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The Effects of Climate Change on Cocoa Production and Vulnerability Assessment in Nigeria

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Abstract: Cocoa production in Nigeria has been experiencing a declining trend in recent years and many factors has been implicated. One of these factors is the effect of climatic factors hence, this study investigate the effect of climatic variables in cocoa seedling raising, production and processing and also assess the degree of vulnerability and coping strategies adopted by the farmers. In all, rainfall, temperature and sunshine were observed to have been the most important climatic factors that affect cocoa production.

Key words: Cocoa production, vulnerability, climatic factors, Nigeria

INTRODUCTION

Cocoa (*Theobroma cacao*) was introduced to West Africa sub region from Brazil and into Nigeria from Fernando Po in the year 1874 (Adegeye, 1996). It was first cultivated into the western region of Nigeria in 1890. Its cultivation gained prominence rapidly in Nigeria such that by 1965, Nigeria became the second largest producer in the world (Adegeye, 1996). Cocoa is produced mainly in the rainforest area of the country, known as the cocoa belt. The main producing states are Ondo, Ekiti, Oyo, Osun, Ogun, Delta, Edo, Cross Rivers and Akwa Ibom. According to Adegeye (1996), over 50% of the total quantity of cocoa produced for export or utilized locally per annum comes from Ondo state. In cocoa production process, resources are required. These resources are classified as natural and man-made resources. Natural resources include all the materials and forces that are supplied by nature. Those that are most essential for cocoa production are land, water, sunshine, air and temperature and soil conditions. Man-made resources are supplied and influenced by man.

They include labour (family or hired labour), capital, management or entrepreneurs. Among the natural resources, climate is the predominant factor that influences cocoa production. Climate is the state of atmosphere, which is created by weather events over a period of time. The importance of cocoa in the economy of Nigeria cannot be over emphasized. In Nigeria the popularity and earnings from cocoa have made this sub-sector an area of interest to policy makers especially due to its contributions to total Gross Domestic Product (GDP) and being the highest foreign exchange earner among all agricultural commodities. A study of this nature is necessary because a relatively large proportion of the labour force in the study area engaged in cocoa farming. Also, the study of this nature will give the actual picture of cocoa production and the impact of irregularity in climatic conditions on the production.

Effects of climate change on cocoa production: The high rates in climate changes in the economy have greater influence on the 3 phases of cocoa production ranging from seedling phase, establishment phase and processing phase. This is because weather and climate influence most of the processes involved in cocoa production for example: solar radiation produces energy for warming the soil, plants, air and metabolic processes; rainfall and it characteristics in terms of amount, intensity, reliability and distribution influence crop growth and soil erosion. Atmospheric evaporability determines the performance and survival of crops. Planting date of cocoa seeds are determined by start of the rains. Irrigation adds economic value to the products. Sun drying reduces the water content of cocoa seed and make its processing easier. From the above, we can see that all cocoa production processes are directly or indirectly weather and climate dependent.

Cocoa is highly sensitive to changes in climate from hours of sunshine to rainfall and application of water, soil condition and particularly to temperature due to effects on evapotranspiration. Climate changes could also alter stages of rates of development of cocoa pests and pathogens, modify host resistance and results in changes

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in physiology of host pathogen or pest interaction and this altered cocoa yields and resulted to crop loses which, will impact socio-economic variables such as farm income, farm level decision making, marketability and farmers' livelihoods.

Cocoa is highly susceptible to drought and the pattern of cropping cocoa is related to rainfall distribution. Significant correlations between cocoa yield and rainfall over varying interval prior harvest of cocoa pods have been reported. Cocoa seedling mortality is encouraged by prolonged dry season (drought), short dry season affects pod filling which will affect the bean size. In mature cocoa plant water deficit results in low yield and increases the level of capsid damage. Capsid is an insect that makes cocoa difficult to establish. Blackpod diseases are the most destructive disease that affect ripening cocoa pod and it is mostly related to climate and prevalent in damp situation and most destructive during wet season. Prolonged wet season, windy or cloudy days and rains slow down drying and processing of cocoa seeds thereby reducing the value of the bean and increase the cost of processing. During dry season, livestock or wild animals contaminated the bean. This study, the way climate change may affect cocoa production in Ondo East local government area and then outlines the degree of vulnerability of cocoa farmers and adaptation strategies to climate change.

