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Vulnerability of Peasant Cocoa Farmers to Climate Change in South-west Nigeria

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ABSTRACT Vulnerability of farmers to climate change has recently occupied a central place in research endeavours. This study focused on cocoa as one of the highly vulnerable crops to climate change. Data were collected using multi-stage random sampling of 513 farmers. Factor analysis and the ordinary least square regression were used for data analysis. Results show that at $p<0.10$, years of education, dependency ratio, age, cocoa as primary crop, primary occupation, other member sick, missed regular spraying due to illness, number of cocoa farms, farm ownership type, proportion of land covered with cocoa, age of cocoa trees, year of cocoa rehabilitation, climate affects health, ownership of bicycle, ownership of vehicle and access to extension services have statistically significant influence on climatic change vulnerability. The study recommended adequate education, youth involvements, and rural market development among others, for addressing climate change vulnerability.

INTRODUCTION

The dominant role of agriculture in many developing countries, and its primary dependence on rainfall make it obvious that a small climatic instability can cause some devastating socio-economic consequences (Medugu 2009). In Nigeria, agriculture as the dominant sector of the economy contributed 41.84 percent to the Gross Domestic Product (GDP) in 2009 (National Bureau of Statistics (NBS) 2009) out of which cocoa accounted for about 27 percent (Gumm 2010). Despite current rapid urbanization, more than half of the Nigerian population still lives in rural areas and primarily depends on farming for their livelihoods {United States Agency for International Development (USAID) 2003}. Some statistics have shown that about 70 percent of the total labour force is engaged in agriculture and related activities (Adejuwon 2004).

Accordingly, Nigeria's home-grown poverty reduction document - National Economic Empowerment and Development Strategy (NEEDS) - emphasized adequate agricultural development as a priority for enhancing peasant farmers' productivity {Federal Government of Nigeria (FGN) 2004}. It has also been realized that because of high poverty level, Nigerian farmers exhibit some vulnerability to several adverse economic, environmental and climatic shocks.

Blaikie (1994) described vulnerability as the characteristics of a person or group to anticipate, cope, resist and recover from the impact of some natural hazards. In some other context, risk and vulnerability to environmental change have generally considered resources such as land or economic assets as the object of analysis, while some climatic factors act as subject of risk. Also, some disciplines have attempted to examine the various aspects of social vulnerability, often in the context of vulnerability to famine

United Nations (2004) distinguished four groups of vulnerability factors that are relevant in the context of disaster reduction. The first is the physical factors which describe the exposure of vulnerable elements within a region. The second is economic factors which describe the economic resources of individuals, populations groups, and communities. Social factors is the third and they describe non-economic factors that determine the well-being of individuals, populations groups, and communities, such as the level of education, security, access to basic human rights, and good governance. The fourth is the environmental factors that describe the state of the environment within a region. All of these factors describe properties of the vulnerable system or community rather than of the external stressors.

Hassan (2003) submitted that agro-ecosystems in Africa are most vulnerable to climate change. It was noted that climate is already hot in most parts of Africa with crop productivity decline, higher demand for land conversion and irrigation, increased intensification, higher dependence on agriculture livelihoods, low ability of African farmers to adapt, limited access to capital and technological options and poor public infrastructure (roads, information, research, extension).

Füssel (2009) submitted that the scientific use of 'vulnerability' has its roots in geography and natural hazards research. However, it was noted that the term is now a central concept in a variety of research contexts such as natural hazards and disaster management, ecology, public health, poverty and development, secure livelihoods and famine, sustainability science, land change, and climate impacts and adaptation. Vulnerability is conceptualized in very different ways by scholars from different knowledge domains, and even within the same domain. For instance, natural scientists and engineers tend to apply the term in a descriptive manner whereas social scientists tend to use it in the context of a specific explanatory model (O'Brien et al. 2004; Gow 2005).

Füssel (2009) submitted that the most prominent interpretations of vulnerability in the climate change context are contextual vulnerability and outcome vulnerability. These interpretations of vulnerability are based on different conceptual frameworks and are based on different rankings that suggest different strategies for reducing vulnerability. Contextual vulnerability is rooted in political economy. It is determined exclusively by internal characteristics of the vulnerable system or community that determine its propensity to harm for a wide range of hazards. Outcome vulnerability represents an integrated vulnerability concept that combines information on potential climate impacts and on the socio-economic capacity to cope and adapt (O'Brien et al. 2004; O'Brien et al. 2007; Füssel 2007).

