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Effects of Climate Change on Cocoa Farmers' Production

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ABSTRACT Cocoa is predominantly produced in the rainforest region of the country, an area that is vulnerable to changes in climatic conditions. This study examined the vulnerability of cocoa farmers to changes in climatic conditions in Ekiti State. Data for the study were collected through the administration questionnaires; this was done purposively by selecting four local government areas that have the highest percentage of cocoa productions among the 16 local government areas in the study area. Questions were given to cocoa farmers on their vulnerability to climate changes and other socio-economic problems affecting their production. Findings in the study revealed that there are more households headed by male as compared to the female households. Household sizes are large with 42.05 percent of the household having 7-10 members. Majority of the farmers have no formal education, with 59-81 percent of the households, indicating that most of the cocoa farmers in the study area have no formal education. Distribution of the households by primary occupation showed that 80-37 percent of the households are predominantly cocoa farmers. Findings in the study further indicated that malaria is a major sickness which also negatively affects the production of cocoa among farmers in the study area, affecting about 66-36 percent of the households, this justified the claim that malaria is a major disease-affecting households in tropical Africa. The result of the probity regression analysis showed that, the higher the age of the farmers the less productive they are in cocoa production, because of their inactiveness, this justified the decline in cocoa production over years. The study showed that cocoa farmers are vulnerable to hunger and poverty due to excessive climate change that might come in form of flood, high temperature and heat which often affect the performance of cocoa plantations.

INTRODUCTION

"Cocoa (*Theobroma cacao*) was introduced into Nigeria in 1804. Cocoa was one of major foreign exchange earners in Nigeria before the discovery of crude oil in 1957. This accounted for a greater part of the foreign exchange generated for the country between the 1950s and 70s. Cacao tree belong to the family of *sterculiaceae* and the genus *Theobroma*. Its natural habitat is the lower storey of the evergreen rainforest. There are over twenty species in the genus but *Theobroma cacao* is the only one cultivated widely. Since its discovery in the 18th century at the Amazon basin, its cultivation has spread to other tropical areas of South and Central America, and indeed West Africa, which became the major producer from the mid-1960s (Opeke 1987). Recently, with the application of molecular marker, cacao was reclassified to belong to the family *Malvaceae* (Alvenson et al. 1999; Kovats 2008). Cocoa was introduced to west Africa in the nineteenth century and its introduction to Nigeria is believed to have taken place about 1874 through the Spanish Island Fernando Po (Ikuomola 2007; Adams 2014; Addae 2014) when a local chief (Squiss Ibaningo) established a plantation at Bonny in the then Eastern region".

"The first recorded effort of the government in the development of cacao cultivation was the distribution of seedling up country for trial planting from the old botanical garden at Ebute-meta, Lagos in 1887 (Fanaye et al. 2003). One of the earliest commercial planting was made near Ibadan; and the cultivation of cocoa gained its first impetus in Ibadan province, which produced the bulk of Nigeria cocoa up to the early twentieth century. The two major factors affecting crop yield are weather conditions and ero-

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sion (Hassan 2008). Thus, to improve the production of any crop there is need to understand the average weather conditions of such area (observed as the climate), whereby climatic parameters such as temperature, rainfall, humidity as well as sunshine hours affect the agricultural output of any region. Daily, seasonal, or annual variations in the values of the climatic element are of greater importance in determining the efficiency of crop growth" (Ayoade 2004).

"A number of factors have an interrelated impact on the growth of cocoa plant. This factor ranges from the weather element of rainfall, temperature, sunlight and humidity to others such as soil nutrient status, pest and diseases, farmers planting practices and so on. It was observed that the higher the temperature (Maximum of 320c), the higher the yield, while the lower the relative humidity, the better the yield. Cocoa is known to produce well with minimal but sustained water availability throughout the year" (Obatolu et al. 2003).

"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 a severe damage to yield. Being a very picky (that is, selective plant), cocoa reacts badly to any incidence of extreme weather (Wood 1985). The International Cocoa Organization (ICO) (2003) describe extreme weather to include weather phenomena that are at the extreme of the historical distribution, especially severe or unfavorable weather, they noted that temperature and rainfall are important factors that impacts on optimum yield. Also, the amount of sunlight falling on the cocoa tree will affect its growth and yield, the most marked effect of humidity on cocoa is on the leaf area, the other effects of humidity concern the spread of fungal diseases and the difficulties of drying and storage of the product. In general, the cumulative effect of temperature, rainfall, humidity, limits of altitude, and sunshine hour have impacts on the yield of cocoa. Another danger to cocoa yield is prolonged dry season which encourages bush burning and this is always very disastrous. On the other hand, incessant rainfall for several weeks (as it normally occurs in July and September) easily leads to wide spread of black pod disease which is very contagious also this poses untold hardship to the farmers because it drastically reduce the yield".

