IJAAAR 11 (1&2): 37-50, 2015 *International Journal of Applied Agricultural and Apicultural Research*

Cocoa farming households' vulnerability to climate variability in Ekiti State, Nigeria

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Abstract

Rural livelihoods in south western Nigeria are at risk to climate variability on the short run and climate change on the long run. This subjects agro ecological niches to high sensitivity and exposure thus reducing the adaptive capacity. Vulnerability results and the cocoa farming households, the major contributors to the Nigerian non-oil foreign exchange earnings are not exempted. This paper therefore attempts to assess the degree of vulnerability of cocoa farmers in Ekiti State to climate variability hazards using the Integrated Vulnerability Assessment Approach (IVAA). Multi-stage sampling technique was used to select 120 cocoa farmers from whom data were generated for this study. Data were processed using the Principal Component Analysis (PCA).The result indicated that Cocoa farmers in Ekiti North, Ekiti South and Ekiti Central Agro Ecological Zones (AEZs) had the vulnerability index of -0.05, -0.76 and 0.82. This implies the first two zones are more relatively vulnerable as compared to the Ekiti Central AEZ. This is attributable to the higher exposure, sensitivity and the lower adaptive capacity in the Ekiti North and South AEZs in relation to the Central. The relative low level development and poor adaptive capacity in terms of access to basic infrastructure, technology, institutions and pervading poverty in the first two AEZs can be held accountable for this. All efforts should be in put in place by all relevant agencies to promote integrated rural development that enhances investment in infrastructure and alleviation of poverty. National regulations that restrict anthropogenic activities inimical to climate variability should be put in place. Efforts should equally be made by our national government to endorse and key-in to international treaties and protocols that control climate variability and change.

Keywords: Adaptive capacity, agro ecological zones, anthropogenic activities, climate variability, exposure, hazards, sensitivity, vulnerability

Introduction

The cocoa sub-sector is an area of keen interest to policy makers in Nigeria because of its contribution to the Gross Domestic Product (GDP) and as a result of the position it occupies as the highest foreign exchange earner to non-oil export revenues. Natural and man-made resources are required in production processes. Among the natural resources necessary for cocoa production are land, water, soil and climatic variables (rainfall, temperature, relative humidity, sunshine, air and so on). The man-made resources however include labour, capital, management, e.t.c. Among the natural resources, climate is the predominant factor that greatly influences cocoa production activities. Climate by the International Panel on Climate Change (IPCC) glossary is defined as the average weather conditions over a period of time (the classical period for averaging these variables is 30 years) and the relevant quantities are most often surface variables such as temperature, precipitation, wind, cloudiness, storm, e.t.c. (http://www.ipcc.ch/pdf/glossary/ar4-wg1.pdf). Climate change implies a statistically significant change in climate characteristics over a period of time. This could be from one 30-year period to another, from one century to another or from one millennium to another. The period that is essential for climate change must not be less than 30 years. It can be a change in the mean, extremes or change in frequencies. Climate variability is variations (ups and downs) in climatic conditions on time scales of months, years, decades, centuries, and millennia. This manifests through droughts and floods. It is indicated through change in annual mean temperature and through constant mean temperature with change in extremes. In addition, is through constant mean temperature with change in frequency of extremes. In this sense, climate variability is measured by those deviations, which are usually termed anomalies. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability). Agriculture places heavy burden on the environment in the process of providing humanity with food and fibre and climate is the primary determinant of its productivity.

Given the fundamental role of agriculture in human welfare, concern has been expressed by international and national agencies regarding the potential effects of climate variability and change on agricultural productivity. Interest in this issue has motivated a substantial body of research on climate variability/change and agriculture over the last decades (Lobell *et. al*., 2008; Wolfe *et. al*., 2005; Fischer *et. al*., 2002). Nigeria`s agriculture depends highly on climate, because temperature, sunlight, water and relative humidity are the main drivers of crop growth and yield (Adejuwon, 2004). Climate change and variability are also predicted to have adverse effects on the agricultural sector of the poorer part of the world especially Sub-Saharan Africa. This has resulted to vulnerability of cocoa farming households. Vulnerability in this perspective according to Santiago (2001) is the extent to which a natural or social system is susceptible to sustaining damage from climate change. Okunmadewa (2003) puts it more succinctly as 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 before or after. Kelly and Adger (2000) conceptualized vulnerability in terms of the capacity of individuals and social groups to respond to, recover from or adapt to, any external stress placed on their livelihoods and well-being. This brings forward the close association between vulnerability and adaptation. Adaptation in this context from Alao (1999) means any adjustment, whether passive, or reactive or anticipatory that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change. 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 therefore involves adjustment to enhance the viability of social and economic activities and to reduce their vulnerability to climate variability as well as longer-term climate change.