In some previous studies, Blaikie et al. (1994) highlighted some social factors that are involved in collective vulnerability as gender and ethnic factor. Also, Adger and Kelly (1998) highlighted the role of credit in recovery from stress and disruption of livelihoods. Adger (1996) justified the focus on absolute poverty as variable for climate change vulnerability because it exacerbates vulnerability through the mechanisms of lack of resources for handling external shocks, correlation of poverty to disempowerment, lack of access to resources when shocks occur, and the reliance of the poor on communal and other resources which may be more physically vulnerable to external shocks.

Objectives of the Study

This study seeks to fulfill the following objectives:

i. Describe the nature of climatic change parameters that households have recently observed.
ii. Construct indices of vulnerability and provide a village-level spatial description.
iii. Determine the factors that influence computed vulnerability.

The working hypothesis is that vulnerability to climate is the same across gender, across educational groups and different household sizes.

MATERIAL AND METHODS

Data Sources and Sampling Procedures

Cocoa is largely grown in the southwestern part of Nigeria. Data for the study were derived from both primary and secondary sources. Primary data were collected from a representative household survey that was conducted in three (3) cocoa producing states in southwest Nigeria. The primary data were obtained through a multi-stage sampling procedure. In the first stage, three cocoa growing states were randomly selected from the six states that make up southwest Nigeria. The selected states were Ondo, Osun and Ekiti. The second stage involved the random selection of some major cocoa producing Local Government Areas (LGAs). These include, Ile-Oluji/Oke Igbo, Owo and Idanre LGAs in Ondo state, were randomly selected. In Osun state, Aiyedaade, Irewole, IsokanAtakumosaWest LGAs were selected. and IseOrun, Gbonyin, Ekiti East and Ikole LGAs in Ekiti state were selected. In the 3rd stage, a list of cocoa growing villages from each of the LGAs were compiled from where specific numbers of cocoa farm households were sampled in proportion to the estimated number of cocoa farmers that existed in those villages. Being the highest cocoa growing state, a total of 282 questionnaires were administered in Ondo state and 106 and 125 in Ekiti and Osun states respectively. The distribution of the respondents according to states, LGAs and villages is presented in Table 1. Also, secondary data on weather variables available from the Nigerian Meteorological

Agencies along with soil data contained in several soil map data for the selected states were used.

Construction of Climate Change Vulnerability Indices and its Correlates

Indices of climate change vulnerability were computed using information sought on those weather variables that have recently had adverse welfare impacts on the farmers. Specifically, the questions probed into the impact of extremely high temperature, extremely low temperature, too much rainfall, too low rainfall, delay in rainfall commencement, delay in rainfall stopping and stormy rainfall. The choice for composite vulnerability index was inspired by that nature of the data, probing into 2009, 2010 and 2011and the fact that the weather attributes are seven. It was therefore resolved to have a composite vulnerability index that can vividly portray the extent of vulnerability of the households, using the factor analysis (FA).

Vulnerability index derived from FA can be represented as:

$$A_i = f_1(a_{i1} - a_1)/(s_1) + \ldots\ldots\ldots\ldots + f_n(a_{in} - a_n)/(s_n) \qquad 1$$

$$Z_i = \sum_{j=1}^{n} f_j (a_{ij} - a_j)/s_j \qquad 2$$

where A_i is the climate change vulnerability index for each farmer (*i=1….513*). Ignoring the time dimension, f_j is the scoring factor for each weather variable (j=1,….n), a_{ij} is the jth weather exposure of ith farmer (i,j = 1,……n), a_j is the mean of ith weather exposure of farmer (j = 1,…..n), s_j is the standard deviation of jth weather exposure of farmer (j = 1, …… n) and z is the standardized variables of each farmer. Derived from FA, scoring factors of the first principal component (the efficient component) was used for constructing the vulnerability index of each farmer. Since all weather variables are dichotomous and take only a value of zero or one, then the weight is easy to be interpreted. A move from 0 to 1 changes the index by *fj / sj* .

Using the vulnerability index computed by this formula, each farmer can then be gauged on the extent of vulnerability to climatic change, while the indices were also subjected to further parametric analysis using the ordinary least square method (OLS). This is to explore the correlates of climate change vulnerability by estimating the specified equation:

