

DETERMINANTS OF AGRICULTURAL LAND EXPANSION IN NIGERIA: AN APPLICATION OF ERROR CORRECTION MODELING (ECM)

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ABSTRACT

This study used an ECM to analyze the determinants of agricultural land expansion in Nigeria. Results show that at first differencing, Augmented Dickey Fuller test indicated stationarity for all the variables ($p < 0.05$) and there were 7 cointegrating vectors using Johansen test. The dynamic unrestricted short-run parameters of permanent cropland growth rates (68.62), agricultural production index (10.23), livestock population (0.003), human population (-0.145), other land (-0.265) and cereal cropland growth rate (0.621) have significant impact on agricultural land expansion ($p < 0.05$). The study recommended that appropriate policies to address the problem of expansion of agricultural land and agricultural production must focus on development of cereal and permanent crop hybrids that are high yielding and resistant to environmental stress, human population control and guided use of land for industrial and urban development, among others.

Keywords: cointegrating vector, ECM, agricultural land expansion, Nigeria

INTRODUCTION

Land is the pivot of man's absolute existence. Sheng (1989) stressed this by asserting that through the past, in the present, and through the foreseeable future, soil continues to be the foundation of our food supply chain, which is a vital recurrent and capital resource of any nation. However, Vink (1975) observed that in most cases, because of the temporary high economic gains, man may not care about the effect of the use to which land is subjected. The need for putting land to optimum use through adequate and effective planning has never been greatly felt than at present, when rapid population growth and urban expansion are making available agricultural land scarce [1].

Land use is the end to which land is allocated, assuming a conscious decision to use it for a desired end [15, 20]. In the rural areas, land use patterns are governed mainly by the requirements of the agricultural industry, which is important for the livelihood of the people. In Nigeria, given the level of agricultural technology, the capacity of available land had been exceeded by 40-50 million people who mine the soil nutrients to support themselves [8].

Nigerian lands are either productive or non-productive for agricultural purposes. Because of the long fallow period, the traditional agricultural production system was stable and biologically conducive to soil nutrient replenishment [13, 22]. Increasing demographic pressure has now compelled expansion of crop production to marginal lands. Persistent deforestation for agricultural production is now a form of environmental degradation as crop yields drastically decreased [16, 13, 5, 19]. In Nigeria, the scope of the land problem can be well conceptualized from the fact that, despite that the nation depends mainly on oil revenue since the 1970s, land remains the most important long term resource base for the direct and indirect support of plants and animals, which man uses [17].

This paper has the objective of determining the factors explaining agricultural land expansion in Nigeria. This will be done with an error correction mechanism (ECM), an approach that was first used by Sargan (1964) and popularized by Engle and Granger (1987). It is based on the behavioral assumption that two or more time series sometimes exhibit an equilibrium relationship that ultimately determines their short- and long-run behavior [4]. In order to therefore avoid getting spurious results if Ordinary Least Square (OLS) regression is used [6] analysis of time-series data requires appropriate specification of an ECM. The findings are expected to provide direction for Nigerian policy makers in their efforts towards addressing sustainable agricultural production in Nigeria.

Determinants of Agricultural Land Expansion

Barbier and Burgess (1996) noted that difficulty in obtaining data on forest cover or deforestation rates often leads to the analysis of deforestation indirectly through examining the factors explaining expansion of agriculture or other conversion activities. For example, many of the direct deforestation analysis have pointed to expansion of cropping and possibly livestock production as major factor underlying deforestation.

The use of time series data has encouraged the analysis of the factors determining the rates of agricultural land expansion at the country or cross-country levels. However, most of the available works are cross-country analyses. In Thailand, a study by Phantumvarit and Panayotou (1990) shows the complex linkage between agricultural crop prices, relative returns from different crops and demand for agricultural land. It was found that the most important factors affecting the demand for cropland, and forest conversion, were population growth, non-agricultural returns and agricultural price.

Southgate (1991) also provided a comparative analysis of twenty-four Latin American countries, which showed that there is a strong but indirect relationship between population pressure and forest expansion, and thus forest clearance. The results showed that increased yield growth determine agricultural land expansion. An important addition of the analysis was the inclusion of a land constraint variable, which showed that where there is little appropriate land available for conversion, the growth in arable land, and thereby forest clearance significantly reduced.