Nigeria has lost her leading role in exportation of cocoa. This has been attributed mainly to the downward trend in cocoa production. A number of other reasons have been the inability of cocoa based industry to increase the output of their finished secondary products, small farm holdings, transportation mode and unavailability of human labour. In addition are low capital availability to farmers, variability in climatic factors and vulnerability of cocoa farming households to vagaries of climate extremes. Anim-Kwapong and Frimpong (2005) assert that cocoa is highly sensitive to variation in climatic factors most especially temperature with the resultant effect on evapotranspiration. Several views have been expressed about the impacts of irregularity of climate on cocoa production but few have been said on the level of vulnerability of cocoa farming households' to the hazards of climatic variations. It is in this respect, this paper seeks to undertake the following:

(i) Describe the socio-economic characteristics of cocoa farmers in the study area.
(ii) Assess the vulnerability of cocoa farming households to climate variability hazards.
(iii) Examine the perception and adaptation strategies adopted by the cocoa farmers to climate variability.

Mc Carthy *et al.* (2001) described vulnerability to climate change as a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity. Adger (2006) defined vulnerability as the exposure of individuals or collective groups to livelihood stress as a result of the impacts of environmental changes. This is based on cause-effect relationship. There are three major conceptual approaches to analysing vulnerability to climate change: the socioeconomic, the biophysical (impact assessment) and the integrated assessment approach respectively. Fusel (2007) suggested a framework of analysis which combines both socio-economic and biophysical aspects resulting in the integrated approach. This framework has been adopted in this study.

The socioeconomic vulnerability assessment approach mainly focuses on the socioeconomic and political status of individuals or social groups (Adger, 1999; Fussel, 2007). Individuals in a community often vary in terms of education, gender, wealth and health status. In addition, they also differ based on access to credit, access to information and technology, social capital, political power, and so on. These variations are responsible for the differences in the vulnerability levels. In this case, vulnerability is considered to be a starting point or a state (i.e. a variable describing the internal state of a system) that exists within a system before it encounters a hazard event (Allen, 2003; Kelly and Adger 2000). Vulnerability is considered to be constructed by society as a result of institutional and economic changes (Adger and Kelly, 1999). In general, the biophysical approach focuses on identifying the adaptive capacity of individuals or communities based on their internal characteristics. A study by Adger and Kelly (1999) in which the environmental factors in a district to coastal lowlands of Vietnam were taken as given, and vulnerability was analysed based only on variations in socioeconomic attributes of individuals and social groups is an example of this approach. In that study, this conceptual approach assesses the level of damage that a given environmental stress causes on both social and biological systems. This is exemplified in the monetary impact of climate change on agriculture as measured by modelling the relationship between climatic variables and farm incomes (Mendelsohn, Nordhaus and Shaw, 1994; Polsky and Esterling, 2001; Sanghi, Mendelsohn, and Dinar 1998). In addition are the yield impacts of climate change as modelled by Adams (1989), Kaiser *et al*. (1993), Olsen, Bocher, and Jensen, (2000). Other related impact assessment studies abound - climate change on human mortality and health (Martens *et al.* 1999), on food and water availability (Du Toit, Prinsloo, and Marthinus, 2001; Food and Agriculture Organization [FAO], 2005; Xiao *et al.*, 2002), and on ecosystem damage (Forner, 2006; Villers-Ruiz and Trejo- Vasquez, 1997). Although very informative, the limitation of biophysical approach however is its main focus on physical damage with respect to yield, income, and so on.