$$A_i = \eta + \beta_j \sum_{j=1}^{28} Z_i + e_i \qquad 3$$

With β_j being the estimated parameters, are the explanatory variables with sex (male =1, 0 otherwise), years of education, household size, dependency ratio (number of household members that are less than 15/Number that are more than 15 years old), age of household head (years), cocoa as primary crop (yes =1, 0 otherwise), primary occupation is farming (yes =1, 0 otherwise), number of time the farmer was sick during the cropping season, malaria as a major sickness during the cropping season (yes =1, 0 otherwise), other household members fell sick during cropping season (yes =1, 0 otherwise), missed cocoa spraying due to illness (yes =1, 0 otherwise), number of cocoa farms, farm ownership type (personal = 1, 0 otherwise), cocoa land area (acres), proportion of land covered with cocoa (%), age of cocoa trees (years), year of cocoa farm rehabilitation, cocoa farm distance to village (miles), number of cocoa sprayers owned by the farmer, climate affects health (yes =1, 0 otherwise), ownership of radio (yes =1, 0 otherwise), ownership of television (yes =1, 0 otherwise), ownership of motorcycle (yes =1, 0 otherwise), ownership of bicycle (yes =1, 0 otherwise), ownership of vehicle (yes =1, 0 otherwise), ownership of mobile phone (yes =1, 0 otherwise), access to extension services (yes =1, 0 otherwise) and cocoa market distance (miles). The researcher used the Variance Inflation Factor (VIF) to test for multicollinearity among the variables.

RESULTS AND DISCUSSION

Vulnerability of Cocoa Farmers to Climatic Change

Assessment of vulnerability of cocoa farmers to some specific elements of climate requires construction of composite indices using the FA method. Table 2 shows the responses of the farmers in terms of those weather parameters they are vulnerable to. Seven indicators of climate change including extremely high temperature, extremely low temperature, too much rainfall, too low rainfall, delay in rainfall commencement, delay in rainfall stopping and stormy rainfall were selected. The factor analysis results show that out of the seven factors, the first factor has an Eigen value of 1.50344 which accounts for 102.09 percent of the total variance in the data. This implies that the first factor already explains ev-

Table 1: Distribution of cocoa farmers in the selected states in southwest Nigeria

State	*Local Government Areas (LGAs)*	*Villages*	*Frequency*
Ekiti State	Ise Orun	Adeyanju	4
	Ise Orun	Afolu	5
	Ise Orun	Ekemode	10
	Ise Orun	Kajola	10
	Ise Orun	Temidire	10
	Gbonyin	Ajebamidele	14
	Gbonyin	Akowonjo	4
	Gbonyin	Bolorunduro	6
	Gbonyin	Ologoji	4
	Gbonyin	Oyan Orete	6
	Ekiti East	Eda Ile	9
	Ekiti East	Igbo Odun	5
	Ekiti East	Isinbode	6
	Ikole	Fatunla	8
	Ikole	Ikoyi Ile	5
Total	Total		106
Ondo State	Ile Oluji/Oke Igbo	Akinye	24
	Ile Oluji/Oke Igbo	Araromi	35
	Ile Oluji/Oke Igbo	Bankemo	75
	Ile Oluji/Oke Igbo	Leegun	7
	Ile Oluji/Oke Igbo	Ojowo	21
	Ile Oluji/Oke Igbo	Onipanu	10
	Owo	Amurin Owo	18
	Idanre	Apomu-Okemaye	15
	Idanre	Gberiwojo	14
	Idanre	Italoru	8
	Idanre	Igbola	10
	Idanre	Ita Olorun	26
	Idanre	Olanikan	19
Total	Total		282
Osun State	Ayedaade	Araromi Owu	20
	Ayedaade	Orile Owu	15
	Ayedaade	Mokore	8
	Isokan	Ayepe	19
	Isokan	Oja Oosa	6
	Irewole	Ayetoro	9
	Irewole	Bembe	10
	Irewole	Odeyinka	12
	Atakumosa West	Osu	26
Total	Total		125

Source: Field Survey 2011

Table 2: Frequency distribution of observed forms of climatic change that cocoa farmers are vulnerable to in southwest Nigeria

Year	*2009*			*2010*			*2011*		
Observed climate changes	*Ondo*	*Osun*	*Ekiti*	*Ondo*	*Osun*	*Ekiti*	*Ondo*	*Osun*	*Ekiti*
Extremely high temperature	32	8	87	37	3	5	33	11	9
Extremely low temperature	7	1	2	14	0	93	9	6	92
Too much rainfall	42	2	2	100	5	88	190	96	89
Too low rainfall	18	1	87	14	1	6	13	10	0
Delay in rainfall commencement	25	1	85	53	6	16	64	29	4
Delay in rainfall stopping	19	0	0	33	3	81	68	18	88
Too stormy rainfall	25	1	2	53	0	43	68	3	76
Total	282	125	106	282	125	106	282	125	106

Source: Field Survey 2011

ery variance in the data, and should be used for the analysis. The results further reveal the factor loadings, which are the weights and correlations between each variable and the factors. These show that only four factors were retained due to the fact that they have Eigen value greater than zero. Also, the results show that all the variables in factor 1 are positively correlated with all the seven climate change vulnerability indicators but extremely low temperature, delay in rain stopping and stormy rainfall have highest correlation coefficients of 0.7114, 0.6681 and 0.6213, respectively. These are the most important variables that define factor 1. The uniqueness values, which show the variations not shared by other variables further reveal that extremely high temperature, too much rainfall, too low rainfall and delay in rainfall commencement are with the highest values of 0.9018, 0.8039, 0.9067 and 0.8050, respectively.