Barbier and Burgess (1996) studied the determinants of agricultural land expansion in Mexico using panel longitudinal data for planted agricultural area of 31 states of Mexico plus the Distrito Federal (Federal District) over the 1970, 1980 and 1985 time periods. It was found that relative maize/fertilizer prices and population were statistically significantly affected agricultural land expansion. It was stressed that it is expected that an increase in the relative returns from maize would have an important influence on the total agricultural area planted across Mexico, and therefore possibly on forest clearance. Population was explained to be associated with increased planted agricultural area because increased population could mean absorbing more people into the agricultural sector, thus putting more pressure on the land base, including the forests. Increased population also creates pressure on land indirectly through demand for food, fuel, fodder and other consumptive goods.

Barbier (2001) used a model synthesized from the Environmental Kuznet Curve (EKC), competing land model, forestland conversion model, and institutional

Table 1: Descriptive Statistics of Analyzed Variables (1961-2000)

Variable	Mean	Standard Deviation	Coefficient of variation
Agricultural land area ('000 ha)	70,485.25	43,779.66	62.11
Cocoa price (₦)	20121.34	37744.37	187.58
Gross Domestic Product ('₦000)	75612.19	25603.95	33.86
Cereal land growth (%)	0.15	16.21	10806.67
Tuber land growth (%)	4.01	9.06	225.93
Permanent cropland growth (%)	0.14	0.29	207.14
Crop production index	76.43	34.79	45.52
Livestock population ('000)	385927.30	214270.20	55.52
Human Population ('000)	68781.45	22893.33	33.28
Other land areas ('000ha)	5666.95	2516.64	44.40
Rainfall (mm)	1287.22	178.90	13.89
Fertilizer ('000 tons)	152546.30	147853.30	96.92
Tuber yield (kg)	92793.50	10506.54	11.32

Sources: computed from data from FAO database (www.fao.org) and Federal Office of Statistics, Nigeria.

Table 2: Average agricultural land area in Nigeria (1961-2000)

Period	Average agricultural land area ('000 ha)	Growth rate (%)
1961-1965	69004.00	0.15
1966-1970	69524.00	0.23
1971-1975	69920.00	0.04
1976-1990	70259.00	0.10
1987-1985	70710.20	0.23
1986-1990	71703.20	0.25
1991-1995	72580.20	0.06
1996-2000	70243.25	-0.57

Sources: Computed from data from FAO and Federal Ministry of Agriculture and Natural Resources, Nigeria.

model to estimate the determinants of agricultural land expansion in the tropical regions of the world. Across all the tropical countries, the structural variables appear to be more important factor explaining the expansion in agricultural land. Specifically, growth in agricultural land area increased with cropland share of total land area and agricultural export share, but declined with cereal yield. In Africa, the cropland share of total land area mainly explains agricultural land expansion. In Asia, increase in cereal production reduces expansion in agricultural land, and the EKC hypothesis could not be rejected.

Furthermore, Barbier (2001) included three institutional variables represented as a corruption index, a property right index, and a political stability

index. The results show that for all tropical countries, the EKC hypothesis was accepted. Also, population growth, the ratio of cropland to total land area, the share of agricultural exports and political instability all have positive and significant impacts on the expansion of agricultural land.

MATERIALS AND METHODS

The data

The data were the national aggregates obtained from secondary sources. The data cover the period 1961-2000. The major sources include several issues of the Production Yearbook published by the FAO, FAOSTAT web site (www.fao.org), the Federal Office of Statistics

(FOS) Annual Abstract of Statistics, and several issues of the Central Bank of Nigeria’s (CBN) Annual Reports and Statement of Accounts. Since the data used were from secondary sources, their level of accuracy is unknown, except that their values were confirmed in different sources/publications. All these form some of the limitations of the study.

Model Specification

Keele (2004) noted that the linkage between cointegration and ECM stems from the theory proposed by Granger. This theorem proposes that two or more integrated time series that are cointegrated have an error correction component, and the two or more time series that are error correcting are cointegrated [6]. Therefore, these concepts are isomorphic because each of them implies the other. Basically, a group of non-stationary time series data is co-integrated if there is a linear combination of them that is stationary. This implies that the combination does not have a stochastic trend. The linear combination is called the co-integrating equation. Its normal interpretation is long-run equilibrium relationship [9].