"Yet several studies have reported that there is enormous potential to further diversify and enhance productivity and environmental resilience of the tree-based cropping systems of the region, including the cocoa agro-forests (Tchatat 1996; International Centre for Research in Agroforestry (ICRAF) 1987); Duguma et al. 1998; Duguma et al. 2001). Most of the indigenous and exotic tree species grown in the system are unimproved genetically. There has been a little systematic research effort to improve the genetic base to enhance product quality and quantity or to identify pest- and disease-resistant strains. Many of the indigenous species have not been successfully propagated even by research".

Literature Review

Cocoa Production in Nigeria

All cultivated cocoa is classified into a single species, *Theobroma cacao*. The three main recognized groups are Criollo, Amazonian Forastero and Trinitario. The West Africa Amelonado ("Lower Amazonians") cultivated in Nigeria belongs to the Forastero groups; despite the relatively bitter and often acidic taste of the processed beans, its high level of homogeneity is much appreciated by manufacturers. A general purpose variety*F3* Amazon belonging to the "Upper Amazonians" was successfully introduced into Nigeria about 1950 and is found to be superior to Amelonado in establishment, vegetative vigour, yield, etc. The processed product of the criollo types has a fine aroma and only a slightly bitter taste, thanks to its low tannin content. It is used for luxury chocolate products however they are not very productive, grow slowly and are less hardy than Amelonado.

Nursery and Transplanting

A nursery is here defined as an intensive plant care centre. The intensive care practices start with the selection of appropriate nursery site and the provision of the correct type of recommended or approved planting materials. Cocoa produces recalcitrant and generally viviparous seeds. They are short lived and normally lose viability rapidly even within 2 years. The propagation therefore depends heavily on the

operation of very good nurseries and nursery practices. The level of successful establishment of cocoa farm starts long before the field operations are set in motion. The selected nursery site must be flat and well drained to prevent surface erosion and seasonal water logging. The site is cleared, levelled and beds 15.25m x 1.82m x 10cm high are prepared across the slopes. Artificial shade, which can be easily adjusted as required, must be erected over the beds and they are fenced round with wire netting (1.2cm mesh) to prevent rodents, millipedes, frogs and reptiles from damaging the plantings. High quality (heavy and plump), good seeds are selected for sowing. Seedlings are gradually hardened off when shade materials, for example palm fronds, naturally dry out and they are due for transplanting between 5 and 6 months of age.

Transplanting on to the field starts late in May and is completed latest by mid-July. The soil dug out of the hole should preferably be returned and compacted round the ball of earth and the seedling roots. The base should runoff water away from the seedling base so as to avoid water logging. Each seedling thus successfully transplanted should be supported with a 30 – 40cm stick preferably a fresh *Glyricidia* stick. Since cocoa farmers are generally provided with high quality seedlings at subsidized price (40% of market price), nursery practices contribute to only about 6 percent deterioration of quality in the cocoa production chain in Nigerian Transplanting operations are often not well carried out and could contribute up to 8 percent deterioration of overall quality.

Primary Processing

The processing of cacao beans is still based on traditional methods. It involves natural fermentation and drying, followed by a final sorting which is simpler and more economical than that for other perennial crops. Fermentation alters the organoleptic properties of the beans. It leads to the separation of the beans from the surrounding pulp, causes reduction of cocoa astringency by making the tannins partially insoluble, develops the aroma of cocoa and helps detach the cotyledons from the seed coat with a view to their separation for chocolate making. Drying continues these modifications and ensures bean conservation. The processed product is called cocoa. Fermentation of cocoa beans is usually done in trays and can be completed in 4 days. These trays are of 2 sizes: small, which is about 75cm x 75cm and 7.5cm deep and a BIG size of 120cm x 90cm, 7.5cm deep; with capacities for about 23kg and 41kgwet Beans respectively. Trays can be stacked up to 10 in number or any convenient height, depending on the volume of harvest. The first tray is put on a raised wooden platform to facilitate drainage and aeration. The top tray is covered with banana or plantain leaves and sacks to retain the heat. The advantages of this latest method of fermentation over the previous ones the BOX fermentation and the farmer´s traditional methods of heap and basket fermentation include: quicker and more uniform fermentation, leading to good quality beans after drying and less labour requirement (no mixing of beans required). During drying, internal fermentation continues to refine the taste and develop the characteristic flavour of cocoa. Drying takes place either on racks or mats at ambient temperature or in a hot air drier.