Table 3 further reveals the indices of vulnerability at the state and village levels. It shows that across the states and time, cocoa farmers in Ekiti state show the highest climate change vulnerability. This is followed by the farmers from Ondo and Osun states. At the village level, for

Table 3: Climate change vulnerability indices of cocoa farmers in southwest Nigeria

State	*LGA*	*Village*	*Freq*	*Average climate vulnerability indices*			
				2009	*2010*	*2011*	*All*
Ekiti State	Ise Orun	Adeyanju	4	2.73	2.47	2.16	4.37
	Ise Orun	Afolu	5	0.97	0.74	0.24	0.79
	Ise Orun	Ekemode	10	0.57	1.15	-0.04	1.02
	Ise Orun	Kajola	10	2.42	2.00	2.28	4.07
	Ise Orun	Temidire	10	2.71	2.36	2.37	4.35
	Gbonyin	Ajebamidele	14	2.93	2.66	2.48	4.90
	Gbonyin	Akowonjo	4	1.05	0.91	1.35	2.05
	Gbonyin	Bolorunduro	6	3.24	2.32	2.81	5.04
	Gbonyin	Ologoji	4	0.69	0.95	0.38	1.47
	Gbonyin	Oyan Orete	6	3.08	3.09	2.74	5.37
	Ekiti East	Eda Ile	9	3.17	2.62	2.69	5.09
	Ekiti East	Igbo Odun	5	2.27	2.01	1.94	3.79
	Ekiti East	Isinbode	6	2.41	2.78	1.96	4.20
	Ikole	Fatunla	8	2.75	1.93	2.60	4.43
	Ikole	Ikoyi Ile	5	2.80	2.07	2.12	4.32
	Total		106	2.36	2.09	1.96	3.88
Ondo State	Ile Oluji/Oke Igbo	Akinye	24	-0.58	-0.13	-0.45	-0.71
	Ile Oluji/Oke Igbo	Araromi	35	-0.26	-0.09	-0.51	-0.53
	Ile Oluji/Oke Igbo	Bankemo	75	-0.40	-0.25	-0.31	-0.60
	Ile Oluji/Oke Igbo	Leegun	7	-0.54	0.99	0.55	0.46
	Ile Oluji/Oke Igbo	Ojowo	21	0.06	-0.06	-0.63	-0.38
	Ile Oluji/Oke Igbo	Onipanu	10	-0.31	0.02	-0.21	-0.43
	Owo	Amurin Owo	18	-0.76	-0.99	-0.36	-1.27
	Idanre	Apomu-Okemaye	15	-0.77	-0.18	-0.23	-0.75
	Idanre	Gberiwojo	14	-0.33	-0.55	-1.21	-1.17
	Idanre	Italoru	8	-0.74	-0.45	-0.84	-1.17
	Idanre	Igbola	10	-0.53	0.59	0.38	0.11
	Idanre	Ita Olorun	26	-0.95	-0.97	-0.81	-1.58
	Idanre	Olanikan	19	-0.79	-0.42	-0.35	-0.94
	Total		282	-0.49	-0.28	-0.43	-0.73
Osun State	Ayedaade	Araromi Owu	20	-0.63	-1.22	-0.63	-1.49
	Ayedaade	Orile Owu	15	-0.98	-1.25	-0.49	-1.64
	Ayedaade	Mokore	8	-0.98	-1.02	-0.35	-1.43
	Isokan	Ayepe	19	-0.81	-0.87	-0.92	-1.49
	Isokan	Oja Oosa	6	-0.57	-1.28	-0.85	-1.57
	Irewole	Ayetoro	9	-0.98	-1.06	-0.41	-1.46
	Irewole	Bembe	10	-0.97	-1.28	-0.65	-1.70
	Irewole	Odeyinka	12	-0.87	-1.09	-0.52	-1.49
	Atakumosa West	Osu	26	-0.98	-1.28	-0.97	-1.86
	Total		125	-0.87	-1.15	-0.70	-1.60

Source: Computed from field survey data 2011 the combined data, Oyan Orete, Eda Ile and Bolorunduro (all from Ekiti state) have the highest vulnerability indices of 5.37, 5.09 and 5.04, respectively.

