Evaluation of the Vulnerability of Cocoa Farmers to Climate Change and Their Coping Strategies in Nigeria

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Abstract

The renewed quest for sustainable economic development which is synonymous with sustainable agricultural development and hence agricultural sustainability impelled this study titled "evaluation of the vulnerability of cocoa farmers to climate change and their coping strategies in Nigeria" the study was carried out in Ondo State. Multi-stage sampling technique was used to select a sample of 140 cocoa farmers from whom data were collected using structured and validated questionnaire. Data bothering on the respondents' socio-economic characteristics, such as age, years of farming experiences, household size, level of education as well as data on the various methods of farmers copping strategies were collected and analyzed with the use of descriptive statistical tools. The Ordinary Least Square multiple regression analytical tools were also used in determining the factors that majorly affect the farmers' vulnerability to climate. Result showed that the average age of farmers is 48years and with an average farming experience of 25years. Result further shows that the study area has an average household size of six and an average yearly income of one hundred and eleven thousand, seven hundred and thirty naira. Majority (30 farmers representing 21.58%)of the farmers experience drought and heavy rain as major climatic problem affecting cocoa production while 10% of them indicated heavy rain as major climatic problem. Factors such as farm size and year of farming experience has positive effect on the adaptability of the cocoa farmers to climate change and this are significant at 1 percent level. It was concluded that, efforts should be made at both micro and macro levels of government to improve on the mitigation and adaptive strategies of climate change available to farmers by making such more affordable, available and user friendly through extension education on the appropriate uses of such technologies in a more sustainable manner.

Keywords: vulnerability, cocoa, sustainability, climate change, mitigation

INTRODUCTION

Cocoa (*Theobroma Cacao*) is an international crop that has determined both the economic and political fate of many countries of the world of which Nigeria, Cote D'Ivoire, Trinidad, Ghana, Brazil, Costa Rica and Fernando Po are prominent. Cocoa is a major cash crop of the tropical forest, most notably in West Africa where export earnings from its sales forms a major part of the economy (Mayhew and Perry, 1998).

Nigeria was the second world largest cocoa producer in the 1960s producing between 250,000 to 308,000 metric tons for export yearly and generating about 50 percent of Nigeria's revenue at that time. It thus contributed significantly to infrastructural development in the country. However, Cocoa production witnessed a downward trend after 1970/1971 season when its export declined to 216,000 metric tons and this reduced Nigeria's market share to about 6 percent to date and fifth world largest cocoa producer (ICCO, 2008). By Implication, Nigeria competes favorably with other frontline producing nations in supplying the world market. However, the production of this export crop in Nigeria has suffered a reduction in recent years owing to a number of factors (Lawal and Emaku, 2009; Oluyole and Sanusi, 2009). Among the most pressing limiting factors is climate change.

Climate change is the change in the average weather that a region experiences. Average weather includes all the features associated with weather such as temperature, rainfall and wind patterns. Climate change is caused by the accumulation of greenhouse gases in the lower atmosphere. However, the concentration of these gases is increasing mainly due to human activities such as combustion of fossil fuels (releases carbon (iv) oxide) and deforestation which adds about 1.6 million metric tons of carbon (iv) oxide in the atmosphere annually (Botkin and Keller, 2000). This is not to say that climate change is caused only by man's activities, there are other causes

created by nature such as release of methane gas which is a greenhouse gas from wetlands (Strasburg, 2009). Another one is that the earth goes through a cycle of climatic changes, which usually lasts about 40,000 years (Wikipedia, 2007).

Climate is the primary determinant of agricultural productivity hence it is expected to influence crop and livestock production, hydrological balances and other components of agricultural systems (Adams and Carl, 1999). It is characterized by the stability over a long period of meteorological characteristics specific to a given geographic environment. However, when talking about climate change and its effects, it is important to make adjustments and interventions in order to manage the losses or take advantages of opportunities presented by it. These adjustments or interventions are known as adaptation (IPCC, 2001). Adaptation can be viewed as reducing the severity of many impacts of adverse conditions that is prevailing in the environment. Adaptation to environmental change is a fundamental human trait and is not a new concept. Throughout the ages, human societies have shown a strong capacity for adapting to different climates and environmental changes. As evidenced by the widespread and climatically diverse location of human settlements throughout the world, humans have learned how to thrive in a Wide variety of climate regimes, ranging from cold to hot and from humid to dry. The resilience and flexibility exhibited in the patterns of human settlements evidence an inherent desire and some measure of capacity to adapt to climate change.