The order of time series data can be tested by using Dickey Fuller (DF) test or the Augmented Dickey Fuller (ADF) approach. However, ADF was used in this study because it normally gives a more accurate result.

The Augmented Dickey Fuller statistics is expressed as:

$$\Delta A_t = \phi_1 + \phi_2 T + \phi_3 A_{t-1} + \phi_4 \sum_{i=1}^m \Delta A_{t-i} + e_t \tag{1}$$

Where ΔA_t is the first difference of variable A in time t, T is a time trend variable, ΔA_{t-1} is lagged value of variable A_t in year t, ϕ_i are the parameter estimated and is the random error terms. Under the null hypothesis that $\phi_3=1$, the conventional computed t statistics is known as tau statistics which will have to be compared with Monte Carlo critical values which are always higher than the t- statistics values at any given level of significance [9]. If the null hypothesis is rejected, this implies that there is stationarity in the data.

Test of cointegration of land use model

Two variables are cointegrated if they are nonstationary at level, but there exists a linear combination between the two variables that is stationary. This is explained as follows:

$$A_t = \theta_1 + \phi X_t + v_t \tag{2}$$

$$v_t = A_t - \theta_1 - \phi X_t \tag{3}$$

If the error term is stationary, then variables A_t and X_t are cointegrated, v_t is I(0), and the trends in the two variables

cancel out. And they will be of the same wavelength if they are integrated of the same order. Therefore, if a series A_t is I(1) and another series X_t is integrated of I(1), they can be cointegrated. It therefore implies that regression on the level form of the variables is spurious, and valuable long-term information will be lost.

Two major methods of testing for cointegration are the Engel Granger [6] and Johansen methods [10, 11, 12]. This study used the latter method with Microfit 4.1 statistical software.

Co-integration model

When the variables are co-integrated, an ECM will be used, and the estimated model can be stated as:

$$\Delta A_t = \zeta_0 + \zeta_1 \Delta GC_t + \zeta_2 \Delta RP_t + \zeta_3 \Delta GR_t + \zeta_4 \Delta YR_t + \zeta_5 \Delta GDP_t + \zeta_6 \Delta Z_t + \zeta_7 \Delta AP_t + \zeta_8 \Delta HP_t + \zeta_9 \Delta OL_t + \zeta_{10} \Delta AR_t + \zeta_{11} \Delta R_{t-1} + y_t \tag{4}$$

Where:

- ζ_i , are estimated parameters
- A_t = agricultural land area (‘000 hectares) in year t
- GC_t = growth in cereal cropland area (%) in year t
- RP_t = cocoa price index in year t
- GR_t = growth in root and tuber cropland area (%) in year t
- YR_t = yield per hectare of roots and tuber crops (kg) in year t
- GDP_t = Agricultural Gross Domestic Product in year t
- X_t = quantity of fertilizers (‘000 tons) in year t
- GP_t = growth rate of permanent cropland (%) in year t
- Z_t = index of agricultural production in year t
- AP_t = animal population per hectare in year t
- HP_t = human population per hectare in year t
- OL_t = other land (‘000 hectares) in year t
- AR_t = annual rainfall (mm) in year t
- R_{t-1} = lagged residual error measuring long equilibrium adjustment (agricultural land) in year t
- y_t = random error terms in year t
- ζ_i is the long run equilibrium parameters which on the a priori should be less than 0 and the absolute value should be less than or equal to one. Two hypotheses were tested. The first states that there is no cointegration among the variables above, while the second states that agricultural land expansion is not positively influenced by human demographic pressures.

RESULTS AND DISCUSSIONS

Description of Agricultural Land

Table 1 shows some descriptive statistics of the variables included for the analysis. It reveals that while average

