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Cocoa Production and Related Social-Economic and Climate Factors: A Case Study of Ayedire Local Government Area of Osun State, Nigeria

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Abstract

Cocoa has been a major source of income for many Nigerians and a major source of foreign exchange earnings for the country. However its production has been experiencing a declining trend in recent times. Many factors have been implicated. One major factor is changes in climate variables. This study therefore investigates into the socio-economic effects of some climate variables on cocoa production and aims at guiding policy makers in drawing policies that will mitigate the effect of these variables. The study was carried out in Ayedire Local Government Area (LGA) of Osun State. Data were collected with the aid of structured questionnaire employing interview schedule. One hundred cocoa farmers registered with the state's Cocoa Growers Association (CGA) were randomly selected from four major cocoa growing areas of the L.G.A. The data set was then analyzed using descriptive statistics and regression techniques. The study found that major climate variables affecting cocoa production were rainfall, sunshine and temperature. Other factors observed was ageing cocoa tree and the prevalence of pest infestation and disease emergence occurring as the result of climate variation thereby causing yield reduction as well as loss of income. In the short run, enactment and implementation of policies that can mitigate the adverse impact of climate variations can help to improve the yield of cocoa, thereby increasing the producers' income and consequently boost their living standard. In the long run, conscientious efforts should be made to educate and train the minds of all towards safety and best practices for the prevention of climatic adversities.

Keywords: climate variations, cocoa, impacts, mitigation, mind training, climatic adversities

1. Introduction

1.1 Agriculture in the Economy of Nigeria

Agriculture is the largest and oldest industry in the world. It is a vital sector of the Nigerian economy, supplying food for the population and providing raw materials for the industry. Its role in the provision of foreign exchange cannot be overstated as it remained for a long time, the main machine for the earnings. In terms of sustainable employment, agriculture is by far the most important sector of Nigeria's economy, engaging about 60% of the labor force (Central Bank of Nigeria [CBN], 2003).

About 30.7 million hectares (76 million acres) or 33% of Nigeria's land area are under cultivation (www.nationencyclopedia.com (Africa) Nigeria- Agriculture.html). Nigeria's diverse climate, from the tropical areas of the coast to the arid zone of the north, make it possible to produce virtually all agricultural products that can be grown in the tropical and semitropical areas of the world.

A few years after independence in 1960, and up till 1970's, the percentage contribution of the agricultural sector to Gross Domestic Product (GDP) was 61.5%. Nigerian agriculture remained the core and mainstay of the economy, with the country ably sustaining her population and even having surplus food for export. Crops that were exported included cocoa, rubber, coffee, palm kernels, cashew nut among others and they contributed reasonably to the country's Gross National product (GNP). Agriculture contributed 32% to GDP in 2001(Ayorinde, 1966; CBN, 2003).

1.2 The Status of Cocoa in Nigerian Agriculture

Cocoa is the leading non-oil foreign exchange earner in Nigeria, however, growth in the sector has been slow since the abolition of the Nigerian Cocoa Board in 1986 (Folayan, Oguntade, & Ogundari, 2006). The dominance of smallholders in the cocoa production sector and the lack of farm labor due to increased rate of urbanization held back production. Nigeria has the potential to produce over 300,000 tons of cocoa beans per year, but production only amounted to 145,000 tons in 1999 (Nigeria Agriculture Stats, 2014). Low yield, ageing trees, and lack of proper equipment have been identified to inhibit production (Iremiren, 2011).

The contribution of the agricultural sector to the Nigerian foreign earnings had fallen from 62% before the discovery petroleum to less than 3% in the 1990s (CBN, 2003). Despite the decline in the sector's contribution, cocoa still stands tall for its significance in foreign exchange earnings coming second after petroleum. Cocoa is an important generator of income for most rural farmers in Nigeria especially in the South West and serves as a backbone for their livelihood. However, in recent times, Nigeria has slipped from being the world's second largest producer to the fifth position, behind Cote d'lvoire, Ghana, Indonesia and Cameroon with a production figure of 160 thousand tonnes representing 4.6% of the world production in 2006-2007 seasons (International Cocoa Organization [ICCO], 2005). Reasons elicited for the reduction in production included; less emphasis on agriculture, inadequate government program on agricultural input subsidy such as chemicals and planting materials, small farm sizes, inadequate capital, inadequate labour availability and most importantly, change in global climate (Oduwole, 2004).