The Integrated Vulnerability Assessment Approach combines both socioeconomic and biophysical approaches to determine vulnerability. The hazard-of-place model (Cutter, Mitchell, and Scott, 2000) is a good example of this approach, in which both biophysical and socioeconomic factors are systematically combined to determine vulnerability. The vulnerability mapping approach (O'Brien *et. al.,* 2004) is the other related example, in which both socioeconomic and biophysical factors were combined to indicate the level of vulnerability through mapping. This is done by first identifying social and biophysical factors that were consistently identified within literature as contributing to vulnerability (Table 1). These target variables are then used to identify a set of normalised independent variables which influence vulnerability. These variables are then entered into a Principal Component Analysis (PCA), from which the first principal components that have the capacity of explaining highest percent of the total variance in the original dataset are determined. These components are assessed to identify what component of vulnerability they represent, and they are scaled to ensure that they contribute to the final vulnerability index in an appropriate manner. The factors are then added with equal weights to create the final vulnerability index. The lower the vulnerability index, the higher the vulnerability and the higher the index, the lower the vulnerability of the community or the ecological zone. The Integrated Vulnerability Assessment Approach though corrects the weaknesses of the other approaches, has its criticisms. The non-existence of standard method for combining the biophysical and socioeconomic indicators has been mentioned. Cutter, Mitchell, and Scott (2000) have equally queried the absence of common metric for determining the relative importance of the social and biophysical variables of vulnerability. Not accounting for dynamism in vulnerability has also been raised. Campbell (1999) and Eriksen and Kelly (2007) assert that coping and adaptation are characterized by a continual change of strategies to take advantage of opportunities. This dynamism though claimed to be missing in this approach, it still has much to offer in terms of policy formulations to solving the problem of vulnerability and the search for relevant adaptation strategies hence the adoption for this study.

Methodology

Study Area

The study was carried out in Ekiti State. The State was carved out of Ondo State on October 1, 1996. It is located in the south-western part of Nigeria and it has 16 component Local Government Areas. It is bounded on the west by Osun State, on the south by Ondo State, on the north by Kwara State and on the east by Kogi State.

The total land area of the state is about 6,353km^2 and it has a population of 3,930,212 (NPC, 2006) with more than 60 percent residing in rural areas. The climate follows the usual tropical pattern - the rainy season from April to October while the dry season from November to March. The state is predominantly agrarian with the inhabitants mostly engaging in the production of food crops at subsistence level. Cocoa is the major commercial (cash) crop produced for the export market.

Sampling Procedure and Size

The multi-stage sampling technique was adopted to select cocoa farmers from whom data were collected for this paper. The state was stratified along the three agro-ecological zones based on geographical location – Ekiti North, Central and South. The second stage involved a random selection of four Local Government Areas from each zone. This was followed by a random selection of two farm settlements from each of the four Local Government Areas. Finally, five cocoa farmers were randomly selected from each farm settlement bringing the total sample size to 120 respondents.

Data Sources and Collection

Primary data were used for the study. The primary data were collected through well-structured questionnaire used for personal interviews. The questionnaire derived information on socio-economic characteristics of the respondents, farm size, input sources, cocoa output, costs, income, adaptive capacities, sensitivity, exposure and adaptation strategies adopted by farmers in response to climate hazards. Information was also collected on farmers' perception on climate variability over the preceding two years.

Analytical Techniques

Descriptive statistics involving tabular presentations, frequencies and percentage distributions were used to describe the socio-economic characteristics, perception on climate variability and adaptation options of the respondents in the study area.

The Integrated Vulnerability Assessment Approach that terminated to Principal Component Analysis (PCA) was used to derive the indices of vulnerability of cocoa farmers to climate variability based on their responses in the three agro ecological zones of Ekiti State. This technique was used to extract from a set of variables few orthogonal linear combinations of the variables that capture the common information most successfully. PCA was performed to obtain the component scores which were used to weigh the variables. The purpose was to attach weights to the vulnerability variables using the component scores of the first principal component. Vulnerability is calculated thus - as the net effect of adaptive capacity, sensitivity and exposure:

Vulnerability = (Adaptive capacity) – (Sensitivity + Exposure)............................ (1)

This equation can be operationalized as follows:

$$V = [(wA_1 + wA_2 + \ldots wA_n) - (wS_1 + wS_2 + \ldots wS_n) - (wE_1 + wE_2 + \ldots wE_n)] \qquad (2)$$

Where:

V = vulnerability index

w = the weight obtained from the first principal component scores

A_1-A_n = the adaptive variables

S_1-S_n = the sensitivity variables

E_1-E_n = the exposure variables.