Harvesting

Seasonal fluctuations occur, sustained by a clearly differentiated wet and dry season, although cacao fruits all the year round. A production peak is observed during the period with least rainfall. The main October November harvest (80% of total production) begins in the middle or towards the end of the rainy season and continues until the middle of the dry season (December to mid-January). The smaller harvest (20% of total production) takes place in the period April June. Harvesting of the pods, which is done at regular intervals of 10 to 15 days, commences when they have completely ripened. Green pods turn yellow when maturing while maintaining a light green colour at the base. It is at this point that the aqueous sweet mucilage, essential to successful fermentation of the beans is most developed to produce beans of best quality. Overripe and under ripe pods produce beans of low quality. During periods of low yield, less frequent harvesting can be practised. The peduncle of the pod is cut with a sharp blade (harvesting hook or a sharp cutlass), attention being paid not to damage the flower cushion in which the peduncle is developed. Damage to this flower cushion, always a risk when removing pods, may compromise future productivity. A little stub should therefore al-

ways be left behind after cutting off the pod. Diseased or insect infested pods should be gathered separately at the same time as the ripe fruit is harvested. Other precautions that should also be taken to avoid yield reduction in subsequent years include:

- Harvesters must not climb the cocoa trees to avoid rubbing (or bruising) flowering cushions and
  Cocoa pods should not be pull (or tear) off by hand. A smooth object, preferably wooden, rather than cutlass should be used to break pods if bashing one pod against another cannot break them.

This is to avoid injuring the beans and thus creating access for infections. Pods should not be kept for more than 2 days before breaking as longer periods affect fermentation and consequently, the development of the desired chocolate flavour. The contribution of bad harvesting practices to deterioration of quality in the cocoa production chain is about 15 percent.

Bagging and Storage

Moisture level must be kept below 8 percent after drying; otherwise cocoa could become spoiled due to mould development. Once dry, the cocoa beans are placed in jute bags and stored for sale. Proper storage prior to sales is as important as any of the earlier stages, even if the storage in this case is for only a relatively short term compared to storage by the exporters and chocolate manufacturers, which is long term. It is necessary to preserve the bean quality and prevent any deterioration. Storage is usually in jute bags that are properly sealed and stacked on wooden supports on a concrete floor. Old bags that have been used to store maize or other foodstuff should be avoided while cocoa should be kept away from other produce and smoke. In short it is important to avoid any source of contamination during storage. Beans should therefore not be exposed to hazards such as mould development, rodent attack, bacterial activity and unfavourable storage environment, fat degradation, insect infestation and contamination by other stored products. The cocoa should be sold to buyers or export firms as soon as possible. There is no advantage in keeping cocoa in the house where it is liable to deteriorate in quality. This practice by price speculators should be discouraged. The estimated contribution of bagging and storage practices to quality decline in the cocoa production chain is about 10 percent.

METHODOLOGY

The study made use of primary data. Data was collected through personal interview 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. The interviews were conducted privately to avoid duplication of ideas and unnecessary influence of one farmer answer on the others. A total of 107 questionnaires were administered across the four local government areas. A multistage sampling technique was employed in the study to select the respondents. This made a total of 4 Local Government Areas (LGAs) out of the 16 LGAs in the state. 14 rural communities were later selected with at least four from each of the LGAs. Respondents were randomly selected based on probability proportionate to size and a total of 120 questionnaires were administered out of which only 107 were used for the analysis. Data analysis included descriptive statistics, principal component analysis and Probity model regression analysis as the statistical tools. Ekiti State was carved out of the former Ondo State on the 1st October 1996, and is one of the six states constituting the South-Western region of Nigeria. The State is situated entirely within the tropics. It is located between longitudes 40451 to 500 51 East of Greenwich meridian and latitudes 70 151 to 80 51 North of Equator. Ekiti State has 16 Local Government Areas. Going by the 2006 National Census, Ekiti State has a population of 2,385,212 (National Population Commission 2006) and covers a total land area of 5,43500 sqkm. Ekiti State is chosen as the study area because of its prominent agricultural activities being the primary occupation the inhabitants of the study area.

RESULTS AND DISCUSSION

From the analysis of the socio-economic characteristics of the households, the result shows that majority of the respondents are male.