Statement of the problem: The discovery and exploitation of petroleum, the black gold led to the decline in the importance attached to the golden crop cocoa. Nevertheless, cocoa still remains the 2nd largest foreign exchange earner after petroleum (Adegeye, 1996). Part from providing foreign exchange to the exporting countries, cocoa is a means of conserving foreign exchange. This is achieved by producing cocoa based products, for instance cocoa-butter, cocoa cake, cocoa powder, cocoa wine and so on, locally instead of importing them.

In the recent years, Nigeria has lost her leading role in exportation of cocoa. This was due to downward trend in cocoa production (Adegeye, 1996). A number of reasons have been given for the decline in cocoa production of the inability of cocoa industry to increase output. Some of these reasons include small farm holdings, transportation mode, unavailability of human labour, low capital and variability in climatic factors and so on.

However, Ondo state being the highest cocoa producing state in Nigeria is highly sensitive to variation in climatic factors most especially rainfall, temperature and sunshine hours. Several views have been expressed about the impacts of irregularity of climate on cocoa production, some claimed that rural and poor cocoa farmers are most affected; some said that farmers who depend on traditional livelihood system such as farming, fishing and pastoralism are most affected while some other researchers claimed that subsistence cocoa farmers are the most affected.

With the foregoing, can we say these claims are really true of climate change? This study therefore, endeavors to find answers to the following research questions.

- What are the effects of climate change on cocoa production?
- Does wealth play any role in adapting to changes in climate?
- Which categories of cocoa farmers are most vulnerable to climate changes and why?
- What coping strategies were adopted by cocoa farmers in sustaining crop failure and cocoa yield loses?

Objectives of the study: The main objective of this study is to examine the effect of climate change on cocoa production and vulnerability assessment in Ondo East local government area of Ondo state. Specifically, this study will:

- Examine the socio-economic characteristics of cocoa farm-households
- Determine the coping strategies adopted by cocoa farmers in adjusting to the impact of climate change on cocoa production
- Determine the effect of climate change on cocoa production losses
- Make recommendations on the basis of the findings

Conceptual framework

Concept of vulnerability: Vulnerability is the degree to which a system is susceptible to or unable to cope with adverse effects of climate change, including climate variability and extremes. It is a function of character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity IPCC (2001).

According to Okunmadewa (2003), Vulnerability is the likelihood of a shock causing a significant welfare loss. He was of the opinion that vulnerability depends on exposure to risks (uncertain events that can lead to welfare losses) and on risk management actions taken to respond to risks, which may be ex-ante (before) or ex-post (after). Santiago (2001) stated that vulnerability is the extent to which a natural or social system is susceptible to sustaining damage from climate change.

To be vulnerable according to The World Bank (2004), can therefore be understood as the propensity of a society (households) to experience substantial damage and disruption on results of hazards (e.g. drought, flood, conflicts etc.). Vulnerability is not simply a function of exposure, but also of people's capacity to adapt to change. If the people's capacity to adapt to change remains unchanged, increased exposure will lead to increased vulnerability. Vulnerability is caused by inequality, inappropriate governance structures and maladaptive economic and agricultural development. (Jagtap, 1995).

The vulnerability of cocoa production in area of ondo east local government area of ondo state in Nigeria can be view in terms of the problems encountered by cocoa farmers that hamper increased production. This can be categorized into shocks and trends. Shocks include: drought, pest and diseases and flood while trends are fluctuation in prices, inconsistencies in policies, inadequate access to credit, marketing problems and inadequate manpower during season. Cocoa farmers however are said to be vulnerable to the effect of climate change on cocoa production if they are unable to cope with or recover from adverse effect of climate variability and extremes on his production.