In the calculation, both exposure and sensitivity were assigned negative signs. The justification is that areas that are exposed to damaging climate are more sensitive to damages, assuming constant adaptive capacity (Hassan *et. al.*, 2008). Thus, a higher net value indicates lesser vulnerability and vice versa. The vulnerability indicators based on the integrated approach adopted in this paper are as shown in Table 1.

Result and Discussion

The Socio-economic Characteristics of Cocoa Farmers

This section presents information on some selected socio-economic characteristics of cocoa farmers in the study area. These include: age, gender, marital status, educational level, household size, secondary occupation, cocoa farming experience, farm sizes and type of farm ownership.

The age of a farmer is a major factor in farming activities. The mean age of farmers was 45.5 years and majority of the farmers (67.5%) were still in their economic active age of between 30-60 years (Table 2). Substantial proportions (29.2%) of the farmers were above 60 years indicating a lot of aged but experienced respondents in cocoa farming. This is expected to translate to the ability of farmers to cope with the vagaries of climate variability. The cocoa farmers were predominantly (84.2%) male, while the remaining 15.8% were female. This masculine dominance is a pointer to the highly tasking and rigorous efforts involved in cocoa production. The respondents were mostly married (81.7%) though 10.8% were widowed, 1.7% divorced and 5.8% single. This portrays that the likelihood of requiring female partnership especially during the harvesting period cannot be overemphasized in cocoa farming households.

With respect to educational level of respondents, 17.5% proportion had primary education, 19.2% had secondary while about

30% had tertiary education. The implication here is that with the highly literate proportion (66.7%), a less significant impact is expected to be recorded for vulnerability of the farmers in the different agro-ecological zones as the high level of awareness will increase the adaptive capacity to cope with climate variability. This is likely to be further enhanced by the claim of 54.2% of the total cocoa producing respondents of their ability to source additional secondary incomes. The household mean size in the study area was 9 persons indicating availability of family labour though the farm sizes were small as they were mostly 1-2 hectares fragmented lands. Majority of the respondents (70.8%) claimed the available cultivable land for cocoa to be personally owned. This indicates the likelihood of land tenure problem in the study area that might militate against expansion in cocoa production despite the massive experience the farmers possess.

Table 1: Indicators Adopted for the Integrated Vulnerability Assessment Approach

S/N	Indicators	Variable	Conceptual basis
1	Non-farm income	Wealth	Adaptive capacity
2	Ownership of radio	Wealth	Adaptive capacity
3	Ownership of livestock	Wealth	Adaptive capacity
4	Quality of house	Wealth	Adaptive capacity
5	Access to large farm land	Wealth	Adaptive capacity
6	Access to modern toilet	Wealth	Adaptive capacity
7	Use of improved crop variety	Technology	Adaptive capacity
8	Access to inputs supply	Technology	Adaptive capacity
9	Access to cocoa drying machine	Technology	Adaptive capacity
10	Health care services	Infrastructure	Adaptive capacity
11	Access to public transport	Infrastructure	Adaptive capacity
12	Access to market	Infrastructure	Adaptive capacity
13	Primary and secondary school	Institution	Adaptive capacity
14	Telephone services	Infrastructure	Adaptive capacity
15	Extension services	Institution	Adaptive capacity
16	Financial institution	Infrastructure	Adaptive capacity
17	Electricity	Infrastructure	Adaptive capacity
18	Farmer's association	Institution	Adaptive capacity
19	Irrigation potential	Infrastructure	Adaptive capacity
20	Access to improved water source	Infrastructure	Adaptive capacity
21	Incidence of flood/erosion	Climate extreme	Exposure
22	Scarcity of food	Climate extreme	Exposure
23	Malaria incidence	Climate extreme	Exposure
24	Scarcity of water	Climate extreme	Exposure
25	Pest infestation	Climate extreme	Exposure
26	Extremely high temperature	Climate change	Sensitivity
27	Too much rainfall	Climate change	Sensitivity
28	Too low rainfall	Climate change	Sensitivity
29	Too stormy rainfall	Climate change	Sensitivity
30	High intensity sunlight	Climate change	Sensitivity

Source: Field Survey, 2012.