Analysis of the age of the respondents showed that the cocoa farmers are mostly between 50-70 years, having a total percentage of 48.59 percent. Larger percentage of the households have no formal education about 59.81 percent of the respondents. Household sizes are fairly large with household 7-10 having the highest percentage of the respondents about 42.05 percent. About 80.37 percent of the respondents are predominantly cocoa farmers as their major occupation, out of the total respondents. The result of the survey also showed that malaria is the major sickness affecting the farmers in the study area, about 66.36 percent of the households are affected by malaria at least one to three times a year. The survey also showed that most of the respondents had been engaging in cocoa farming for long period (years of cocoa farming) about 42.06 percent of the respondents has been in the business for about 40-60 years. It also showed that most of the respondents have their own cocoa farm, about 63.55 percent of the respondents, Area of land cultivated by the farmers according to the survey are fairly large with 71.96 percent of the respondents cultivating between 0.5-3acres of land. Rehabilitation of the farm is done mostly every year by the farmers about 57.94 percent of the respondents, while about 54.21 percent of the respondents have their proportion of cocoa farm covered totally with cocoa alone. It also showed that nearly all the households are affected by climate variables like rainfall (stormy, high or low) temperature (high or low) and the amount of cloud cover**.** The result of the probity regression analysis showed that age, education, marital status, household sizes, Number of cocoa farms, Nature of major sickness, land area and years of cocoa farming all have negative effect, while primary occupation and gender have positive coefficients. It all showed that they have effect on cocoa production. The vulnerability index shows that vulnerability is highly related to poverty (coping options, adaptation options and mitigation options) and the assets owned by the households.

The respondents for this study were drawn from four local governments that have highest cocoa production in Ekiti-State. In all, 107 household were respectively sampled and administered questionnaire. Analysis of Socio Economic characteristics of these households in terms of Local Government Areas (LGAs), villages, sex, age, education level, household sizes, marital status et cetera are presented in this section.

Table 1: Local Government Areas (LGAs)

Local Government	*Frequency*	*Percentage*	*C. Percentage*
Gbonyin	34	31.8	31.8
Ekiti/East	21	19.6	51.9
Ise/Orun	39	36.4	87.8
Ikole	13	12.2	100
Total	107	100	

Source: Field Survey, 2011

Table 1 shows the Local Government Areas (LGAs) chosen for the study. The finding shows

Table 2: Villages in the sampled local government

Local Govt. Areas	*Village*	*Frequency*	*Percentage*	*C. percentage*
	Bolorunduro	6	5.6	5.6
Gbonyin	Ajebamdele	14	13.1	18.7
	Obalu	2	1.9	20.6
	Akoonjo	2	1.9	22.5
	Oyan Orete	6	5.6	28.1
	Ologoji	4	3.9	31.8
Ekiti/East	Eda-Ile	9	8.4	40.2
	Isinbode	7	6.5	46.7
	Igbo-Odun	6	4.7	51.4
Ise/Orun	Afolu	5	4.7	56.1
	Kajola	10	9.3	65.4
	Adeyanju	4	3.7	69.1
	Ekemode	10	9.3	78.4
Ikole	Fatunla	8	7.5	85.9
	Ikoyi-Ile	5	4.7	90.6
	Temidire	10	9.3	100
Total		107	100	

Source: Field Survey, 2011

that Ise/ Orun Local Government Area (LGA) has 36.4 percent of cocoa production in Ekiti State, followed by Gboyin Local government Area (LGA) with 31.8 percent, Ekiti East LGA has 19.6percent while Ikole LGA has 12.2 percent of cocoa production.

Table 2 shows the responses received from each village in the selected LGAs. Ajebamidele village in Gboyin LGA has the highest numbers of villages with 13.1 percent of cocoa production and the least in the distribution are Obaaolu and Konjo villages with 1.9 percent. In Ekiti East, Eda ile with 8.4 percent has the highest, Kajola and Ekemode in Ise/orun local government ranked the highest with 9.3 percent while Temidire village in Ikole LGA has 9.3 percent of cocoa production.

Table 3: Gender of the respondents

Gender	*Frequency*	*Percentage*	*C. Percentage*
Male	104	97.2	97.2
Female	03	2.8	100.0
Total	107	100	

Source: Field Survey, 2011

Table 3 shows the gender distribution of the household. Based on the summary report, 97.2 percent of the respondents were males and 2.8 percent were females. It shows that there are more males engaging in cocoa farming than females in the study area.

