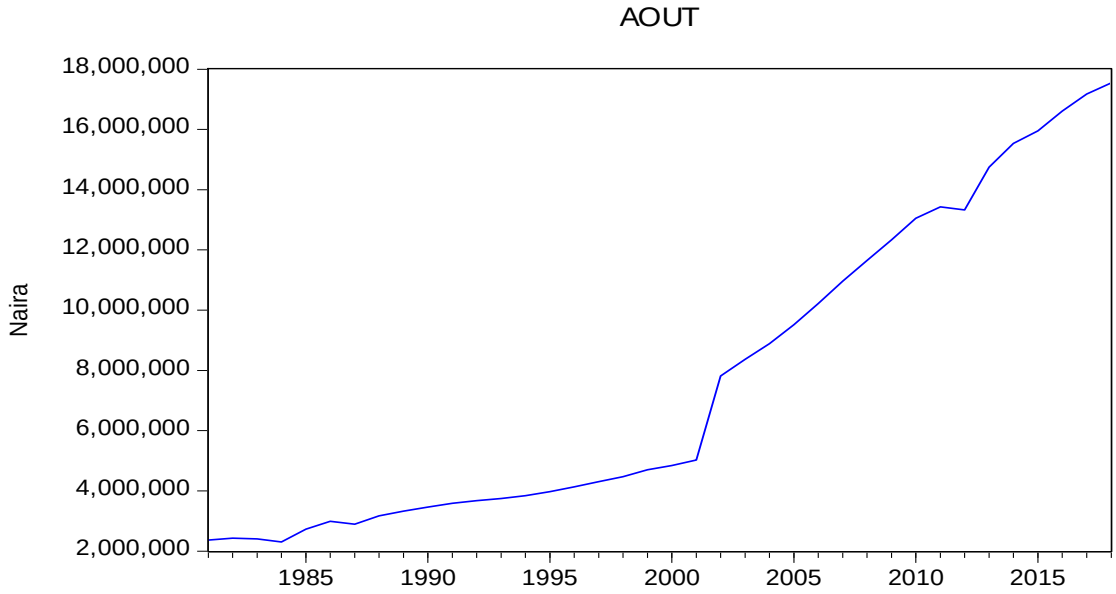

Figure 3: Trends of agricultural output in Nigeria (1981-2019)
Source: Data analysis, 2020.

Growth Rates and Direction of Maize Production in Nigeria (1981-2019)

The result of the trend analysis of maize production is shown in Table 1. The trend equation revealed that the growth rate of maize production was positive which implies a positive growth rate. The coefficient for estimating the growth (0.124) was positive and significant at 1%. The instantaneous growth rate (growth at a point) of maize production is 12.4% while the compound growth rate is 13.3%. The direction of growth of maize production shows that there was deceleration in maize production over the years. The coefficient of multiple determination (R^2) value of 0.73 shows that 73% of the variations in the trend of maize 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 Maize Production

Variables	Coefficient	t-statistics
Constant	14.07634	82.60680
@ trend	0.124335	5.834918***
@ trend^2	-0.002020	-6.627531***
R^2	0.732584	
F-statistics	47.94111	

*** 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 5.06%. The direction of growth of agricultural output in Nigeria shows that there was acceleration in agricultural output. This is paramount and significant in achieving sustainable development in Nigeria. 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.

Table 3. Growth Rates and Direction of Maize Production and Agricultural Output

Variables	Growth rate	Direction of growth
Agricultural Output	4.4%	Acceleration
Maize	2.4%	Deceleration

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 (Table 4). The result indicated that the variables were not integrated of order zero and this implies that the variables were not stationary at level form. However, the variables were 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 4. Result of Augmented Dickey-Fuller (ADF) Test

Variable	Level				First Difference				
	ADF	1%	5%	10%	ADF	5%	1%	10%	Inference
Agricultural Output	-2.122	-3.626	-2.946	-2.612	-4.973***	-3.626	-2.946	-2.612	I (1)
Maize Production	-1.334	-3.626	-2.946	-2.612	-5.431***	-3.626	-2.946	-2.612	I (1)

*** Significant at 1%

Source: Data analysis, 2020.