Table 2: Socio-economic Characteristics of the Respondents

Personal characteristics	*Frequency*	*Percentages*	*Mean*
Sex:			
Male	101	84.2	
Female	19	15.8	
Age (years):			
Bellow 30	4	3.3	
Between 30-60	81	67.5	45.5
Above 60	35	29.2	
Marital status:			
Married	98	81.7	
Single	7	5.8	
Divorced	2	1.7	
Widowed	13	10.8	
Educational level:			
No former education	40	33.3	
Primary education	21	17.5	
Secondary education	23	19.2	
Tertiary education	36	30.0	
Cocoa farming experience (years):			
Less than 30	55	45.8	
More than 30	65	54.2	
Secondary source of income:			
Yes	65	54.2	
No	55	45.8	
Household size:			
1 - 5 persons	31	25.8	
6 - 10 persons	82	68.3	9
Above 10 persons	7	5.8	
Farm size (hectare):			
1 – 2 ha	89	74.2	
3 – 5 ha	28	23.4	
Above 5 ha	3	2.5	
Type of farm ownership:			
Personal farm	64	53.3	
Lease/rent farm	35	29.2	
Inherited farm	21	17.5	

Source: Computed from Field Survey Data, 2011.

Vulnerability Assessment

The cocoa households' vulnerability to climate variability in the study area was assessed based on its agro-ecological zones using the integrated vulnerability assessment approach. The relevant socio-economic and biophysical indicators of vulnerability were classified based on the Intergovernmental Panel on Climate Change (2001) definition of vulnerability that broke the components into adaptive capacity, sensitivity and exposure. Principal Component Analysis (PCA) was performed on the selected indicators (Table 3) using the SPSS statistical software. The principal component analysis produced the component scores and only the component scores of the first principal component were used in weighting the variables for the construction of the vulnerability indices, since it explained the majority of the variation in the data set. The indicators were assigned these different weights determined by the first principal component to avoid the uncertainty of equal weighting given the diversity of indicators so used.

These weights from the first principal component which were chosen for the computation of the vulnerability indices in the different agro-ecological zones were positively associated with the majority of the indicators identified under adaptive capacity and negatively associated with most of the indicators categorized under exposure and sensitivity (Table 3). The higher the value of the index, the lesser the vulnerability, and the lower the value, the greater the vulnerability. This results because of the positive loading of the adaptive capacity and the negative loading of the exposure and sensitivity to the PCA. The results of the vulnerability indices calculated show that two of the three agro-ecological zones in Ekiti State (North and South) are vulnerable since the negative value of the indices (-0.76 and – 0.05 in that order) imply vulnerability (Figure 1). The Central AEZ had positive index (0.82) and so was relatively not vulnerable to climate variability. The implication is that the overall effect of adaptive capacity, exposure, and sensitivity is only positive for Ekiti Central AEZ and negative for both Ekiti North and South. The lesser vulnerability of cocoa farmers in Ekiti Central AEZ can be associated with their relatively higher access to infrastructure and technology. In addition are the high irrigation potentials prevalent and the high literacy rate.

Table 3: Vulnerability Indicators with their Corresponding Factor Scores of First Principal Component.