Table 4: Distribution of household by age

Age	*Frequency*	*Percentage*	*C. Percentage*
31-40	08	7.48	10.28
41-50	26	24.30	34.58
51-60	25	23.36	57.94
61-70	27	25.23	83.17
71-80	17	15.89	99.06
81-90	01	0.93	100
Total	107	100	

Source: Field Survey, 2011

Table 4 shows the distribution of household by age**.** Analysis of the age structure of the respondent shows that the age with the highest frequency falls within 61-70, with 25.28 percent of the total respondents, 2.80 percent were between less than/equal to 30, 7.48 percent were between 31-40, 24.30 percent are between 41-50, 23.36 percent are between 51-60, 15.89 percent talks between 71-80 and the coast percentage is between 81-90, with 0.93 percent. It shows that the highest frequency and percentage of coca farms are between 61-70 and are aged.

Table 5: Distribution of household by formal education

Education	*Frequency*	*Percentage*	*C. Percentage*
No	64	59.81	59.81
Yes	43	40.19	100
Total	107	100	

Source: Field Survey, 2011

Table 5 shows distribution of household by formal education. Analysis of the household formal education status showed that 59.81 percent of the household had no formal education, while 40.19 percent, of the household had formal education, then implied that large percentage of the household had no formal education.

Table 6: Distribution of the household by education level

Education level	*Frequency*	*Percentage*	*C. Percentage*
PRY.	16	14.95	14.95
JSS	2	1.87	16.82
SSCE	14	13.08	29.90
NCE	5	4.67	34.57
OND	4	3.74	38.31
HND	1	0.93	39.24
B.Sc./MA	1	0.93	40.19
No Formal Education	64	59.81	100
Total	107	100	

Source: Field Survey, 2011

Table 6 shows the educational distribution of the farmers in the study area. The finding reveals that 59.81percent of the cocoa farmers had no formal education. In addition, 14.95 percent of the farmers have primary education while 13.08 percent of respondents accounted for SSCE (Secondary School Certificate Examination).

Table 7 shows the years of education of the respondents**.** The distribution of the house by the years of education showed that 51.16 percent of the households had years of education between 4-10, while 34.88 falls within 11-15 and the least percentage is between 16-20 with 13.95

percent of the households that had formal education.

Table 7: Years of education

Years of education	*Frequency*	*Percentage*	*C. Percentage*
4-10	22	51.16	51.16
11-15	15	34.88	86.04
16-20	16	13.95	100
Total	43	100	

Source: Field Survey, 2011

Table 8 shows the distribution of the household by the sizes of household. The distribution of the household by their sizes household that 40.19 percent of the households fall between 3-6, 42.05 of the households is between 42.05 percent, that is, the largest while 17.76 percent of the households is between 11-15. It showed that the household with larger percentage fall within 7-10, with 42.05 percent.

Table 8: Distribution of the household by the sizes of household

Household sizes	*Frequency*	*Percentage*	*C. Percentage*
3-6	43	40.19	40.19
7-10	45	42.05	82.24
11-15	19	17.76	100
Total	107	100	

Source: Field Survey, 2011

Table 9 shows the distribution of the household primary occupation of the respondents. The distribution of the household by primary occupation showed that 80.37 percent of the household are majorly in farming, followed by 7.48 percent teaching, 4.64 percent are artisans 3.74 percent did not significant there occupation status it showed that larger percentage of the household sampled are majorly farming.

Table 9: Distribution of the household primary occupation

Occupation	*Frequency*	*Percentage*	*C. Percentage*
Family	86	80.37	80.37
Teaching	8	7.48	87.85
Civil servant	4	3.74	91.59
Artisans/apprentices	5	4.64	96.23
Not specified	4	3.74	100
Total	107	100	

Source: Field Survey, 2011

Table 10 shows distribution of the households by the nature of sickness. The distribution of the household by the nature of the sickness showed that 66.36 percent of the household had malaria, are the largest percentage, 4.69 of the households had cold, 0.93 percent is hypertensive, 3.74 percent had typhoid 6.54 percent had cough and 17.56 percent did not specified their nature of diseases. It showed that, malaria in the major disease plagued the households in the study area with 66.36 percent, the highest.

Table 10: Distribution of the households by the nature of sickness

Nature of sickness	*Frequency*	*Percentage*	*C. Percentage*
Malaria	71	66.36	66.36
Cold	5	4.67	71.06
Hypertension	1	0.93	71.96
Typhoid	4	3.74	75.70
Cough	7	6.54	82.24
Not specified	19	17.56	100
Total	107	100	

Source: Field Survey, 2011

The finding from Table 11 shows the time sick by the households. The distribution of the households by time they sick showed that 56.07 percent of the household fell sick between 1-2times last seasons, 21.50 percent fell sick between 3-5 times and 22.43 percent did not signified the time they fell sick it showed that, most of the farms in the study area fall sick between 1-2 times during the last cocoa farming seasons.