Concept of adaptation: Adaptation are adjustment to or interventions, which take place in order to manage the losses or take advantage of the opportunities presented by a changing climate (IPCC, 2001). Adaptation is the process of improving time scales, from short term (e.g., seasonal to annual) to long term (e.g., decades to centuries). The IPCC (2001) defines adaptive capacity as the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with consequences. The goal of adaptation measure should be to increase the capacity of a system to survive external shocks or changes.

According to Santiago (2001), Adaptation involves adjustment to enhance the viability of social and economic activities and to reduce their vulnerability to climate, including its current variability and extreme events as well as longer-term climate change. Adaptation to climate is the process through which people reduce the adverse effects of climate on their health and wellbeing and take advantage of opportunities that their climatic environment provides.

The term adaptation means any adjustment, whether passive, reactive or anticipatory that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change (Alao, 1999).

According to IPCC Third Assessment Report, adaptation has the potential to reduce adverse impacts of climate change and to enhance beneficial impacts but will incur cost and will not prevent all damages. Adaptations are adjustments or interventions; which takes place in order to manage the loses or take advantage of the opportunities presented by a changing climate (IPCC, 2001). Adaptation is the process of improving society's ability to cope with changes in climatic conditions across time scales, from short term to (seasonal to annual) to long term (e.g. decades to centuries) (IPCC, 2001). The IPCC (2001) defines adaptive capacity as the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. The goal of adaptation measure should be to increase the capacity of a system to survive external shocks or change.

The assessment of coping strategies (adaptation options) adopted by Cocoa farmers to sustain adverse effect imposed on cocoa production by climate change is important to formulate policies that enhance adaptation as a tool for managing a variety risks associated with climate change and it also provide information that increases the capacity of farmers to survive external shocks or changes.

Important adaptation options in the agricultural sector include: Crop diversification, mixed cropping, livestock farming system, using different crop varieties, changing planting and harvesting dates, mixing less productive, drought resistant varieties and high yield water sensitive crops (Jagtap, 1995). Agriculture adaptation involves 2 types of modifications in production systems. The first is increased diversification that involves engaging in production activities that are drought tolerant and or resistant to temperature stresses as well as activities that make efficient sue and take full advantage of prevailing water and temperature conditions, among other factors. Crop diversification can serve as insurance against rainfall variability as different crops are affected differently by climate events. The second strategy focuses on crop management practices geared towards ensuring that critical crop growth stages do not coincide with very harsh climatic condition such as mid-season droughts. Crop management practices that can be sued include modifying the length of growing period and changing planting and harvesting dates.

Cocoa farmers in Ondo east local government area of Ondo state however, adapt to dry spell and lengthening growing season resulting from unexpected climate change by constructing irrigation system in order to improve their productivity. The adaptive decision make by these

farmers in response to seasonal variation I climate factors are influenced by a number of socio-economic factors that include farm household characteristics, house hold resource, access to information and availability to formal institutions (input and output markets) for even distribution and consumption.

Adaptation to climate change however involves changes in agricultural management practices in response to changes in climate conditions. It often involves a combination of various individual responses at the farm-level and assumes that farmers have access to alternative practices and technologies available in the region.

MATERIALS AND METHODS

Study area: The study was carried out in Ondo East Local Government area of Ondo state. Ondo state has 18 local government of which ondo east is one. The total land area of ondo state is about 20,595ha with population of about 2, 255, 723 persons (NPC, 1991). The state is characterized by heavy rainfall with climate following usual tropical pattern. The rainy season is from April to October while the dry season starts from November to March. The state is predominantly an agricultural area and most of the inhabitant (about 70%) are farmers (Akinsorotan, 1997). These farmers engaged primarily in the production of food crops. However, the production of cocoa assumes prominence in Ondo east local government area, Idanre and Ile-oluji/Okeigbo.

