Modelling Demand and Supply of Cocoa Produce in Nigeria using Regression Method

B. Kareem, O.O. Awopetu, P.K. Oke, B.O. Akinnuli, S.P. Ayodeji, P.B. Mogaji

Abstract—**Nigerian agro-allied industries are suffering from inadequate supply of raw material for the effective operation of their plant. This has impeded production output and many factory workers lost their jobs as a result of low turnover. Nigerian cocoa products industries were badly affected and they contributed immensely to Nigerian economic development through conservation of foreign exchange. Cocoa, a major raw material for cocoa products industries, was cultivated by peasant farmers and the quantity been produced was greatly affected by a number of factors including population of farmers, climate, microeconomic policy, global trading environment, and developmental assistance. Cocoa user-industries' population, income, and price had high influence on demand rate. A framework is required that will properly related the afore-stated supply and demand influencing factors such that appropriate actions are taken in meeting the future need of cocoa produce. In this study, cocoa produce supply and demand were modeled using multiple regression method. First, relationships among supply and other influencing factors (percentage changes in population of farmers, climate, and level of mechanization) were established, then the demand and its factors (percentage changes in population of customers, income and price). Second, coefficient of determination and standard errors were determined using Statistical Software for Social Sciences (SPSS). The modelling results and the observed data were highly corrected and they explained over 90 % of what was taking place in the system. This showed that demand and supply can be predicted accurately using the established relationships among the influencing factors. Percentage changes in price and level of mechanization were found to be dominant factors that were easily controllable through legislation and policy.**

Index Terms—**Cocoa supply and demand, influencing factors, modelling, regression method.**

B. Kareem is with the University of Benin, P.M.B. 1154, Benin City, Nigeria, on sabbatical leave from the Federal University of Technology, P.M.B. 704, Akure, Nigeria (phone: +234-803-373-7251; email: karbil2002@yahoo.com, bkareem@futa.edu.ng).

O.O. Awopetu, is with the Federal University of Technology, P.M.B. 704, Akure, Nigeria (e-mail: ooawopetu@futa.edu.ng).

P.K. Oke is with the Federal University of Technology, P.M.B. 704, Akure, Nigeria (e-mail: okekayode2002@yahoo.com).

B.O. Akinnuli is with the Federal University of Technology, P.M.B. 704, Akure, Nigeria (e-mail: ifembola@yahoo.com).

S.P. Ayodeji is with the Federal University of Technology, P.M.B. 704, Akure, Nigeria (e-mail: ayodejisesan@yahoo.com, spayodeji@futa.edu.ng).

P.B. Mogaji is with the Federal University of Technology, P.M.B. 704, Akure, Nigeria (e-mail: pbmogaji@yahoo.com).

I. INTRODUCTION

Agriculture deals with production of crops and animals using factors such as land, labour and capital. Economic principles are applied to agriculture from the point of view of producer, the consumer, and the nation. Therefore, agriculture that involved the cultivation of cash-crops such as cocoa requires adequate knowledge of the management of these factors of production to be able to survive in a competitive environment. Global market forces and laws of demand and supply must be understood in relation to cocoa production before one can really determine the level of foreign exchange expected from it.

The farmers are not in control of many complex economic factors influencing the production of cocoa. For instance, an announcement of higher price of cocoa beans may be advantageous to the farmer, whereas lifting of ban on the importation of it may adversely affected farmers' income. With this income reduction, cocoa farmers may have less interest, which may lead to reduction in the population of cocoa farmers. Political instability and regular attacks in Nigeria, especially in the Niger Delta areas, have adversely affected the oil sectors, which dominated the economy, and accounted for about 96 % of the Nigeria's total exchange earnings [1]-[6]. In the recent time attention has been diverted from oil sectors to agricultural sectors (that is year 2000). Agriculture as contributed up to 41.5 % to the Gross Domestic Production (GDP). The GDP from the agriculture was the highest compared with other sectors of economy, including oil and gas, and distribution trade with 10.4 %, and 11.6 %, respectively [5], [6]. The export revenue from the cocoa produce has increased from ₦2.85 billion in 1990 to ₦ 19.97 billion in 2000 [3], [4]. Naira, ₦ is the symbol for Nigeria currency.