Table 11: Time sick by the households

Time sick	*Frequency*	*Percentage*	*C. Percentage*
1-2	60	56.07	56.07
3-5	23	21.50	77.54
Not specified	24	22.43	100
Total	107	100	

Source: Field Survey, 2011

Table 12 shows the distribution of the household by the years of cocoa farming. The distribution of the households by years of cocoa farming showed that 30.84 percent of the households had 10-40 years of farming, 42.06 percent had

41-60 years of farming, and 7.48 percent had 61-80 years of farming and lastly, 19.62 percent did not signified their years of farming, is showed that 42.06 percent of the respondent had 41-60 years, that is, largest percentage, and most of the farmers are young and not too old.

Table 12: Distribution of the household by the years of cocoa farming

Year of cocoa farming	*Frequency*	*Percentage*	*C. Percentage*
10-40	68	63.55	63.55
41-60	9	8.41	71.96
61-80	14	13.08	85.04
Share cropping	9	8.41	93.45
Not specified	7	6.54	100
Total	107	100	

Source: Field Survey, 2011

Table 13 shows the distribution of the households by types of farms ownership. The distribution of the households by types of farm ownership showed that 63.55 percent of the households have their own personal farms, 8.41 percent have rented farms, 13.08 percent of the households have lease farms, 8.41 percent of the specified the types of their farm ownership. It showed that 63.55 percent of the household's, that is, the largest percentage has their own personal cocoa farm.

Table 13: Distribution of the households by types of farms ownership

Types of farm farming	*Frequency*	*Percentage*	*C. Percentage*
Personal farm	68	63.55	63.55
Rented	9	8.41	71.96
Lease	14	13.08	85.04
Share cropping	9	8.41	93.45
Not specified	7	6.54	100
Total	07	100	

Source: Field Survey, 2011

Table 14 shows the distribution of the household by land area. The distribution of the households by land area (in acres) of their farm showed that 71.96 percent of the respondents cultivate between 0.5-3 acres of cocoa farm lands, 21.50 percent of the respondent cultivate between 4-6 acres of cocoa farm land while 6.54 percent of the respondents didn't specified the area of land their cocoa covered. It showed that larger percentage of cocoa farms 71.96 percent have their cocoa covered between 0.5-3acres of land.

Table 14: Distribution of the household by land area

Areas of land (in acres)	*Frequency*	*Percentage*	*C. Percentage*
0.5-3	77	71-96	71.96
4-6	23	21-50	98.46
Not Specified	07	6.54	100
Total	107	100	

Source: Field Survey, 2011

Table 15 shows the distribution of the households by proportion of cocoa covered**.** The distribution of the households by proportion of land covered by their cocoa farm showed that 54.21 percent of the respondent have their cocoa farm carried 100 percent, 14.95 percent has 80 percent of cocoa farm land 8.41 has 90 percent cocoa farm land, 1.87 percent has 70 percent of cocoa farmland and 20.56 percent of the respondent did not specified their proportion of their farmland covered by cocoa. It showed that 54.21 percent of the respondents have a farmland covered with 100 percent cocoa.

Table 15: Distribution of the households by proportion of cocoa covered

Proportion of Cocoa covered	*Frequency*	*Percentage*	*C. Percentage*
70	2	1.87	1.87
80	16	14.95	16.82
90	9	8.41	25.25
100	58	54.21	79.44
Not Specified	22	20.56	100
Total	107	100	

Source: Field Survey, 2011

Table 16 shows the distribution of the households by year of cocoa farm rehabilitations. The

Table 16: Distribution of the households by year of cocoa farm rehabilitations

Years of cocoa rehabilitation	*Frequency*	*Percentage*	*C. Percentage*
Yearly	62	57.94	57.94
Between 20 years–2006	45	42.06	100
Total	107	100	

Source: Field Survey, 2011

distribution of the households by years of cocoa rehabilitation showed that 59.94 percent of the household rehabilitate their cocoa farm clearly while 42.06 percent of the households rehabilitate their cocoa farm between 2006 and within the last 20 years.

Table 17 shows the vulnerability to climate changes. It was discovered from the findings that the paraments of climate change was on the increase yearly, Thus the possibility of climate change as evident in all the reviewed paraments are very noticeable.