Non-agricultural income	0.048
Ownership of radio and television	0.050
Ownership of livestock	0.005
Quality of house	0.050
Access to large farmland	-0.019
Modern toilet facility	0.051
Access improved crop variety	0.024
Access to inputs supply	0.036
Access to cocoa drying machine	0.027
Heath care services	0.051
Road	0.040
Access to market	0.051
Primary and secondary schools	0.051
Telecommunication	0.051
Extension services	0.035
Financial institutions	0.047
Access to electricity	-0.037
Farmer's association	-0.051
Irrigation potential	0.050
Access to water supply	-0.017
Incidence of flood	0.048
Scarcity of food	-0.045
Incidence of malaria	0.048
Scarcity of water	-0.051
Pest infestation	0.007
Extreme high temperature	-0.040
Too much rainfall	-0.047
Too low rainfall	0.048
Too stormy rainfall	-0.027
High intensity sunlight	-0.009
Eigenvalue	19.49
Proportion of variance	64.96
Cumulative proportion	64.96

Source: Computed from Field Survey Data, 2011.

Vulnerability of Ekiti North and South AEZs can therefore be attributed to the relatively lower levels of zonal development. This is manifested in the poor quality of houses, high frequency of floods and lower access to technology and infrastructure in the form of health care facilities, portable water, markets, electricity coverage etc. In this position, Ekiti South AEZ still has a lower level of vulnerability as compared to the North.

Perception of Climate Variability and Adaptation Options

Farmers' perception of climate variability indicated that majority (98.3%) of the total respondents sampled claimed to be aware of variation in climate variability while

1.7% claimed to be ignorant (Table 4). This is an indication that majority of the people in the study area are not ignorant of the variations that occurred in their climatic conditions.

Table 4: Respondents' Awareness of Climate Variability

Awareness	Frequency	Percentage
Yes	118	98.3
No	2	1.7
Total 120	100	

Source: Computed from Field Survey Data, 2011.

Cocoa Farming Households' Adaptation Strategies from 2010-2011

With respect to farming households adaptation strategies over the preceding two seasons (2010-2011), 79.2% of the respondents diversified their production activities into other crops in 2010 while 83.3% did in 2011 (Table 5). Furthermore, 42.5% engaged in non-farming activities in the year 2010 and 50.0% in 2011. A small proportion of the cocoa farmers (34.5%) monitored weather conditions through the radio and television in 2010 but this number increased in 2011 to 51.7%. The proportion of farmers who used improved varieties of cocoa in both year 2010 and 2011 were 32.5% and 33.3% respectively. Though much of the respondents did not use, it shows however a gradual shift towards fighting climate variability hazards through adaptation to the use of improved hybrid varieties. In the same vein too, majority of the farmers (72.5% in 2010 and 78.3% in 2011) have also started to spray their cocoa farms with pesticides regularly. These are bold attempts to enhance adaptive capacities to diseased conditions associated with climate variability stress. Results also show that low inputs farming system is being adopted by the majority (82.5%) of respondents (Table 6). The same is true for organic farming (60.8%) and of the farmers' use of the planting of shade trees (91.7%) to prevent effect of high intensity sunlight on their cocoa especially during the growing stage. Only 8.3% of the respondents did not. The areas where there are still some challenges in ensuring farmers adaptation to climate variability however are in insuring cocoa farms against natural disasters and other related risks such as fire outbreaks and yield losses. Accessing credit is yet another.

Table 5: Distribution of Respondents by Enterprise-Based Adaptation Strategies in the Previous Two Seasons.

Coping strategies	2010		2011	
	Frequency	Percentage	Frequency	Percentage
Diversify into other crops	95	79.2	100	83.3
Diversify into non- farming	51	42.5	60	50.0
Media weather monitoring	41	34.5	62	51.7
Planting hybrid cocoa seedling	39	32.5	40	33.3
Regular cocoa spraying	87	72.5	94	78.3

Source: Computed from Field Survey Data, 2011.

Table 6: Distribution of Respondents by Farm Practice-Based Adaptation Strategies

Adaptation strategies	Frequency	Percentages
Low inputs farming system	99	82.5
Organic farming practices	73	60.8
Cocoa farm insurance	4	3.3
Credit access	39	32.5
Plant shade tree	87	91.7

Source: Computed from Field Survey Data, 2011.