Given its inherent link to natural resources, agricultural production is at the mercy of uncertainties driven by climate variation, including extreme events such as flooding and drought. Over the last fifteen years, climate change (in terms of long-term changes in mean temperature or precipitation, as well as an increased frequency of extreme climate effects) has gradually been recognized as an additional factor which, with other conventional pressures, will have a significant weight on the form, scale, and spatial and temporal impact on agricultural productivity.

Some of the most important impacts of global climate change will be felt among the populations, predominantly in developing countries. Their vulnerability to climate change comes both from being predominantly located in the tropics, and from various socioeconomic, demographic, and policy trends limiting their capacity to adapt to change (Morton, 2007).This study therefore tries to find the socio-economic impacts of these climate variations on the production of cocoa in Ayedire Local Government Area of Osun State.

1.3 Climate Variables and Cocoa Production: An Overview

Climate is the state of atmosphere that is created by weather events over a period of time. Climate change in Intergovernmental Panel on Climate Change (IPCC) usage refers to any alteration/change

in climate over time, whether due to natural variability or as a result of human activity (Parry, Canziani, Palutikof, van der Linden, & Hanson, 2007). Climate change has wide-ranging effects on the environment, and on socio-economic and other related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity and coastal zones. This is because it poses serious environmental threats to mankind worldwide and affects agriculture in several ways including its direct impact on food production (Ziervogel *et al*, 2006). The impact of climate change which is attributable to the natural climate and human activities is global but mostly felt by developing countries especially those in Africa, due to their low level of coping capabilities (Jagtap, 1995).

Cocoa was introduced into Nigeria in 1874 (Opeke, 1987) and has since gained prominence rapidly in the country such that in the early seventies, cocoa production has spread to all the agro-ecological zones in Nigeria. Presently, fourteen of the thirty six states produce cocoa in the country; they include Ondo, Cross River, Osun, Ekiti, Ogun, Oyo, Edo, Delta, Kwara, Kogi, Abia, Taraba, Adamawa and Akwa Ibom (Oluyole & Sanusi, 2009). Cocoa has contributed to the economy of the country over the years and gained popularity because of the benefits from its earnings and its contribution to Gross Domestic Product (GDP) as the highest foreign exchange earner among all agricultural commodities (Oyekale, Bolaji, & Olowa, 2009) . However, the modest growth in cocoa subsector has been traced among other things to include favorable weather conditions.

Cocoa is highly sensitive to changes in climate, particularly to temperature due to its effects on evapo-transpiration (Anim-Kwapong & Frimpong, 2005) and is known to thrive well with minimal but sustained water availability throughout the year (Obatolu & Esan, 1999). Meanwhile, yearly variation in the yield of cocoa is affected more by rainfall than any other climatic factors. Cocoa prefers calm conditions and persistent moderate wind can cause severe damage to yield. Thus being a selective plant, cocoa reacts badly to any incidence of extreme weather (Wood & Lass, 1985).

The International Cocoa Organization (2005) described extreme weather to include weather phenomena that are at the extreme of the historical distribution and observed that temperature and rainfall are important factors that impacts on optimum yield. This occurs when changes in weather element alter stages and rate of development of cocoa, cocoa pests and pathogens, modify host resistance and result in changes in the physiology of host pathogens and pest interaction, causing shift in the geographical distribution of host. This ultimately results in low cocoa yield and crop losses and a resultant effect on socio-economic variables such as farm income, livelihood and farm level decision making. However, basic skills in cocoa production, coupled with an optimum motivation, are sensitive requirements for best practices and consequently high quality yield of cocoa (Ajewole & Iyanda, 2010).