Table18 shows various methods adopted by these farmers in mitigating the occurrence of climate change in the study area. In 2009, farmers diversified into various crops so that the effect of climate change would not be much or too high on their cocoa production, changing of planting and harvesting periods were also use as a strategy to combat the menace of climate change.

Table 19 shows that farmers really experienced climate change and it menace in the study area with almost 91.59 percent responding positively to the question.

Table 19: Noticeable changes in climatic condition

Noticeable changes	*Frequency*	*Percentage*	*C. Percentage*
Yes	98	91.59	91.59
No	7	8.41	100
Total	100	100	

Source: Field Survey, 2011

Table 20 shows the observable climate change in the year 2010, Low temperature and delay in rain fall accounted for most of the climate change indicators in 2010.

Table 20: Observed climate changes (2010)

Climate variables	*Yes*	*No*
High temperature	4	103
Low temperature	90	17
Too much rainfall	36	21
Too low rainfall	34	86
Delay in rainfall commencement	19	88
Delay in rainfall stopping	72	35
Too stormy rainfall	22	85
Thick cloud cover	56	51

Source: Field Survey, 2011

Table 17: Vulnerability to climate changes

Climatic variables	*2009*		*2010*		*2011*	
	Yes	*No*	*Yes*	*No*	*Yes*	*No*
Observed climate change	92	15	93	14	98	09
Extremely high temperature	88	19	05	102	10	94
Extremely low temperature	88	105	94	13	93	14
Too much rainfall	02	105	89	18	90	17
Too low rainfall	02	18	07	100	86	21
Delay in rainfall commencement	86	21	11	96	04	103
Delay in rainfall stopping	04	103	82	25	89	18
Stormy rainfall	02	105	44	63	77	30

Source: Field Survey, 2011

Table 18: Mitigation option adopted by the formers in respect to climate changes

Mitigation option	*2009*		*2010*		*2011*	
	Yes	*No*	*Yes*	*No*	*Yes*	*No*
Diversify into other crops	74	33	81	26	82	25
Diversity into non-far many activities	44	63	53	54	55	52
Invest in cocoa drying machine	Nil	Nil	Nil	Nil	Nil	Nil
Monitor weather by indigenous knowledge	79	28	80	27	78	29
Re-spraying of cocoa	65	42	63	44	65	42
Irrigation	Nil	Nil	Nil	Nil	Nil	Nil
Monitor weather through the media	74	33	76	31	73	34
Planting of hybrid sees	11	96	15	92	16	91
Regular cocoa spraying	85	22	86	12	83	24
Change planting and harvesting time	37	70	38	69	37	70

Source: Field Survey, 2011

Table 21 shows that in 2009, the temperature was very high and there was delay in the rain fall timing indicating the pronounced climate change compare to 2010.

Table 21: Observed climate changes (2009)

Climate variables	*Yes*	*No*
High temperature	96	11
Low temperature	11	96
Too much rainfall	05	102
Too low rainfall	34	23
Delay in rainfall comment	85	22
Delay in rainfall stopping	44	63
Too stormy rainfall	05	102
Thick cloud cover	4	103

Source: Field Survey, 2011

Table 22 shows the observed climate change paraments that were noticeable during the study year; rainfall was too low during the farming period under review. Rainfall started too late during this time.

Table 22: Observed climate changes (2011)

Climate variables	*Yes*	*No*
High temperature	03	104
Low temperature	90	17
Too much rainfall	88	19
Too low rainfall	25	82
Delay in rainfall commencement	84	23
Delay in rainfall stopping	64	23
Too stormy rainfall	64	43
Thick cloud cover	74	33
Too low rainfall	90	51

Source: Field Survey, 2011

Table 23 shows the assets owned by these individual farmers with radio being the highest of assets this implied that these farmers are poor. With technology mobile phone accounted for 63.55 percent.

Table 23: Assets owned by the households

Assets	*Frequencies*	*Percentages*
Radio	78	72.89
Television	48	44.86
Bicycle	18	16.82
Motorcycle	54	50.47
Vehicle	20	18.69
Mobile phone	68	63.55

Source: Field Survey, 2011

Table 24 shows the effect of climate change on the farmers in the study area, the effect of this climate change was noticed in the study.