Table 3: Univariate stationarity properties of the variable series

Variables	ADF <i>Tau Statistics</i>	Inference	Variables	ADF	Inference
Agric Land	-0.858	I(1)	ΔA_t	-4.187	I(1)
Cereal crop Land growth Rate	-3.211	I(1)	ΔGC_t	-6.904	I(1)
Rural Consumer Price Index	-2.003	I(1)	ΔRP_t	-5.654	I(1)
Tuber crop Land Growth Rate	-2.643	I(1)	ΔGR_t	-6.367	I(1)
Tuber Yield	-2.866	I(1)	ΔYR_t	-4.222	I(1)
Agricultural GDP	-3.001	I(1)	ΔNI_t	-5.214	I(1)
Fertilizer	-1.562	I(1)	ΔX_t	-3.997	I(1)
Permanent Crop Land Growth Rate	-3.750	I(0)	ΔGP_t	-6.901	I(1)
Agricultural Index	-0.710	I(1)	ΔZ_t	-4.219	I(1)
Livestock Population	-2.768	I(1)	ΔAP_t	-3.933	I(1)
Human Population	-0.312	I(1)	ΔHP_t	-5.533	I(1)
Other Land	-1.404	I(1)	ΔOL_t	-4.052	I(1)
Annual Rainfall	-3.084	I(1)	ΔAR_t	-4.897	I(1)
A_{ut}	-3.994	I(0)			
Critical values -5%	-3.624			-3.899	

Table 4: Johansen multivariate cointegration test for agricultural land areas

Trace Test				Maximum Eigenvalue Test			
Ho	Ha	<i>Test Statistics</i>	Critical Value	Ho	Ha	<i>Test Statistics</i>	Critical Value
R = 0	r = 1	900.44	328.52	r = 0	r >= 1	285.22	74.61
R <= 1	r = 2	621.11	279.84	r <= 1	r >= 2	170.12	68.91
r <= 2	r = 3	436.71	234.98	r <= 2	r >= 3	102.56	63.32
r <= 3	r = 4	344.15	194.42	r <= 3	r >= 4	90.41	57.20
r <= 4	r = 5	236.26	150.21	r <= 4	r >= 5	70.41	51.15
r <= 5	r = 6	172.38	124.62	r <= 5	r >= 6	61.09	45.63
r <= 6	r = 7	115.45	95.87	r <= 6	r >= 7	42.12	39.83
r <= 7	r = 8	75.86	70.49	r <= 7	r >= 8	25.56	33.64
r <= 8	r = 9	42.27	48.88	r <= 8	r >= 9	18.24	27.42
r <= 9	r = 10	27.19	31.54	r <= 9	r >= 10	15.66	21.12
r <= 10	r = 11	11.15	17.86	r <= 10	r >= 11	10.26	14.88
r <= 11	r = 12	0.23	8.07	r <= 11	r >= 12	0.41	8.07

agricultural land area is 70,485,250 hectares, its variability index is 62.11 percent. Cereal land growth rates, permanent cropland growth rates and average annual cocoa prices have the highest variability, while tuber yield, average annual rainfall and human population have the lowest coefficient of variation.

Table 2 shows that average agricultural land area increased from 69,004,000 hectares in 1961-1965 to 72,580,200 hectares in 1991-1995, after which it declined to 70,243,250 hectares in the 1996-2000 period (see fig 1). This decline could imply that previously cultivated agricultural lands are now being converted into non-agricultural purposes. Agricultural land area has the lowest average growth rate of -0.57% in 1996-2000.

Determinants of agricultural land expansion and deforestation

In order to determine the factors influencing agricultural land expansion in Nigeria, an Error Correction Model (ECM) was used. The first step was to determine whether the series of variables at their present levels were stationary or not. Using the Augmented Dickey Fuller (ADF) methods, a conclusion was reached based on comparison of the absolute values of the computed statistics with the critical table values at the 5 percent level. Conclusion was made basically based on the significance of ADF test because of its superiority over some other methods [9]. The results of the analysis are in table 3.

The table shows that only the tau statistics of growth rates of permanent cropland and agricultural land error term are statistically significant at 5 percent level. Therefore the null hypothesis of non-stationarity has to be rejected, implying that they are stationary at level - I(0). However, for other variables included, the null hypothesis of non-stationarity was accepted because the absolute values of tau statistics are lower than the absolute values of the critical ADF value. Therefore, we proceeded to test whether they are integrated of order 1. Considering the stationarity of the first difference of the variables, the tests show that the series are stationary at 5 percent level.

In the next step, it was established whether cointegration exists among the variables or not. The Johansen test for cointegration was used. The results of the analysis are in table 4. This test yields two likelihood ratio test statistics, referred to as the trace test and the maximum Eigenvalue test, which were used to determine the level of cointegration of the data series. The study used both results to conclude on the sensitivity of the results to different tests. In the trace test, the null hypothesis that there are at most r vectors being cointegrated is tested against the general alternative, whereas in the maximum

Eigenvalue test, the null hypothesis of r cointegrating vectors is tested against the alternative of at least $(r+1)$ cointegrating vectors.