This is worrisome because agriculture (especially cocoa production) plays a significant role in supporting the livelihoods of individuals and economic growth of many African countries (Obatolu, Fashina, & Olaiya, 2003; Lawal & Emaku, 2007). High dependence on agriculture and the predicted high negative impact of climate change on productivity of agriculture draws a bleak picture of rural and national economies of most West African states.

1.4 Methodological Concept: A Synthesis from the Literature

Nhemachena and Hassan (2007) analyzed determinants of farm-level climate adaptation measures in Africa using a multinomial choice model fitted to data from a cross-sectional survey of over 8000 farms from 11 African countries. The results indicated that specialized crop cultivation (mono cropping) was the agricultural practice most vulnerable to climate change in Africa. The decision processes by farmers to adopt a new technology require more than one step; models with two- step regressions are employed to correct for the selection bias generated during the decision-making processes (Deressa, 2009).

Apata, Samuel, and Adeola (2009) used the Logit model to analyze the determinants of the perception and adaptation to climate change among arable crop farmers in southwest Nigeria. Low outputs from farms were observed resulting from low rainfall and increased temperature; farmers had shifted from mono-cropping to mixed crop-livestock systems as a way of coping. Farmers in the area of study relied on rain fed agriculture, while considering risky, mono-cropping practice under dry land.

Oyekale *et al.* (2009) investigated the effect of climatic variables in cocoa seedling raising, production and processing and also assessed the degree of vulnerability and coping strategies adopted by the farmers and observed that rainfall, temperature and sunshine were the most important climatic factors that affect cocoa production.

Ogunsola and Oyekale (2013) used Ordinary least square regression and principal component analysis in their study on determinants of small-holder cocoa farmers adaptation to climate change in Ile-oluji/Oke-igbo Local Government Area in Ondo state and observed that 35.8% of cocoa farmers noticed extremely high temperature, 24.2% noticed extremely low temperature and 85.2% of the farmers noticed too much rainfall and efforts mostly used to cope were re-spray of cocoa and regular cocoa spraying (50.53%). Adaptation significantly increased (p<0.05) with household size, farmers' awareness of climate change and access to information through radio. They suggested that efforts at reducing the impacts of climate change on cocoa production should focus on communicating climate change-related information to farmers through several media.

Oluyole and Sanusi (2009) in their work on overview of the trend of climate change and its effects on cocoa production in Nigeria observed that there was a significant correlation between cocoa output and rainfall as well as cocoa output and humidity and recommended that in as much that rainfall significantly affected cocoa output, irrigation facility should be provided to make water available especially during the dry season. This will make water to always be available year round so as to boost cocoa production.

Some of the most important impacts of global climate change will be felt among the populations, predominantly in developing countries. Their vulnerability to climate change comes both from being predominantly located in the tropics, and from various socioeconomic, demographic, and policy trends limiting their capacity to adapt to change (Morton, 2007).This study therefore tries to find the socio-economic impacts of these climate variations on the production of cocoa in Ayedire Local Government Area of Osun State.

2. Materials and Methods

2.1 The Study Area and Sampling Procedures

Ayedire Local Government Area comprises three major towns, Kuta, Ile-ogbo and Oluponna. Farming is the predominant economic activity of the people in the area (75%). Cocoa is a major cash crop cultivated in the area solely or in combination with other agricultural crops such as coffee, cassava, palm oil, kola nut, maize, pineapple and yam. The Local Government Area has a population of 120,392 (National Population Census [NPC], 2006). The data used for the current study were collected through interview schedule using structured questionnaire on cocoa farmers registered with the Osun state Cocoa Growers Association (OSCGA) in the study area. Purposive sampling technique was employed in selecting four villages noted for high volume of cocoa production, so also the cocoa farmers for the study. One village was selected in each of the three major towns while two were selected in Ile-ogbo, the L.G.A. Headquarters. Selection was based in proportion to the number of villages under each major town. A total of 100 farmers were selected randomly for the study, 25 from each of the villages. The villages are Osunwoyin, Eleji, Abimbola and Agba.