Ondo east local government is within tropical rain forest with rainfall of about 1,634 mm and 4 months of dry season. The humidity and temperature are relatively high. The area is known to be producing the largest tonnage of cocoa in the country. The inhabitants are Yoruba speaking with people from northern and eastern part of the country in the rural villages and communities. The major occupation of people in the area is cultivation of cash crops with cocoa being the main crop, but often intercropped with kolanut, oil palm, plantain and banana. Also food crops like cassava, maize, yam and vegetables are cultivated while others are cocoa merchant traders and artesian.

Source of data and sampling procedure: The study made use of primary data. Data was collected through personal interviw and administering questionnaire on cocoa farm household in the study area. The data provided information on the socio economic characteristics of the cocoa farmers, farm size, input sources, yield, costs, expected returns, effect of climate on cocoa production, degree of vulnerability and coping strategies adopted by farmers in response to these effects.

Simple random techniques is used the farmers were randomly selected from four set of villages in the local government area. The interviews were conducted privately to avoid duplication of ideas and unnecessary influence of one farmer answer on the other. Although, 120 farmers were selected for interview, 50 farmers from Bolorunduro, which is the head quarter of the local government, 30 farmers from Igba and 20 each from Ita-oba and Fagbo. Only information supplies by 99 respondents were used in this study. This was due to lack of cooperation from or lack of consistency in the information supply by others.

Table 1 shows that majority of the cocoa farms are located at Igba, they make up of about 22.2, 16.2% at Fagbo, 12.1% at Ita-oba while the remaining 35.4% are located in areas shown in the Table 1. This distribution do not represent the residence of farmers, some reside in Ita-oba and have their farms in Fagbo, reside in Bolorunduro while their farms are located at Ureje etc.

Data analysis: A combination of various analytical tools was employed. These include descriptive statistics, Principal Component Analysis and Tobit model.

Principal Component Analysis (PCA): PCA tool was used to derive an index of vulnerability to climate change based on farmers responses to some questions relating to experience of seedling mortality due to drought, disturbances from rainfall during spraying thereby leading to respray cocoa farm and too much rainfall resulting into black pod disease. The method is similar to Ordinary Least Square Regression and its implementation is to ensure that an index of vulnerability is computed from all the variables.

Tobit model: Tobit analysis model was used to estimate the responsiveness of yield of cocoa crops under the study to changes in climatic variables. The cocoa production losses resulting from climatic changes were

Table 1: Distributions of respondents by farm locations

Farm location	Frequency	Percentage
Omilarin	3	3.0
Oboto	3	3.0
Ita-oba	12	12.1
Ureje	7	7.1
Saseke	1	1.0
Igbo-oju	5	5.1
Fagbo	14	14.1
Kolawole	4	4.0
Kotayo	8	8.1
Bolorunduro	16	16.2
Igba	22	22.2
Igbo-oja	4	4.0
Total	99	100.0

Source: Field survey, 2008

taken as the dependent variable and was expressed as a function of the socio economic characteristics of cocoa farm households and climate changes. αs are the coefficients of the socio economic characteristics and climatic factors in the Tobit equation.

The implicit form of the model is:

$$AC_i = B + \alpha \sum_{i=0}^{n} X_i + e_i$$

where:

AC_i = Average cocoa yield
X_1 = Sex (male =1, 0 otherwise)
X_2 = Excess seedling cost due to climatic changes (N)
X_3 = Losses from capsid disease (N)
X_4 = Losses from black pod disease (N)
X_5 = Excess processing cost due to excessive rainfall (N)
X_6 = Excess cost on disease prevention
X_7 = Quality of cocoa beans reduce due to climatic changes (yes = 1, 0 otherwise)
X_8 = Spray interval (days)
X_9 = Re-spray hour if unexpected rain falls
X_{10} = Irrigation when rain is inadequate (yes = 1, 0 otherwise)
X_{11} = Market access (yes =1, 0 otherwise)
X_{12} = Marital status (married =1, 0 otherwise)
X_{13} = Number of family labour
X_{14} = Number of hire labour
X_{15} = Years of education
X_{16} = Size land (Ha)
X_{17} = Other sources of income (yes = 1, 0 otherwise)
X_{18} = Experience in cocoa production (years)
e_i = Error term