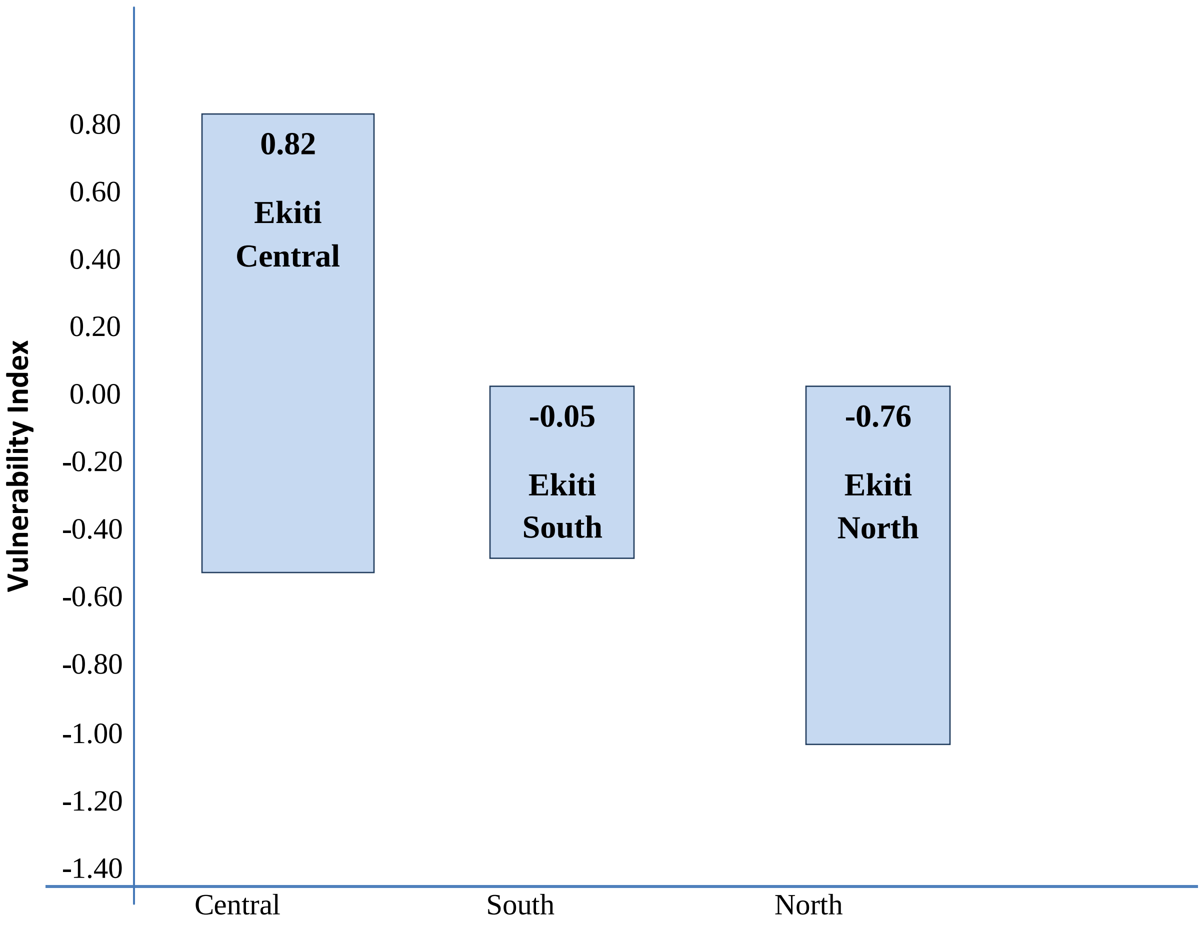

Figure 1: Vulnerability Index of Agro-Ecological Zones

Conclusion

This paper focused on the issue of climate variability and the consequent cocoa farming households' vulnerability. The socio-economic characteristics of the cocoa farmers, their perception on climate variability, the vulnerability assessment along the agro-ecological zones in the study area and the adaptation strategies put in place were major objectives considered. The analytical tools adopted were descriptive statistics, the integrated vulnerability assessment approach that terminated into the principal component analysis. The identification and usage of adaptation strategies in the study area were discussed. The mean age of the farmers was 45.5years and 67.5% were between 30 -60 years while 29.2% were above 60 years. This does not in any way favour sustainability in cocoa production as the human factors in production are seriously ageing. The literate nature of the farmers is an advantage in enhancing adaptation strategies. The land tenure system in place tilts towards farmers' personal ownership of cocoa farmlands which promotes small fragmented cocoa farmland sizes as land is hardly accessible to potential cocoa farmers that might wish to enter the industry. The vulnerability indices calculated showed that two of the three Agro-Ecological Zones (AEZ) in Ekiti State (North and South) were vulnerable with the negative value of indices of -0.76 and – 0.05 in that order. The Central AEZ had positive index (0.82) and so was relatively not vulnerable. The overall effect of adaptive capacity, exposure, and sensitivity was only positive for Ekiti Central AEZ and negative for both Ekiti North and South. The lesser vulnerability of cocoa farmers in Ekiti Central AEZ can be associated with their relatively higher access to infrastructure and technology. In addition are the high irrigation potentials prevalent and the high literacy rate. The cocoa farmers' perception to climate variability and the associated vulnerability showed a very strong awareness and the willingness to tackle the malaise. It led to increased constant monitoring of weather conditions through radio and television on yearly basis. This informed the various adaptation strategies put in place, one of which was diversification into other crops that cocoa farmers embraced increasingly from one year to the other. Others were the use of improved variety of planting stock that were resistant to changes in weather conditions, regular spraying of farms by pesticides to prevent disease outbreaks resulting from climate variability, low input farming systems that mostly involved organic farming and planting of shade trees to prevent the effect of high intensity sunlight on cocoa trees. Based on the findings of this study, a tireless effort must be made by the government to enact and enforce laws and regulations to control social and economic activities that can lead to the emission of Green House Gases (GHGs) which are the major sources of climate variability/change. Such controls should be effected in the area of deforestation, bush burning, use of fossil fuels, land degradation, use of heavy mechanical equipments, waste burning and use of