2.2 Statistics and Data Analysis

Data were analyzed using descriptive statistics and multiple regression analysis. Multiple regression was employed in the analysis of the main objective of the study, to determine the Socio-economic effect of some climate variables on cocoa yield as related to fertilizers used. Three functional forms of regression equation were specified for the analysis. These are Linear, Semi-log and Double- log functions.

The general form of the regression is expressed as:

$$YL= f(X_1,X_2,X_3,X_4,X_5,X_6,U_i).$$

where:

YL= Yield of cocoa last season (tonnes).

X_1 = Quantity of fertilizers used (Kg)

X_2= Number of hired labour (man-days, 1 man-day=8hours).

X_3= Number of family labour (man-days).

X_4=Age of cocoa farm (years).

X_5= Size of cocoa farm (acres).

X_6 = Extra hour spent on re- spray after unpredicted rainfall.

U_i = Error term.

The functional forms are expressed as follows:

Linear:

$$YL= \beta_0 +\beta_1X_1+ \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5+ \beta_6X_6 + U_i$$

Semi-log:

$$YL= Ln\beta_0 +\beta_1LnX1+ \beta_2LnX_2 + \beta_3LnX_3 + \beta_4LnX_4 + \beta_5LnX_5+ \beta_6LnX_6 + LnU_i$$

Double-log:

$$LnYL= Ln\beta_0 +\beta_1LnX1+ \beta_2LnX_2 + \beta_3LnX_3 + \beta_4LnX_4 + \beta_5LnX_5+ \beta_6LnX_6 + LnU_i$$

3. Results and Discussion

3.1 Socio-Economic Characteristics of Respondents

Table 1 shows the socioeconomic characteristics of respondents. 90.5% of the respondents were male. Few females were into cocoa farming, revealing that males were mainly the carriers of responsibilities of household needs. They therefore need engagement in gainful occupation like cocoa production to cope. Women are limited in this regard due to the customary belief in the study area that they must be in-door and their work is in the kitchen only. This conventional belief has however been proved wrong as a result of modern civilization. Majority of the farmers were married (67.4%), about 15.8% with more than one wife, a few were single (5.3%), while the rest were widowed. This implies that people involved in cocoa farming have sufficient responsibilities that could necessitate their commitment to their chosen occupations. Farmers within the age range of 41-60 years were of the highest frequency with mean age of about 55 years while the modal age was 45 years. The implication of this is that most of the farmers were getting too old and might find it difficult to meet the demands which the intensive care of cocoa farms required. In addition young and energetic people were scarce in the industry. This unfortunate trend if not checked might pose a

danger of extinction to cocoa farmers in the near future. Majority of the farmers were non literates with 36.8% of the farmers having no formal education. About 22% completed primary education and 25.3% possessed secondary education. Those with post-secondary education were 15.8%. This is suggestive of the level of neglect/rejection of the occupation by educated people who migrate to the towns and cities in search for 'white and blue collar jobs'. This could further affect productivity level negatively since new technologies and discoveries to improve the farm yield positively may not be readily accepted by non-literate farmers.

Table 1. Socioeconomic characteristics of cocoa farmers in Ayedire local government area of Osun State

Socioeconomic Characteristics	Frequency	Percentage
Sex		
Male	86	90.5
Female	9	9.5
Total	95	100
Age (in years)		
Less than 20	2	2.1
20 – 40	13	13.7
41 – 60	49	51.6
61 – 80	26	27.4
Above 80	5	5.2
Total	95	100
Marital status		
Single	5	5.3
Married with one wife	64	67.4
Married (polygamous)	15	15.8
Widow	8	8.4
Widower	3	3.2
Total	95	100
Educational level		
No formal education	35	36.8
Primary education completed	21	22.1
Secondary education completed	24	25.3
Post-secondary education	15	15.8
Total	95	100

Source: Field survey, 2010.