RESULTS AND DISCUSSION

The socio-economic characteristics of cocoa farmers: This study presents information on selected socio-economic characteristics of cocoa farm households in the studies sample.

Sex of respondents: The Table 2 shows that cocoa farmers are predominantly male, making up of about 90.9% of the total respondents while the remaining 9.1% are female. This is because this study recognizes both male and female farmers in the study area.

Marital status of respondents: According to Table 3 majority of the sampled population are married about 86.9%, while the remaining 13.1% are single.

Table 2: Sex distributions of respondents

Sex	Frequency	Percentage
Male	90	90.9
Female	9	9.1
Total	99	100.0

Table 3: Distributions of respondents by marital status

Marital status	Frequency	Percentage
Married	86	86.9
Single	13	13.1
Total	99	100.0

Source: Field survey data, 2008

Educational status of respondents: Table 4 indicates that 15.1% of the respondents have no formal education, while just 6.1% had adult education. Majority of the respondent are educated up to primary school level (31.3%) had only secondary education, while 18.2% had only secondary education. This shows that majority of the respondents are literates. At least 94.9% of the cocoa farm households in the sampled population had some form of formal education.

Farming practices of respondents: Table 5 gives a summary of farming practices adopted by the respondents. Majority of the respondents are subsistence farmers, they make up of about 94.9%, while the remaining 5.1% did not indicate the farming practices. This shows that majority of the farmers are subsistence farmers.

Other sources of income of respondents: Table 6 gives the summary of cocoa farmers with and with out other source of income. About 78.8% of the respondents have other sources of income such as Trading, lecturing, cultivation of food crops such as maize, yam, plantain etc. and some others mixed cropped their cocoa with kolanut, banana etc 21.2% have no other sources of income, are mainly cocoa farmers.

Perception of climatic change and its effects

Farmers awareness of climate change: Table 7 shows that 96% of the respondents are aware of climate changes while the remaining 4% are ignorant about the changes.

Climate change noticed by the respondents: According to Table 8, the most noticeable climate changes among the respondent is low rainfall (58.6%). This is followed by high rainfall about 21.2, 11.1% of the respondents noticed unfavorable sunlight, 4.0% noticed high temperature while the remaining 5.0% noticed 2 or more changes each of the mentioned variables.

Degree of importance of climatic variables in cocoa production: Table 9 shows that rainfall is the most

Table 4: Distribution of education level of respondents

Educational level	Frequency	Percentage
No formal education	15	15.1
Primary education	31	31.1
Secondary education	18	18.2
Adult education	6	6.1
Post secondary education	29	29.3
Total	99	100.0

Table 5: Distribution of farming practices of respondents

Farming practices	Frequency	Percentage
Subsistence	94	94.9
None	5	5.1
Total	99	100.0

Table 6: Distributions of respondents by other sources of income

Other sources of income	Frequency	Percentage
Yes	78	78.8
No	21	21.2
Total	99	100.0

Table 7: Distributions of farmers by awareness

Awareness	Frequency	Percentage
Yes	95	96.0
No	4	4.0
Total	99	100.0

Table 8: Distributions of respondents by noticed climate changes

Climate change	Frequency	Percentage
High rainfall	21	21.2
Low rainfall	58	58.6
High temperature	4	4.0
Unfavorable sunlight	11	11.1
Others	5	5.0
Total	99	100.0

Table 9: Distributions of respondent by degree of importance of climate variables in cocoa production

Climate varieties	Frequency	Percentage
Rainfall	96	97.0
Temperature	1	1.0
Others	2	2.0
Total	99	100.0

Source: Field Survey 2008

important factor in cocoa production about 97.0% of the respondents claimed that rainfall is very important for growth and development of the pod, this is followed by temperature about 1.0%, while the remaining 2% is for other factors such as wind, sunshine etc.