However, agriculture has not fully performed its expected role in Nigeria, in the areas of: provision of raw material to the industrial sector; provision of employment opportunity; generation of foreign exchange; ensuring food security; and growth of economy. Many obstacles (factors) are on the way to the realization of the role of agriculture in Nigeria, namely: internal factors (climate change, micro-economic, and agriculture sector policies); and external, such as global trading environment and developmental assistance [7]-[10]. These factors have adversely affected the growth of agriculture in Nigerian. Many youths are not interested in taking agriculture as job. This has led to youths' unemployment of about 90% [8], [9], [11]. Over ₦ 15 billion earnings from crude oil has not solved the problem of unemployment [3]. Raw materials for goods production are not adequate in many agro-allied industries [4], [8], [9].

In order to solve the problem of foreign exchange earning,

cash-crop such as cocoa produce is targeted as a good replacement for crude oil. A framework is hereby developed that modeled the identified factors in order to predict the supply and demand of cocoa.

II. METHODOLOGY

Factors that influenced the supply and demand of cocoa produce were identified. These included climate, micro-economic policy, global trading environment, developmental assistance, among others. The factors were grouped into: climatic, price, and population changes for cocoa produce demand; and population, weather, and level of mechanization, for supply. Structured questionnaire were prepared and administered among the Nigerian cocoa farmers, agro-allied industries, and research institutes in identified 13 states where cocoa produce are abundant. The states covered were Ondo, Osun, Edo-Ekiti, Cross-Rivers, Ogun, Lagos, Delta, Rivers, Anambra, Adamawa, and Oyo. Demand data were collected from 2001 to 2006 for the affected states, average of which were taken to represent the observed demand of cocoa produce in each state.

The percentage changes in annual population of customers, price and income were also obtained from cocoa research institution of Nigeria [6]. Data were collected in similar way for supply of cocoa produce by farmers (Table I). In this case, information was obtained on percentage changes in annual population of customers, weather and mechanization level. Average supply per state was also estimated. The data obtained were subjected to multiple linear regression analysis using Statistical Package for Social Sciences (SPSS) for Window^R from which multiple regressing model parameters were estimated. The demand of cocoa was modeled as (1) while that of supply was (2):

$$x_d = a_0 + a_1 x_1 + a_2 x_2 + a_3 x_3 + a_4 x_4 \qquad (1)$$

$$y_s = b_0 + b_1 y_1 + b_2 y_2 + b_3 y_3 + b_4 y_4 \qquad (2)$$

Where:

x_d = quantity of cocoa produce demanded (in million metric tons.) annually

x_1 = annual percentage changes in population of customers

x_2 = annual percentage change in price of cocoa

x_3 = annual percentage change in income of customers

x_4 = period (in years) of demand consideration.

y_s = quantity of cocoa produce supplied (in million metric tons.) annually

y_1 = annual percentage changes in population of farmers

y_2 = annual percentage change in weather condition

y_3 = annual percentage change in level of mechanization

y_4 = period (in years) of supply consideration.

a_0 ... a_4, b_0 ... b_4 are coefficients of regression models for demand, and supply, respectively; and to be determined

from SPSS analysis. Coefficients of determination (R^2) were also obtained for both demand and supply models using the same statistical software package. The agreement of theoretical results (from the models) with the observed data was indicated by the values of R^2 [12].

III. RESULTS AND DISCUSSION

The average output of 94.3 million metric tons of cocoa produce was supplied by each of the 13 States to the customers in year 2001. It was increased to 138.7 million metric tons in 2006 (Table I). The output would have been more than recorded, but reduction was due to inadequate facility for mechanization and storage. Low population of farmers, and poor climate was prompted by low capital outlay to control them. Demand of cocoa from agro-allied industries located in-house and abroad also followed similar trend. In this case, the demand of cocoa produce was deeply influenced by change in price, income and the customers' population (Table I). The data on demand and supply with their respective influencing factors were modeled as (1) and (2), with R^2, 0.999 and 1.000, respectively, using SPSS software package.

$$x_d = 124.198 + 10.780 x_1 + 3.037 x_2 + 1.893 x_3 + 3.187 x_4 \qquad (1)$$

$$y_s = 113.037 + 11.362 y_1 + 3.067 y_2 + 1.312 y_3 + 7.642 y_4 \qquad (2)$$

The parameters are as defined before.

The results of the theoretical data from demand and supply models, and observed data were plotted, and shown in Figs. (1), and (2), respectively. The values of R^2, 0.999 and 1.000 showed that there was strong agreement between the theoretical and the observed data. Therefore, the models are good predictors of demand and supply of cocoa produce.

Table I: Annual Demand and Supply of Cocoa Produce (in Million Metric Tons.)