Table 24: Effect of the changes on health of the households

Areas of land (in acres)	*Frequency*	*Percentage*	*C. Percentage*
Yes	49	45.79	45.79
No	58	54.21	100
Total	107	100	

Source: Field Survey, 2011

This study shows how socio-economic characteristics (age, education, gender, household's sizes, marital status, primary occupation, nature of major sickness, land area, numbers of cocoa farms) are vulnerable to climate changes among cocoa farm households in Ekiti-State. The following deductions were made from the analysis presented in the Table 25. The negative coefficient of the age suggest that, the higher the age of the farmers the less productive they are in cocoa production, because they are less active as when they are young, this ultimately leads to decline in their production. It also suggest that, age has a long way in affecting cocoa production as the cocoa tress are also aging like the farmers too. Genders have a positive coefficient indicating that male households are majorly in cocoa production than their female counterparts in the study area. These justify the facts that cocoa production in Africa in general is a major occupation for households headed by males than the females' households. Education level have a negative coefficient, indicating that majority of the households (farmers) are not educated, and care less about changes in climatic conditions in their environment, Hence, their vulnerability to changes in climatic conditions. It also implied that households headed by educated farmers are less vulnerable to changes in climatic conditions within their environment, because they are aware of those effects than illiterate's farms households. Household sizes also have a negative coefficient, showing that the smaller the household's size, the lower is there degree of vulnerability to changes in climatic conditions. Therefore, the larger the household size, the larger is their degree of vulnerability to cope with changes in climatic conditions. Primary occupation have a positive coefficient, this indicates

Table 25: Regression analysis of the social-economic variables to changes in climatic variables in Ekiti State

Variables	*Coefficients*
Age (X1)	-1.621**
	(0.977)
Gender (X2	1.342**
	(0.314)
Education level (X3)	-1.452**
	(0.161)
Marital status (X4)	-0.312*
	(0.682)
Household's sizes (X5)	-0.181**
	(0.719)
Primary occupation (X6)	0.341***
	(0.721)
Nature of major sickness (X7)	-0.241*
	(0.638)
Numbers of cocoa farms (X8)	-0.381**
	(0.779)
Land area (X9)	-0.423**
	(0.664)
Years of cocoa farming (X10)	-0.112**
	(0.548)
Log likelihood = -121.2370	
Numbers of observation = 107	
Chi-squared = 13.10661	
Significance level = 0.4396	
**Coefficient significance at 1%*	
***Coefficient significance at 5%*	
****Coefficient significance at10%*	

that majority of the farmers in the study area are mostly farmers, which are majorly in cocoa production. It also indicate that farming households are vulnerable to changes in climatic conditions, as this may affect their health conditions and productivity. Nature of the major sickness also have a negative coefficient, this implies that majority of the respondent are vulnerable to climatic conditions which make them prone to certain diseases or the others, majorly malaria , this greatly affect their productivity as this may lead to decrease in their yield. The coefficient of numbers of cocoa farms owned by each household is also negative; this implies that most cocoa farms are in small fragment in different farm locations in the study are, this justify their vulnerability to cope with changes in climatic conditions, as the small farms fragments are easily prone to the changes in extreme climatic conditions. Land area cultivated by the farmers for cocoa production also have a negative coefficient, this implies that respondents in the study area will be very prone to extreme weather conditions as the effect will be very noticeable on their yield and others crops associated with cocoa production. The coefficient of year of cocoa farming also is negative, indicating that, despite the highly experienced of the cocoa farmers, they are still very prone to or vulnerable to extreme weather conditions. This also leads to decline in their productivity over the years.

CONCLUSION

Based on the findings of the survey, it was revealed that climatic variables have both positive and negative effects on cocoa production, this is a great global problem, because the area is very vulnerable to climate changes, this is a great environmental issue that must not be taken with levity. Also, from the survey, malaria is major problems bedeviling cocoa farmers in the study area, and it greatly affects their productivities. Also, most of the farmers agreed that that government aids and assistance to help them in their production are not enough, and even when provided, they do not reach the intended farmers in the rural communities. They suggested a bottom-top approach in the distribution of subsidies to the farmers. So also, they argued that cocoa farming are now left to the aged farmers who are not active again in farming activities, as most youth has gone to the city in seeking white-collar jobs. In summary, it was revealed that fire incidence is not a common occurrence among cocoa farmers, but their production declines due to their inactiveness that is, old age. Insufficient government aids and assistance, inadequate extension services, shortage of improved seedlings and other subsidies.

RECOMMENDATIONS

Bottom-top approach system should be employed in distributing farm subsidies to the farmers, as most of the beneficiaries are not practising farmers. Farming activities should be encouraged among the young farmers, because most cocoa farmers are even older than the cocoa trees, so that new and dynamic ideas will be imported into the activities.

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