Climatic variables failure: Table 10 shows that 91.9% of the respondents experienced some climatic failures while the remaining 8.1% recorded that none of the climatic factors ever failed them throughout last season.

The predominant factor that fails last season: Table 11 shows that rainfall is the most predominant climatic factor that fails the farmers last season about 77.8, 13.1% respondents claimed that sunshine is the climatic factors that facts them, while the remaining 9.1% claimed that both factors fail them.

Table 10: Distributions of respondents by climatic factors failure

Climatic failures	Frequency	Percentage
Yes	91	91.9
No	8	8.1
Total	99	100.0

Table 11: Distributions of respondents by failing factors

Factors	Frequency	Percentage
Rainfall	77	77.8
Sunshine	13	13.1
Both	9	9.1
Total	99	100.0

Source: Field survey 2008

Effect of climatic failure on cocoa production: Table 12 shows that 74.7% of climatic factors failure results in reduction of cocoa weight 3.0% of the failure leads to disease infestation (Black pod disease) while 13.1% result in emergence of cocoa pests (capsid) and the remaining 9.1% cause 2 of the above effects.

Measurement of cocoa farmers' vulnerability to climatic changes

Major source of water supply to the farm: From Table 13, the major source of water supply to the farm is rainfall, it make up of about 82.8, 5.1% depend on stream, 2.0% depend on immigration (well water) while the remaining 10.0% depend on both stream and rainfall. This shows that the agricultural practices in Ondo East is mainly rain-fed.

Time interval used in spraying last season: Table 14 shows that most of the farmers, about 42.4% spend 10-12 h in spraying their farms, which is the minimum hours spend in spraying while 1% spend 26 h, which is the maximum hours spend the other hour spend in spraying varies. This shows that there is variation in hours used in spraying because of the differences in the size of land cultivated.

Condition under which spraying is carried out: Table 15 shows that spraying is carried out by the respondents under sunny condition about 45.5, 40.4% t spray at any condition while 14.1% spray under a cloudy condition. There are reason for variation in condition under, which spraying is carried out. For example, most of the respondents that spray under sunny condition claimed that is the most favorable time to spray, those that spray under a cloudy condition claim that, it will help them solve any root disease.

Table 16 shows that 77.8%of the respondents have to respray their farm due to unexpected rainfall while the remaining 22.2% do not have any cause to respray their farm.

Table 12: Distributions of respondents by effect of climatic failures

Effect	Frequency	Percentage
Reduce weight	74	74.7
Disease	3	3.0
Pest	13	13.1
Others	9	9.0
Total	99	100.0

Table 13: Distributions of respondents by source of water supply

Source	Frequency	Percentage
Rainfall	82	82.8
Stream	5	5.1
Irrigation	2	2.0
Rainfall and stream	10	10.0
Total	99	100.0

Table 14: Distribution of respondent by spraying interval

Spraying interval	Frequency	Percentage
10-12 h	42	42.4
13-15 h	36	36.4
16-18	10	10.1
19-21 h	10	10.1
26 h	1	1.0
Total	99	100.0

Table 15: Distributions of respondents by spraying condition

Spraying condition	Frequency	Percentage
Cloudy	14	14.1
Sunny	45	45.5
Any condition	40	40.4
Total	99	100.0

Source: Field survey 2008

Extra hours spent on re-spraying: According to Table 17 the minimum hours spend by the respondent to re-spray their farm is 2 h, while the maximum is 48 h. This time period depends on the area of their farm sizes.

Cocoa farm households' coping strategies

Application of chemicals to prevent black pod diseases: Table 18 shows that 93.9% of the respondent applied chemicals on their farms to prevent black pod disease while the remaining 6.1% do not.