Climatic constraints, of which rainfall is a major factor, play a predominant role in the performance of National Agriculture and theircapacity to support economic growth and assure food security for the population. Therefore, rainfall variability which is as a result of climate change will affect cocoa production either positively or negatively. Rainfall stability in term of availability of water will increase cocoa production and which will invariably affects the economic welfare of the cocoa

farmers and the state at large since cocoa production is water dependent (Omotosho, 2007). While rainfall variability as a result of climate change will affect cocoa production negatively, this will equally impact negatively on the economic welfare of the cocoa farmers and the income generated by the government from graded cocoa.

Black pod diseases account for quite a lot of cocoa production losses by attacking the ripened or very young pods (Opoku*et al*, 1999). The diseases are closely related to the pattern of rainfall distribution. It is more prevalent in damp situations with utmost pod infection in years when the short dry period from July to August is very wet. Ondo State being one of the largest cocoa producers in Nigeria; it has records of fluctuations in some climatic parameters, especially rainfall, temperature and sunshine hours. Nigeria Meteorological Agency (NIMET) (2011) noted that in August 2010, some places in the South West including Ondo State recorded rainfall values that were 200-300 percent higher than normal. Consequently, this study tries to evaluate the vulnerability of the climate change to cocoa production and how the farmers has been copping through the various strategies they employ in mitigating the change.

Objectives of the Study

The objectives of the study are to evaluate the extent of vulnerability of the farmers due to climate change as its affect cocoa production and to evaluate the coping strategies the farmers are employing to mitigate against the climate change in cocoa production.In addition, the study aims at determining the socio- economic characteristics of the farmers as well as evolve policies that can militate against the farmers vulnerability to climate change.

METHODOLOGY

The study was carried out in Ondo state of Nigeria. Ondo state is bounded in the west by Osun and Ogun states, in the north by Ekiti and Kogi states, in the east by Edo and Delta States

and in the South by the Atlantic Ocean. The majority of the inhabitants live in the urban areas. It has a population of 3,812,793 (National Population Commission, 2006). The state is characterized by heavy rainfall with climate following the usual tropical pattern. The rainy season starts from March and rounds up around October while dry season is from November to February/march. Food crops such as cocoyam, tomato, maize, plantain and cash crops such as cocoa and timber are cultivated in the state (Oseni, 2010). This study was carried out in Idanre and owena areas of Ondo state. Idanre local government was chosen because it has been the highest producer of cocoa in Ondo state in the last few years (Cocoa Grading Figures, 2007-2010) and Owena local Government Area was also chosen because majority of the farmers there are engaged in cocoa production. The study made use of primary data. The Primary data were collected through personal interview and administration of questionnaire on cocoa farming households in the study area using the Multi-stage sampling technique approach in the selection of the farmers that were interviewed. The interviews were conducted privately to avoid duplication of ideas and unnecessary influence of one farmer answer on the other. On the whole, one hundred and seventy three(173) respondents were interviewed at an average of eighty six respondents per local government area.

Data Analytical Techniques: Descriptive Statistics such as frequency and percentages were used. The descriptive statistics was used to analyze the socio-economic characteristics of cocoa farming households while Tobit model was applied to analyze the factors influencing the coping strategies adopted by the farmers to mitigate climate change effects on their cocoa plantation.

The Tobit Regression model: This is stated in an implicit form is specified as:

$Yi = \beta0 + \beta1\ X1 + \beta2\ X2 + \beta3\ X3 + \beta4\ X4 + \beta5\ X5 + ei$

Where: Yi = output of cocoa in (kg)

$\beta0$ = constant

βi = estimated coefficients of the explanatory variables

Xi = explanatory variables Where Xi = X1……..X6

X1 = age

X2= years in community

X3= farming experience

X4 = farm size

X5 = retension of trees

X_6=irrigation

ei =Error Term

Result and discussion

Socio Economic Characteristics of the Cocoa Farmers

Table 1 shows the average age, years spent in school, size of farm as well as the age of the farmers cocoa farms. The result analysis shows that the average age of the farmers is 48 years indicating that majority of the farmers are still in there productive years and are vibrant capable of improving their cocoa output. Also majority of the farmers has spent an average of 6.5years in school indicating that majority has the first school leaving certificate however, table 2 further shows that 60.11% of the cocoa farmers has formal education (either completed primary/secondary/post-secondary education) this shows that most of them are literate and has the ability to adopt innovation that is capable of combating climate change. Furthermore, the result also shows that the farmer has an average of 7.7ha of cocoa farm size and an average farming experience of 24.43years. This indicates that most of them operate on a medium sca cocoa farm. It is also expected that the farmers years of experience is long enough for the farmers to acquire experience on the various methods of climate adaptation and hence his ability to cope with climate change in

his environment. The result also reveals that the average household size, years spent in community, and the age of cocoa farm are 6.7, 31years, and 31.5years respectively.