3.2 Farm Characteristics of Respondents

Table 2 shows the farm characteristics of respondents. Most of the farmers in Eleji cultivated highest farm size of 22.2acres while in Abimbola, Osunwoyin and Agba villages farmers on the average had 15.4, 10.05 and 9.3 acres respectively. The modal farm size across board was about 5

acres, implying that the farmers were relatively large scale cocoa producers. Oduwole (2004) identified ageing cocoa farms as one of the factors responsible for the decline in cocoa production in South West Nigeria. He showed that most of the farms were old and with sparsely populated plantations. Farms of about 50 years of age were most common. The inferences from his findings were: first, most of the plantations had exceeded their useful economic life, generally taken to be 30 years. Second, relatively new plantations were not adequate enough to effectively replace the ageing ones.

Table 2. Farm characteristics of cocoa farmers

Farm characteristics	Frequency	Percentage
Age of cocoa farm (years)		
Less than 10	2	2.1
10 – 25	5	5.3
26 – 40	23	24.2
41 – 55	33	34.7
56 – 70	31	32.6
Total	95	100
Source of input		
Purchase from private agrochemical shops and nurseries	78	82.1
Purchase from government at subsidized rate	6	6.3
Purchase from produce buyers (Retailers shop)	8	8.5
No response	3	3.2
Total	95	100
Possession of other source of income		
Yes	94	98.8
No	1	1.1
Total	95	100
Farm management type		
Owner Managed	73	76.8
Lease Managed	1	1.1
Owner and Lease Managed	21	22.1
Total	95	100
Type of labour employed		
Family	12	12.6
Hired	26	27.4
Family and Hired	57	60
Total	95	100

Source: Field Survey, 2010

Most farmers had other sources of income generation apart from cocoa farming. Some of the farmers still engaged in production of arable crops such as cassava, maize and plantain. Some had

in addition, oil palm and/or orange plantations. Other sources of income identified included civil service, carpentry, tailoring and merchandize. Inputs used by cocoa farmers included seedlings, fertilizer, pesticide, insecticide and herbicide. Most farmers purchased their inputs from private agrochemical shops and nurseries (82.1%). This had an adverse impact on farmers' productivity since they expended much on purchase of such inputs. Few farmers obtained their input at subsidized rates from the government (6.3%). Some farmers obtained inputs in cash/ kind from the local produce buyers (retailers) at the beginning of the season and repaid back with produce made in the season at the end of the year. The study also revealed that most farmers managed their own farms obtained by inheritance and some purchased theirs (76.8%). Only one farmer was on lease farming while 22.1% of the farmers combined both owner and lease farming management. It is believed that farms self-managed by owner can be more efficiently run and the output better. All other resources from the farm were utilized to cater for household needs. About 60% of the cocoa farmers were using a combination of family and hired labours; use of hired labour alone constituted 27.4% while family labour alone was 12.6%.

3.3 Perceived Adaptive Importance of Climate Variables in Cocoa Production

As part of the objectives of this study to identify climate variables considered by farmers to be of adaptive importance in cocoa production, Table 3 presents the results obtained from the analysis. As observed, 14.74% of the farmers showed that rainfall alone was important in cocoa production, 12.63% of the farmers believed it was only sunshine, because it reduces the incidence of disease most especially black pod disease which reduces harvest, 7.37 % and 3.16 % respectively believed that combinations of rainfall and temperature and sunshine and temperature were crucial while 1.1% said the combination of rainfall, temperature and sunshine were essential for cocoa production. However, larger percentage (55.8%) of the farmers perceived that the duo of rainfall and sunshine were important in the production of cocoa. They believed that moderate occurrence of these variables combine best to give better produce.

Table 3. Distribution of cocoa farmers according to importance of climate variables

Variable	Frequency	Percentage
Rainfall	14	14.74
Sunshine	12	12.63
Rainfall and Sunshine	53	55.79
Rainfall and Temperature	7	7.37
Sunshine and Temperature	3	3.16
Rainfall and Temperature and Sunshine	1	1.05
No Response	5	5.26
Total	95	100.00

Source: Field Survey, 2010.