Practice of irrigation system during dry season: Table 19 shows that 36.4% of the respondents practice irrigation system during dry season, while the remaining 63.6% do not. The major form of irrigation system practiced by the respondents is lift irrigation (well-water).

Coping strategies due to variation in climatic condition: From Table 20, the majority of the respondents switch to other source of income out 44.4% when there is unpredictable variation in climate condition, 28.3% adopt delay-planting techniques, 12.1% changes varieties of cocoa used while the remaining 15.2% adopt some other strategies.

Table 16: Distribution of respondent by respray

Respray	Frequency	Percentage
Yes	77	77.8
No	22	22.2
Total	99	100.0

Table 17: Distributions of respondents by extra hours spent on re-spraying

Extra hours	Frequency	Percentage
2-6	71	71.7
7-11	19	19.2
12-16	5	5.1
17-21	2	2.0
48	2	2.0
Total	99	100.0

Table 18: Distribution of respondent by chemical application

Chemical application	Frequency	Percentage
Yes	93	93.9
No	6	6.1
Total	99	100.0

Table 19: Distribution of respondent by irrigation system

Irrigation system	Frequency	Percentage.
Yes	36	36.4
No	63	63.6
Total	99	100.0

Table 20: Distribution of respondent by coping strategies

Coping strategies	Frequency	Percentage
Diversification	44	44.4
Delay planting	28	28.3
Changes varieties	12	12.1
Others	15	15.2
Total	99	100.0

Source: Field survey 2008

Respondents' access to market: Table 21 shows that 89.9% of the respondents have easy access to market while the remaining 10.1% have on access to market.

Respondents' adjustments to consequences of climate change: Table 22 shows that in adjusting to consequence of climate change, majority of the respondent change use of capital and labour about 40.4, 23.2% change use of chemical and fertilizer, 17.2% change area of land use, 11.1% change from cocoa production while the remaining 8.1% are indifference to the consequence.

Tobit model to analyzed determinants of production losses: This study discussed the result from Tobit regression analysis. Table 23 shows the conclusive inferences on the exact quantitative relationship between cocoa yield, socio-economic characteristics of cocoa households and the impact of climate variables on cocoa production. Each slope coefficient in the equation is a partial slope coefficient and it measures the change in the estimated Tobit for a unit change in the value of the given regressor (holding other regressor constant). The coefficient shows variable with positive and negative values. Variables with negative value implies a negative

Table 21: Distribution of respondent by easy access to market

Easy access to market	Frequency	Percentage
Yes	89	89.9
No	10	10.1
Total	99	100.0

Table 22: Distributions of respondents by adjustment strategies

Adjustment	Frequency	Percentage
Change use of capital and labour	40	40.4
Change use of chemical and fertilizer	23	23.2
Change area of land uses	17	17.2
Change from cocoa production	11	11.1
Indifference	8	8.1
Total	99	100.0

Source: Field survey 2008

Table 23: Determinants of cocoa production losses

Variable	Coefficient	Std. err	t-value	Probability
Constant	-408.502	4675.005	-0.09	0.931
Sex	-1395.225	2531.345	-0.55	0.583
Excess cost	0.0118605	0.0269476	0.44	0.661
Losses from capsid	-0.0020569	0.157719	0.13	0.897
Losses from disease	-0.0599645	0.452905	-1.32	0.189
Excess processing cost	0.1158399	0.085012	1.36	0.177
Excess cost on disease	-424.2208	100.4421	-4.22	0.000*
Quality reduce	6530.767	2073.638	3.15	0.002**
Spray interval	153.3281	215.8879	0.71	0.480
Respray hour	26.85051	199.1129	0.13	0.893
Irrigation	0.38475	0.0574748	6.69	0.000*
Market access	-5293.64	2650.406	-2.00	0.049**
Marital status	-544.6826	2494.678	0.22	0.828
Family labour	1030.154	444.3238	2.32	0.023**
Labour	-1135.237	559.7783	-2.03	0.046***
Education	3813.513	2660.663	1.43	0.156
Size land	436.2482	50.05396	8.72	0.000*
Income so	-615.9005	1994.0571	-0.31	0.758
Experience	-139.0303	66.29222	-2.10	0.039**