Table 2 shows the descriptive analysis of the various socioeconomic variables that were considered for the study. The result analysis shows that majority of the farmers are male (81%), married (65%) and from a Christian background. Further analysis shows that most (80%) the farmers belong to cocoa group/organization. Furthermore, majority of the cocoa farmers have formal education at one level or the other and took farming as their major occupation, while some (27.18%) of the cocoa farmers source their inputs among themselves, majority source their information regarding cocoa production majorly through the radio program (46.24%). Also, most of the cocoa farmers 61.85%, 82.66% and 62.79% do not have access to credit facilities, markets and formal institution. These could lead to inability for the farmers to combat adverse climate effects on their cocoa farms. Especially in the area of lack of credit and formal institutions where they could get more awareness on climate change

Table 3 shows the Farmers experience on climate change. The analysis shows that only 11.56% of the farmers are aware of climate change indicating that most (88.44%) of the farmers had poor knowledge of the type of climate change affecting their cocoa production. This predisposes them to adverse climatic conditions. In the evaluation of the climate change on cocoa production in the study area, analysis on table 3 shows the type of climate change that is experienced by the cocoa farmers; the result analysis shows that majority of the farmers (48.6%) experience heavy rainfall, while only 14.5% experience early rainfall. this to a large extent is capable of affecting cocoa production especially the emergence or mirid/black pod diseases. These findings corroborate with the findings of Oseni *et al*, 2011 that “The most critical climatic variable israinfall as attested to

by 57. 8% of the respondents. The modal effect of climate change is highincidence of diseases and pests infestation as attested to by 20% of the respondents".

Further analysis on Table 4 reveals the farmer's knowledge of the type of coping strategies they employed in mitigating the effect of climate on cocoa production. The result of the analysis reveals that most of the farmers (83%) have knowledge on the planting/retention of shade trees. However, a good number of farmers also have knowledge of irrigation (64%) Particularly when cocoa are newly planted, planting of cover crops (68%) and planting of intercrops (76%) on the average, farmers have knowledge on Good Agricultural Practices and use of improved seedling. the result also reveals that most of the cocoa farmers do not have knowledge of farm insurance (about 82%) and weather forecast. these are fundamental knowledge needed for the farmers in combating against climate change thus indicating the possibility of farmers' vulnerability to climate change.

Table 5 shows the result of analysis on the climate adaptation practices by farmers in the study area. The analysis reveals that majority (61%) of the farmers practice the act of using improved seeds. It further reveals that 59% representing 102 of the respondents embark on good agricultural practices that are capable of combating climate change and improving cocoa outputs. A total of 52% of the respondents practice planting of trees/retention of trees on their cocoa plots as against the 83% who has the knowledge on plating /retention of trees. On the other hand, most farmers do not practice weather forecast and farm insurance in spite of their importance to cocoa production. Though there is a corresponding low knowledge on both. This indicates that some of the farmers who process knowledge of coping strategies in combating climate change do not practice the various coping methods probably due to the fact that most of them do not have access to credit facilities as well as formal institution such as Agricultural Extension services in their area.

Factors Influencing the Coping Strategy Adopted by the Farmers using Tobit Model

Table 6: presents the results of Tobit model that showed how socio-economic characteristics of the farmers affected their use of adaptation measures. Adaptation was measured in terms of the number of strategies used by a respondent.The likelihood estimates of the Tobit model indicated that chi-square ($\chi 2$) statistic of 56.01 was highly significant ($P<0.0001$) suggesting that the model has a strong explanatory power. The pseudo coefficient of multiple determination (R^2) showed that 42.48 percent variation in the dependent variable was explained by the included independent variables. This implies that the model showed arelatively good fit to the data. The results revealed that farm size and farming experience were statistically significant at 1%, implying that they were variables found to significantly influence the adoption of coping strategies by the cocoa producing farmers in Ondo State, Nigeria. This result suggests that for every 1 unit increase in these variables there is probability of increase in coping strategies employed.this findings equally corroborate with the findings ofOwoeye, R.S.* and A.B. Sekumade, 2012 where level of education, farm size, access to extension service and farming experience were statistically significant at 1%, 5%, 5% and 10% respectively. The inverse relationship that existed between planting of cover crops,retention of trees and the adoption of coping strategies indicates that the higher these variables were, the lesser the adoption, and vice-versa.

Conclusion and recommendation

In concluding this work, most of the farmers are in their productive years with a long years of farming experience, most of them are not aware of climate change affecting their farms and do not have access to formal institutions however, majority are facing climatic problem such as heavy rainfalls. Their exist a strong correlations between the knowledge acquired by the farmers and the practices of such knowledge of coping methods to climate change. It is recommended that efforts should be made at both micro and macro levels of government to improve on the mitigation and adaptive strategies of climate change available to farmers by making available formal institutions

that can creat awareness of climate change to farmers and provide extension education on the appropriate uses of such technologies that can combat climate change and makes the cocoa farmers less vulnerable in a more sustainable manner.