For agricultural land expansion results in table 3, the trace test $r=0$ was taken first, before the others were considered. The tests rejects the null hypothesis of no cointegration at 5 percent level until the null hypothesis of $r \leq 8$ where the trace test statistic (42.27) is lower than the critical value (48.88). This implies that at least 8 cointegrating vectors are in the model. Using the Maximal Eigenvalue, the results show that the null hypothesis of $r \leq 7$ will have to be rejected since the Eigenvalue statistics (25.56) is lower than critical value at 5 percent (33.64). The conclusion here is that there exist at least 7 cointegrating vectors in the variables. Although the two results have different implications, it can be concluded that there exists between 7 and 8 cointegrating vectors in the model. The existence of more than one cointegrating vector indicates that the system under examination is stationary in more than one direction and, hence, more stable. In sum, the Johansen test results suggest that there could be a long run steady state relationship among agricultural land and the included independent variables.

Table 5 shows the unrestricted error correction model for agricultural land expansion. The result shows that the included variables explained about 60.52 percent of the variations in the mean of agricultural land. However, the computed F statistics is 5.62 and it is statistically significant at 1 percent. This implies that the model produced a good fit for the data. First order autocorrelation is absent from the Durbin Watson statistics of 1.991, and multicollinearity was no problem from the low values of Variance Inflating Factor (VIF) and their high tolerance levels.

The parameters of the constant term, growth rate of cereal cropland, growth rate of permanent cropland, index of agricultural production, livestock population, human population, and other land areas are statistically significant at least at 10 percent level. The parameter of cereal cropland growth rates is 0.621 and it is statistically significant at the 1 percent level. This shows that if the growth rate of cereal cropland increases by 1 percent, agricultural land expansion will increase by 621 hectares. However, the parameter of tuber cropland growth rates is statistically insignificant at 10 percent. This shows that the drive to cultivate cereal crop results more in agricultural land expansion in Nigeria. In like manner, the parameter of permanent cropland growth rate is 68.622 and it is statistically significant at 5 percent level. This shows that if the rate of growth in permanent cropland increases by 1 percent, agricultural land areas will expand by 68,622 hectares. This finding suggests that growth in permanent

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Table 5: Unrestricted Error Correction Mechanism for agricultural land expansion in Nigeria

Variable	Unstd Coeff	T Statistics	Collinearity Statistics	
			Tolerance	VIF
Constant	221.250	5.025***		
Cereal Crop Land Growth Rate	0.621	3.215***	0.899	1.112
Rural consumer price index	-0.261	-1.492	0.812	1.231
Tuber crop land Growth Rate	0.389	0.901	0.905	1.105
Tuber Yield	-0.125	-0.539	0.803	1.245
Agricultural GDP	1.236	0.289	0.738	1.354
Fertilizer	-0.145	-0.871	0.847	1.180
Permanent Crop Land Growth Rate	68.622	2.220**	0.824	1.214
Agricultural Index	10.236	3.036***	0.788	1.269
Livestock Population	0.004	2.940***	0.621	1.610
Human Population	-0.145	-2.561***	0.734	1.362
Other Land	-0.265	-3.054***	0.589	1.695
Rainfall	0.654	1.492	0.701	1.418
Lagged Error Term	-0.235	-1.352	0.781	1.280
DW = 1.991		Adj R ² = 0.605	F = 5.620***	

Note **Statistically significant at 5 percent
*** Statistically significant at 1 percent

Table 6: Restricted Error Correction Mechanism for agricultural land in Nigeria

Variable	Unstd Coeff	T Statistics	Collinearity Statistics	
			Tolerance	VIF
Constant	122.210	6.035***		
Cereal crop Land growth Rate	0.485	3.201***	0.897	1.115
Fertilizer	-0.000	-0.960	0.824	1.214
Perm Cropland Rate	60.123	2.240**	0.739	1.354
Agricultural Index	7.314	3.205***	0.818	1.223
Livestock Population	0.001	3.066***	0.867	1.154
Human Population	-1.519	-1.905*	0.791	1.264
Other Land	-0.062	-3.346***	0.861	1.162
Rainfall	0.080	1.713*	0.615	1.625
Lagged Error Term	-0.426	1.702*	0.891	1.122
DW = 2.025		Adj. R ² = 61.220	F = 6.021***	