R^2 = 0.0558; LR = -996.2444; S.E of regression = 6763.314; No of obs = 99; LR chi2 (18) = 117.68; Prob>chi2 = 0.0000; * Significant at 1%, **Signification at 5%, ***Significant at 10%

relationship between the explanatory variables and the dependent variable for example the negative coefficient of labourer means that the higher the labourer, the lower the yield. For every additional 1 labourer, yield reduces by 1135 kg. Variable with positive coefficient implies a positive relationship of the explanatory variables and dependent variable for example the higher the size of land, the more the yield of cocoa. For every additional 1 acre of land cocoa yield increases by 436 kg.

Also, the probability measures the level of significance of the explanatory variable in the estimated tobit. Among the 18 variables only 8 variables are significant. Excess cost on disease is significant at 1% level this shows that climatic variable (rainfall failure) causing the disease has a significant impact on cocoa yield. Reduced quality is significant at 5% level this show that at 5% level of significant reduce quality resulting from the effect of climatic variables failure has impact on cocoa yield.

Irrigation is significant at 1% level this shows that at 1% level of significant irrigation has impact on cocoa yield. Access to market is significant at 10% level this shows that access to market has impact on cocoa production.

Family labour is significant at 5% level this shows that at 5% level of significance family labour has impact on cocoa production. The hired labours employed in the course of production are significant at 10% level this shows that it has impact on cocoa production. Size of land is significant at 1% level; this shows that size of land has impact on cocoa production. Experience of cocoa farmers is significant at 10% level which implies that experience has impact on cocoa production.

CONCLUSION

The major objective of this study is to determine the impact of climate change on cocoa production in Ondo East Local Government of Ondo State in Nigeria. The study highlights some pertinent climatic factors that affect cocoa production and performance in the area of study. These climatic factors are mainly Rainfall, Temperature and sunshine. The socio-economic characteristics of cocoa farmers revealed that very few women ventured into cocoa farming, as most of the respondent are male. The study also indicated that majority of the farmers practice subsistence farming.

Furthermore, the study revealed that most of all the farmers are married with larger family size because they have more than a wife with many children. Method of analysis employed in the study was frequency, percentage, principal component analysis and tobit model. Majority of the farm examined have their yield declining with unfavourable climate changes. The study revealed that if climatic conditions are favourable and other factors contributing to growth and development of cocoa are put in place, cocoa production is a profitable venture.

Although, this study has been designed to cover the whole Ondo East local Government Area of Ondo State, the results obtained which have been highlighted can still be regarded as inadequate for any conclusive generalizations to be made about the nature of climate and cocoa production in the state. Hence, it will be more reliable if further consideration is give to other local government in the state. Furthermore, the effect of other resources apart from climate change can still be included in other studies. Also effect of climate change in Food crops can be included in further studies in this area.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are hereby suggested to minimize climate risk and hazard: Government should invest in this area of study and make use of available land for cocoa production in the state. Farmers should be trained on techniques of spraying against diseases and how to process the produce for sale. Government should subsidize the price of chemicals used for spraying against black pod diseases and capsid pests. Government should provide measure to modify the climate condition in order to maintain temperature near ground surface, to reduce the direct and associated effect of rainfall on cocoa yield and to mitigate draught by migration. Government should adjust management as carefully as possible correct climate condition. Government must also ensure that the different research institution are researching into making new variables or breads of cocoa that can-adapt to climate change of Nigeria for high productivity. Extension agents should also encourage farmers on the use of seed varieties that can adapt to different climate conditions.

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