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Table 1: Mean value of the variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Age of cocoa farmers	173	47.03468	18.58259	0	92
Years spent in school	173	6.612717	4.850708	0	17
House hold size	173	6.109827	6.645909	0	77
Year spent in community	173	31.11561	24.44021	0	90
Years in farming	173	24.65517	12.82819	0	61
Size of farm	173	7.757225	13.27653	0	40
Age of farm	173	31.48276	21.94389	0	52

Table 2: Socio-Economic Characteristics of the Farmers

VARIABLE	**FREQUENCY**	**PERCENTAGE**
Gender		
Male	140	80.92
Female	33	19.08
Total	173	100
Marital Status		
Divorce	10	5.78
Separated	46	26.59
Married	112	64.74
Widow	5	2.89
Total	173	100
Religion		
Christianity	142	82.08
Islam	29	16.78
Traditional	2	1.15
Total	173	100
Membership of Cocoa group		
No response	92	53.18
Yes	80	46.24
No	1	0.58
Total	173	100
Level of Education		
None	39	22.54

Incomplete primary	27	15.61
Complete primary	35	20.23
Incomplete secondary	25	14.45
Complete secondary	36	20.81
Incomplete poor secondary	3	1.73
Complete poor secondary	8	4.62
Total	173	100
Information Source		
Extension	15	8.67
Friends	02	1.16
Cocoa farmers	25	14.45
Radio	80	46.24
Newspaper	32	18.50
CRIN	12	6.94
Government	7	4.05
Total	173	100
Access to Credit Facilities		
Yes	107	61.85
No	66	38.15
Total	173	100
Access to Market		
Yes	143	82.66
No	30	17.34
Total	173	100
Availability of Formal Institution		
Yes	65	37.57
No	108	62.79
Total	173	100

Table 3: Farmers experience on climate change

Climate Change Awareness

Yes	20	11.56
No	153	88.44
Total	173	100

Type of Climate Change experienced

Drought	14	8.09
Heavy rainfall	84	48.60
Early rainfall	26	14.5
Late rainfall	3	1.7
Low temperature	20	11.60
Long dry season	10	5.8
High temperature	11	6.40
Others	5	2.90
Total	173	100

Table 4: Knowledge of coping strategies for climate change

Variable	**response**	
	Yes	no
Retention/planting of trees	143 (82.66%)	30 (17.34%)
Planting of shade trees	142 (82.08%)	31 (17.92%)
Irrigation practices	111(64.16%)	62(35.84%)
Planting of cover crop	119(68.79%)	54(31.21%)
Planting of inter crops	131 (75.72%)	42 (24.28%)
Weather forecasting	46(26.59%)	109(63.01%)
Using improved varieties	98(56.65%)	75 (43.35%)
Good agronomic practices	101 (58.35%)	72(41.62%)
Farm insurance	18 (10.4%)	155(89.60%)
Soil management practices	64(36.99%)	109(63.01%)

Table 5: Climate adaptation practices

Variable	**response**	
	Yes	no

Retention/planting of trees	90 (52%)	83 (47.98%)
Planting of shade trees	80 (46.24%)	93 (54.07%)
Irrigation practices	26 (15.03%)	147 (84.97%)
Planting of cover crop	78(78%)	95 (54.91%)
planting of inter crops	86 (49.71%)	87 (50.29%)
Weather forecasting	80(46.24%)	93(53.75%)
Using improved varieties	106(61.27%)	67 (38.73%)
Good agronomic practices	102 (58.96%)	71(41.04%)
Farm insurance	31 (17.92%)	142(82.08%)

Factors Influencing the Coping Strategy Adopted by the Farmers using Tobit Model

Ordered logistic regression Number of obs = 173

LR chi2(7) = 56.01

Prob> chi2 = 0.0000 Log likelihood = -37.914163 Pseudo R2 = 0.4248

Awareness of climate change	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Age of cocoa farmer	.0601235	.0187162	3.21	0.001	.0234405	.0968066
Member	.8329993	.7745839	1.08	0.282	-.6851573	2.351156
Level of education	-.1366294	.1897678	-0.72	0.472	-.5085675	.2353088
Size of farm	.0455958	.0271363	1.68	0.093	-.0075903	.0987819
Knowledge of GAP	.8529665	.344187	2.48	0.013	.1783724	1.52756
Knowledge of water retention	.8469649	.3177072	2.67	0.008	.2242702	1.46966
Kw.pltng.shade	.6620466	.2450532	2.70	0.007	.1817512	1.142342