agrochemicals among many others. Vulnerability to climate variability is highly linked to loss of adaptive capacity which partly results from poverty. An integrated rural development schemes aimed at alleviating poverty can play a double role of reducing poverty and increasing adaptive capacity of the farmers to climate variability. Special emphasis should be placed on the relatively less-developed agro-ecological zones of the state (north and south) in terms of investment in technology, institutions, and infrastructure which will go a long way in mitigating against exposure and sensitivity to climate variability and therefore enhancing adaptive capacity. A greater effort should equally be made to enhance the investment in these facilities in the Central AEZ of the study area for sustainability of the vulnerability status. Strengthening the adaptation methods of individual cocoa farmers in terms of organic farming practice, low inputs farming techniques, good drainage and conservation of natural resources can also boost the adaptive capacities of the farmers in the study area. Much have to be done on access to insurance facilities for the cocoa farmers to ameliorate against losses in times of natural disasters elated risks of fire outbreaks, flood, disease and pest infestation resulting to yield losses. An enabling environment should be put in place by government for private insurance companies to embrace to expand their facilities to cocoa producers. Access to credit is another area that can offer choices to cocoa farmers on the most efficient adaptation strategies to adopt to tackle their climate variability induced vulnerability problems. All efforts therefore have to be put in place to ensure farmers are able to access credit facilities. As education offers enhanced perception of climate variability and the consequent hazards, the populace – that include the current and prospective cocoa farmers should be empowered by all relevant agencies to acquire it. Extension services should also mobilize awareness campaigns and education talks on these sensitive areas of climate variability, associated vulnerability and adaptation strategies on their working visits to cocoa farmers. These will go a long way to enhancing mitigation and adaptive capacities to cope with climate variability. In addition, deliberate efforts should be put in place to improve the land tenure system to enable access to land by the current and prospective cocoa farmers. This will change the small fragmented cocoa farms to bigger estates and bring about greater leverage in the resources to tackle the vulnerability associated with climate variability. Furthermore, the younger generations with greater education and skills should be encouraged to imbibe cocoa farming. The state where the ageing class are still mostly dominant in cocoa production is not a situation that promotes sustainability in the industry. There is a lot of hope if these recommendations are put in place, the twin problems of climate variability and cocoa farming households' vulnerability will be put to rest and the "cocoa restoration programme", one of the 8-points agenda of the current Ekiti state government will be achieved.

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