Note * Statistically significant at 10 percent
**Statistically significant at 5 percent
*** Statistically significant at 1 percent

cropland areas contributes the most to agricultural land expansion. This can be explained from the fact that in most cases, land used for cultivating cereal and tuber crops, and even vegetables are those already used over time, while most cash crops especially cocoa requires virgin forest which would be an addition to overall agricultural land areas. The standardized coefficient of the parameter of permanent cropland variable is 0.28, which make it the fourth most important variable. Hypothesis two for agricultural land expansion has to

be rejected because livestock population per hectare and human population per hectare have parameters of .00362 and -145.236 respectively both being statistically significant at 1 percent level. Phantumvarit and Panayotou (1990) found a positive relationship for human population in a cross country analysis. However, this finding implies that increasing human population will lead to decline in the agricultural land areas, while increasing livestock population will result into increase in agricultural land areas. This is expected because when livestock population

increases, the demand for permanent pasture increases, while increase in human population can make available agricultural land to be converted into urban estate and industrial areas. In many rural areas, scarcity of land does not make agricultural land to respond positively to increase in human population. What happens is that farm fragmentation is promoted as children inherit their parents' land or even take charge of the farm operations as the farmers grow older.

The parameters of index of agricultural production is 10.236 being statistically significant at 1 percent. The finding goes in line with that of Southgate (1991), and it buttresses the point that a major factor for agricultural land expansion is the need to increase agricultural production as the nation develops. For a nation like Nigeria that is largely agrarian, realization of the potentials for ensuring economic growth and development through promotion of non-oil sector

will result in agricultural growth and expansion in the agricultural land areas.

Other land parameter is -0.265 and it is statistically significant at 1 percent level. This implies that agricultural land areas will decline as land areas devoted to housing and urban development increase. This goes in line with expectation because most of the land normally used for school construction, construction of industries, house building, road construction etc. were previously used for agricultural activities. In some cases, governments have had to compensate families for using their lands for such purposes listed above.

The restricted model was estimated with those variables that were statistically significant in unrestricted model along with some other ones closer to being significant. The results for agricultural land are presented in Table 6. The included variables explained 61.22 percent of the variations in mean value of agricultural land. The results