Result of Co-integration rank test for the long run relationship among the variables

According to Engle and Granger (1987), regressing a non-stationary series on another non-stationary series yields spurious regression, but if the linear combination of the series is stationary, we could say the variables are cointegrated and the regression is no longer spurious. Variables are said to be cointegrated if they have long run association. Since our variables are non-stationary, it becomes imperative to test whether or not the variables are cointegrated. To do this, the study adopted the Johansen Cointegration Trace test; the result is presented in Table 5. Further investigation into the series properties of the variables through the use of Johansen co-integration mechanism indicates that co-integration exists among the variables. The result shows that the computed trace statistic (20.381) is greater than the critical value (15.495) at 5% level of significance therefore, co-integration exists among the variables. On this basis, the null hypothesis of none of the hypothesized number of equation(s) is rejected.

Table 5. Johansen Co-integration Test for Unrestricted Co-integration

Hypothesized No. of CE(S)	Eigen value	Trace Statistics	0.05 critical value	Prob**
None*	0.393205	20.38107	15.49471	0.0084
At most 1	0.064409	2.396764	3.841466	0.1216

* rejection of the hypothesis at 0.05 level of sig. ** MacKinnon-Haug-Michelis (1999) p-values

Source: Data analysis, 2020.

Vector Error Correction Model result for Effect of Maize Production on Agricultural Output in Nigeria

Consequent upon the existence of one co-integrating equation among the variables, implying long run relationship exist among the variables, the Vector Error Correction Model (VECM) was estimated. The result of VECM as shown in Table 6 indicates that in a long run, the coefficient of maize production is rightly signed as expected and statistically significant at 1% probability level. Thus, this implies that a unit increase in maize production will increase agricultural output by 9.876 units. This shows that maize is a very important crop in Nigeria therefore; its production will inevitably bring about a significant increase in agricultural output and sustainable development in Nigeria in the long run. This is in line with the studies of Balami *et al.* (2011) who observed that, the contribution of maize production to agricultural output in Nigeria has been significant. More so, the coefficient of multiple determination (R^2) is 38%. This implies that the independent variable is found to explain 38% of the movement of the dependent variable.

Table 6. The Vector Error Correction Model of long and short-run relationship between maize production and agricultural output in Nigeria

Long run Estimates		
Regressors	**CointEq1**	
Agricultural output	1.000000	
Maize production	9.876 (6.859***)	
Constant	-199.998	
Short-run Estimates		
Error Correction Model	**Agricultural output model**	**Maize production model**
CointEq1	0.003 (1.766*)	0.003 (-1.357*)
Agricultural output-1	0.463 (2.268**)	-0.169 (-1.144)
Maize production-1	0.332 (2.686**)	0.155 (1.175)
Constant	0.554 (2.613**)	0.019 (2.459)**

R^2 = 0.378; Adjusted R^2 = 0.359; F statistics = 6.223 Likelihood 69.908
Akaike Information Criteria -7.663 Schwarz Criteria -7.215
Figures in parentheses are t-values,*significant at 10% ** significant at 5%
Source: Data analysis, 2020.

CONCLUSION AND RECOMMENDATIONS

The study assessed the effect of maize production on agricultural output in Nigeria (1981-2019) and its implication for sustainable development. The study revealed that, maize production has a positive and significant relationship with agricultural output in Nigeria both in the short run and in the long run which will invariably translates to sustainable development. This implies that the more maize is been produced in Nigeria, there will be a corresponding increase in agricultural output and results to sustainable development in Nigeria. The study therefore recommended that:

i. Government at all levels should formulate better policies that will further harness the Nigerian maize potentials as tools for boosting the agricultural output in Nigeria.
ii. Effort must be made to scale-up and deliver improved multiple stress tolerant and nutrient-use efficient maize varieties so as to increase the production/yield and consequently sustainable development in Nigeria.
iii. 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 maize production and sustainable development in the country.

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