3.4 Effect of Adverse Climate Variation on Cocoa Production

Table 4 shows the adverse effects of climate variations on cocoa production as perceived by the farmers. These perceived impacts had great implications on cocoa farm yield and consequently on the income accruing to them from cocoa farming. The variations also had cost implications to the farmers in terms of cost of purchasing more chemicals and spraying fungicides to prevent and control disease infestation. Disease infestation accounted for the most frequent of the effects (41.1%), followed by reduction in cocoa bean weight and disease infestation (29.5%), reduction in

cocoa bean weight (7.4%) while emergence of pests accounted for only3.2% of the effects. Others with combined effects included: pest and disease infestation 6.3%; reduction in weight, emergence of pest and disease infestation (4.2%) as well as drying off of seedlings and old trees (2.1%).

Table 4. Distribution of effect of climate variation on cocoa production

Effect of Adverse Climate Change	Frequency	Percentage
Reduction in Cocoa Bean Weight	7	7.4
Emergence of Pest	3	3.2
Disease Infestation	39	41.1
Reduction in Bean Weight and Emergence of Pest	4	4.2
Reduction in Weight from Disease Infestation	28	29.5
Reduction in Weight, Emergence of Pest and Disease Infestation	4	4.2
Pest and Disease Infestation	6	6.3
Drying off of seedlings and old trees	2	2.1
No Response	2	2.1
Total	95	100

Source: Field Survey, 2010.

3.5 Results of Regression Analyses

Table 5 presents the results of regression analyses for the three functional forms tried. These are Linear, Semi-log, and Double-log forms.

The double-log function was chosen as a lead equation because it best fits the model in terms of criteria considered. These criteria are the value of the highest coefficient of multiple determination (least standard error estimate (SE); significance of parameters at 5% and conformity with theoretical expectations.

The study showed a coefficient of multiple determination of 0.96. This shows that 96% of variation observed in the yield of cocoa was jointly explained by the independent variables. The result also showed a positive relationship between quantity of fertilizers used and yield of cocoa.

Table 5. Results of Regression Analyses

	Constant	X_1	X_2	X_3	X_4	X_5	X_6	R^2	F
Functional Forms		Fertilizer	Hired labour	Family labour	Age of cocoa farm	Size of cocoa farm	Extra hour spent after rain		
Linear	661.44	-1.25	0.66	-1.21	-0.53	1.69*	1.47	0.95	6.73
		(5.33)	(45.28)	(296.79)	(12.35)	(34.23)	(150.93)		
Semi Log	2.36	0.16	0.14	-0.31	-0.02	0.79	0.51	0.95	6.73
		(0.26)	(0.26)	(1.47)	(0.79)	(0.63)	(0.44)		
Double Log	1.25	0.12	0.09 **	0.01	-0.37*	0.89***	0.42***	0.96	0.01
		(0.24)	(0.08)	(0.28)	(0.49)	(0.26)	(0.14)		

Note: Significance of coefficient at 10% = *, 5% = ** and 1% = ***

Figures in Parentheses are the Standard errors of Co-efficient.