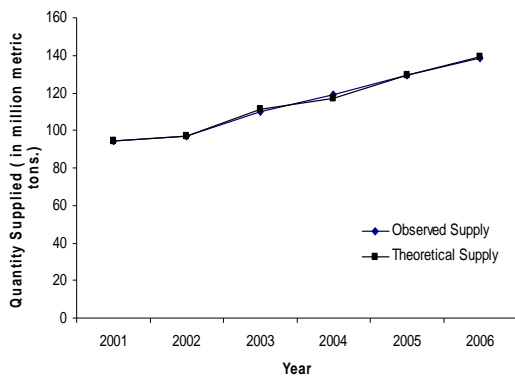| Year	Number	Observed	Theoretical	Observed	Theoretical
2001	1	94.3	94.56	94.3	91.69
2002	2	96.9	96.89	104.6	106.22
2003	3	110.1	111.40	110.4	112.03
2004	4	119.1	116.90	119.0	120.45
2005	5	129.2	129.70	128.5	129.45
2006	6	138.7	138.94	138.6	135.27

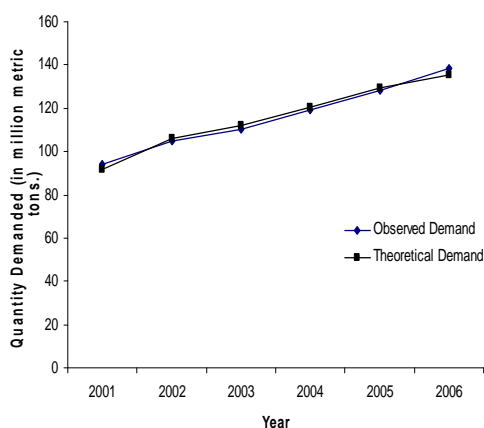**Fig. 1: Relationship between Observed and Theoretical Quantity of Cocoa Supplied**

Fig. 2: Relationship between Observed and Theoretical Quantity of Cocoa Demanded

REFERENCES

[1]   T. Antimo, "Food Problems and Nutrition Situation in Nigeria", *Nutrition and Food Policy in Nigeria*, NIPSS, Jos, Nigeria, 1983.
[2]   CBN, "Central Bank of Nigeria", *Annual Reports and Statement of Account*. Dec, 2000a, Lagos, Nigeria.
[3]   CBN, "Central Bank of Nigeria", *Statistical Bulletin*, Lagos, Vol. 11, No. 2, 2000b. p 89.
[4]   CBN, "Central Bank of Nigeria", *Statistical Bulletin*, Lagos, Vol. 11, No. 2, 2000c. pp 116-117
[5]   CBN, "Central Bank of Nigeria", *Monetary Policy Circulation,* Lagos, No. 35, 2001.
[6]   CBN, "Central Bank of Nigeria", *Annual Reports and Statement of Account,* Lagos, Dec. 2002, pp 53-56
[7]   C.O. Enwonwu, "Nutrition Requirements and Nutrition Status of Nigerians", *Nigerian Journal of Nutrition Science*, Vol. 1, 1980, p 98.
[8]   FAO, "Production Year Book", Vol. 1, 2001, p 55
[9]   FOS, "Federal Office of Statistics", *Abstracts of Statistics*, , Abuja, Nigeria, 1999.
[10] J.S. Oguntoyinbo, "Irrigation and Land Reclamation Projects in Nigeria", *Agricultural Journal*, Vol. 7, No 1, 1981. pp 53-69.
[11] S. Langermann, "Food Insecurity, the WHO and Trade Liberalization in Agriculture: Introduction", *Quarterly Journal of International Agriculture*, Vol. 39, No 4, 2000, pp 339-342.
[12] A.A. Aderoba, *Tools of Engineering Management, Vol 1, Engineering Project Management*, Ondo: Besade Publishing Press, Nigeria, 1995.

IV.   CONCLUSION

It was established that cocoa supply and demand have been affected by a number of factors ranging from climate to population, income, price, and mechanization level. It was also established that the variations in the identified demand and supply influencing factors can be effectively modeled using multiple linear regression approach. A good relationship was obtained for supply and demand with their respective influencing factors. The obtained coefficient of determination R^2 established that more than 99% of what was taking place in the system was explained by the models.

It can be generally concluded that private and public sectors should make agricultural machinery available for the interested farmers, as inadequate supply of such machinery had effect on the quantity of output of cocoa. There was downward percentage change in level of mechanization over the years. Percentage change in price was also decreased steadily over the years. Something must be done on this to improve the lot of cocoa farmers in order to increase supply, income and population.