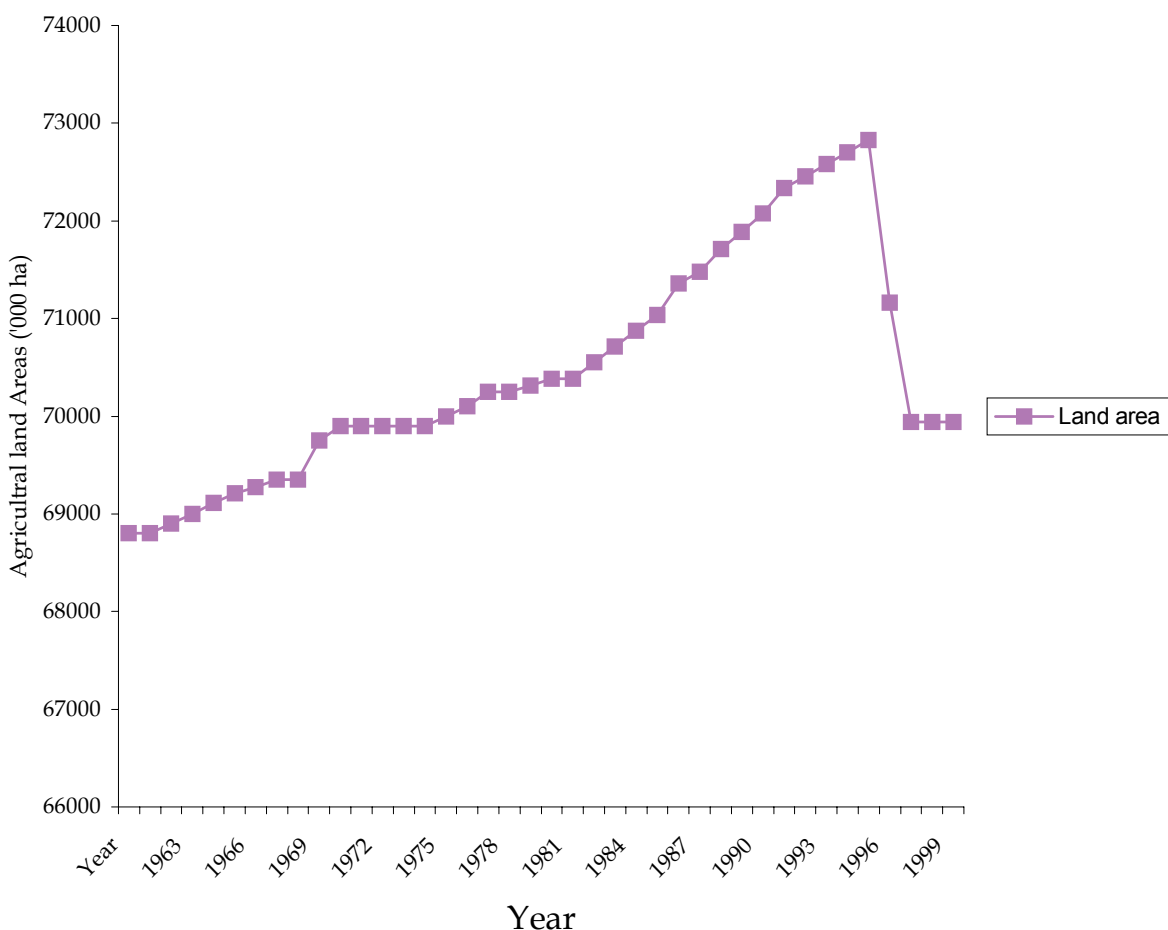


Figure 1: Agricultural Land Areas in Nigeria (1961-2000)

are similar to that estimated for unrestricted model except that the rainfall and lagged error term parameters are both significant at 10 percent. The statistical significance of the error correction term, which measures the speed of adjustment to past shocks in equilibrium, is noted. It implies that the variables in agricultural land model have strong tendency to adjust to their disequilibrium by moving towards the trend values of their counterparts. Also, increasing rainfall will lead to expansion in agricultural land areas. This is expected because rain is a necessary input for agricultural production. Droughts often discourage agricultural production. When there is no rain, no areas expansion could be had.

Policy implications and recommendations

Agricultural production in Nigeria seems to be largely dependent on expansion of land areas harvested. This poses a lot of threat to increased production due to gradual decline in availability of land and extension of crop production to marginal lands. For policy implementation, this study identified some important factors responsible for expansion of agricultural land areas in Nigeria.

Increase in the land areas used for other purposes like housing, industrial development etc. will significantly reduce available land for agricultural uses. This implies that as urban development continues, land areas available for agricultural production will decrease. Appropriate policies to protect available land areas in favour of agricultural production must be put in place. This should clearly identify the type of land that could be massively cleared for urban development. Situations where fertile lands are converted for needs which could have been met by some other marginal lands should be avoided.

Also, expansion in cereal and cash crop production will lead to significant increase in expansion of agricultural land. Policies that encourage the production of cash and cereal crops will therefore have lead to agricultural land expansion. There is therefore the need to encourage and strengthen research on cereal crops. Most Nigerian cereal crops thrive well only on fertile land, and development of hybrids that are high yielding and resistant to environmental stress will go a long way in assisting farmers to get high yields from available degraded farm land instead of clearing forests.

Human population growth negatively affects agricultural land areas expansion. Falusi (1997) noted that most of recent growth in agricultural production resulted from increase in land areas. Without adopting a workable population control policy, provision of food to meet the needs of the growing population is therefore threatened.

Increase in rainfall will lead to increase in agricultural land expansion. This puts a lot of challenge

on Nigerian industries and households by making sure that activities that can lead to distortion of weather should be avoided. One of the major concerns in Nigeria now is depletion of the ozone layer. The regulatory bodies implementing the environmental safety program of the nation should be strengthened on the way of monitoring indicators in Nigeria. Companies found to be involved in environmentally hazardous activities should be sanctioned by constitution.

In conclusion, this study provides an econometric analysis of the determinants of agricultural land expansion in Nigeria. The impetus for doing this is to understand the key driving forces for agricultural land expansion and develop some policy thrusts for addressing the phenomenon. Because, agricultural land expansion indirectly analyzes the processes of deforestation, the Nigerian policy makers and concerned stakeholders should develop appropriate framework for ensuring increased agricultural production while protecting the remaining forest stock.

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