The implication of this is that a 1kg increase in application of fertilizer (X_1) would cause an increase in the yield of cocoa (YL) by 0.12 tonnes. This however conforms to a priori expectation of a greater yield in the production of cocoa due an increase in the use of fertilizer. Also, a positive relationship was achieved from the number of family labour (X_3) and the yield of cocoa meaning a rise in the number of family labour by 1man-day would result into a rise in the yield of cocoa by 0.01 tonnes. This is also expected since hired labour is usually scarce and costly during the peak periods of cocoa production hence availability of family labour at this crucial period enhanced productivity. The same can be said about number of hired labour and year of experience in cocoa farm as they all have positive relationships with the yield of cocoa. Inadequacy or non-availability of labour to process cocoa during the peak periods of harvesting could result into colossal loss to the farmers. Meanwhile, age of cocoa farm has negative correlation. After the peak production age of cocoa farm (usually about 30 – 45 years depending on species), productivity decreases and eventually becomes virtually unproductive. The study further showed that the number of hours spent by farmers on re- application of fungicide after unpredicted rainfall (X_6) was significant ($p<0.05$). This means that number of hours spent on re-spraying had impact on the yield of cocoa. The positive sign of the coefficient of number of hours spent on re-spraying after unpredicted rainfall is an increasing function of yield of cocoa and that an extra hour spent on re-spraying will result in 0.42 tonnes increase in the yield of cocoa though, this is not without cost. This result shows the adverse effect of climate variation on productivity and labour in cocoa production. When unpredicted rain falls after farmers might have already sprayed their farms, it washes away the applied chemical from the trees. This increases the susceptibility of the cocoa trees to incidence of disease infestation especially black pod disease which destroys cocoa pods and consequently reduces harvest from the farm. This eventually reduces the income of the cocoa farmers. Although re-spraying of farm has cost implication to the farmers in terms of purchase of chemical and labour engaged for spraying, but in the long run it saves them from undue loss of cocoa pods to disease infestation. Size of cocoa farm was also significant ($p<0.05$). This means that size of farm had impact on cocoa yield. The positive sign of the coefficient further revealed that farm size is an increasing function of cocoa yield. This is in tandem with theoretical expectation. Increasing the size of cocoa farms by one acre will culminate in 0.89 tonne increase in the yield of cocoa.

4. Conclusion and Recommendations

4.1 Conclusion

Farmers in the study area depended mainly on cocoa farming for their socio-economic advancement. Incomes realized are used to send their children to schools and take care of other household responsibilities. Both young and aged people were found to be engaged in cocoa production business but complained of rigors involved and inadequate motivation to farmers by the government. Meanwhile, majority of the farmers were aware of the global climate change phenomenon threatening their environment. Variations in climatic conditions had significant impacts on cocoa production. These effects were manifested in various dimensions ranging from reduction in pod weight and pest infestation to emergence of diseases. These effects had cost implications to the farmers as they tried to mitigate the intensity of the adverse effects. The cost was often derived from measures geared towards the prevention of diseases and pests, most frequently through the purchase of chemicals and employment of labour to administer these chemicals on the farms. It was also shown in the study that fertilizers used had significant positive effect on the yield of cocoa. Hence, more inputs like fertilizers were used to encourage better yield of the product. Fertilizer use intensity was used as a proxy to measure the extent to which climate variables have damaged the soils thereby resulting into lower yields. It was assumed that the more the damage the more the quantity of fertilizer needed to bring the soil back to the original productive level.

4.2 Recommendations

Based on the result of this study, the following recommendations are hereby put forward to alleviate the adverse effects of climate variations on cocoa production:

- As rainfall and sunshine are important factors influencing cocoa production, such measures like irrigation schemes should be introduced to supplement the inadequacies of water if any, and land cooling strategies in form of mulching could also help to check excessive soil temperature.
- Greater efforts should be at making agrochemicals, especially fungicides for controlling black pod diseases readily available and affordable to farmers. Prices of such chemicals should be heavily subsidized to encourage cocoa farmers acquire them.
- Efforts aimed at mitigating adverse climate variations through aggressive replacement of old cocoa trees with improved varieties should be pursued with zeal by the government. These will help to ameliorate adverse climatic effects on the generality of cocoa farmers.
- Government should encourage and fund research institutes especially, Cocoa Research Institute of Nigeria (CRIN) to undertake research that will produce new varieties and breeds of cocoa plants that can adapt and thrive under severe climatic conditions.
- Cocoa farmers should be encouraged to form cooperative societies so that they can access funds for procurement of various farm inputs such as agrochemicals and spraying machines.

In the long run, policies for preventing the causal agents to climatic change should be instituted by the governments and swiftly followed up. In order to achieve this, conscientious efforts should be made to educate and train the minds of the citizenry towards safety and best practices for the prevention of climatic adversities.

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