The determinants of climatic change vulnerability were estimated using the Ordinary Least Square (OLS) regression and the results are presented in Table 4. The f-value is statistically significant (p<0.01). This implies that the model adequately fits the data. In order to eliminate collinear variables, the tolerance levels of the included variable were computed. The results show that multicollinearity among variables had been sufficiently removed with the smallest tolerance being 53.31 percent for household head age. Out of the variables that were included, years of education, dependency ratio, age, cocoa as primary crop, primary occupation, other member sick, missed regular spraying due to illness, number of cocoa farms, farm ownership type, proportion of land covered with cocoa, age of cocoa trees, year of cocoa rehabilitation, climate affects health, ownership of bicycle, ownership of vehicle and access to extension services have statistically significant influence (p<0.10) on climatic change vulnerability.

The results show that as the years of education of the cocoa farmers increase by one unit, vulnerability to climatic change decreases by 0.0179 (p<0.01). This is expected because Mitchell and Tanner (2006) submitted that education is able to enhance the capacity of individual-farmers to withstand the consequences of climatic change due to timely awareness and preparedness. It should be noted that among the cocoa farmers, average years of education is 6.30, which implies mere completion of primary school. More specifically, 36.34 percent of them had no formal education.

The parameter of child dependency ratio is also with negative sign and implies that as dependency ratio increases by one unit, vulnerability to climatic change will reduce by 0.1439 (p<0.01). Also, average child dependency ratio is 0.957, which means almost equal representation. It should be noted, however, that Vincent

Table 4: Determinants of cocoa farmers' vulnerability to climate change in southwest Nigeria

Variable	*Parameter*	*Standard error*	*Tolerance*	*Mean*
Sex	.0691198	.1152466	0.877034	.9181287
Years of education	- .0179073***	.006454	0.652819	6.296296
Household size	.0007789	.0086601	0.815263	7.276803
Dependency ratio	- .1439274***	. .0424005	0.843547	.6599986
Age	- .0058859**	.002418	0.533093	55.00585
Cocoa as primary crop	- .2898411***	.1003155	0.769053	.8693957
Primary occupation is farming	.1689386*	.0956758	0.702550	.8362573
Number of time sick	- .0110891	.011425	0.869987	1.984405
Malaria as sickness	- .0763873	.0667478	0.819816	.6003899
Other member sick	.3484767***	.0716664	0.711706	.6081871
Missed cocoa spraying due to illness	- .1891871***	.0703798	0.727187	.4152047
Number of cocoa farms	- .0540588***	.0164771	0.857040	2.699805
Farm ownership type	- .180663**	.0794116	0.907868	.8109162
Cocoa land area	- .0026117	.0026801	0.873294	7.977193
Proportion of land covered with cocoa	.0151273***	.0024138	0.834248	79.39766
Age of cocoa trees	.0142407***	.0020098	0.603888	33.45322
Year of cocoa farm rehabilitation	.0051955	.009173	0.907762	1.005848
Cocoa farm distance to village	- .0000526	.0007354	0.891475	6.664133
Number of sprayers	- .000179	.0003482	0.928220	5.922027
Climate affects health	- .0897332	.0632065	0.896901	.5633528
Ownership of radio	.0494702	.1042157	0.668502	.871345
Ownership of television	- .0285805	.0725961	0.681572	.5672515
Ownership of motorcycle	.0926114	.0913943	0.715794	.6101365
Ownership of bicycle	.0648992	.0715356	0.891185	.1364522
Ownership of vehicle	.1561603 *	.0936361	0.810894	.1442495
Mobile phone	.1394453*	.0828885	0.669974	.7446394
Access to extension services	.0178523	.0710217	0.805477	.2553606
Cocoa market distance	.0120311*	.006796	0.872005	2.539086
Constant	- 1.050484 ***	.2954423	-	-

Source: Field Survey 2011

and Cull (2010) submitted that high degree of dependency within households is likely to subject them to more climate change vulnerability because of the likelihood of having a relatively small number adults that are economically active. In this study, it was generally discovered that farmers with higher child dependency ratio are those that are still economically active because children of many of the aged farmers have left the villages for other places in pursuit of their life careers. Similarly, children can often serve as family labour, implying access to higher pull of labour, which can be utilized to withstand the challenges from climatic changes (Salaam-Blyther et al. 2005).

Age also has a negative parameter that is statistically significant ($p<0.05$). The result further shows that as farmer's age increases by one year, vulnerability to climate change reduces by 0.0058. This is contrary to the assertion of Haq et al. (2008) that old people belong to the group that is most at risk to climate change due to physiological changes in their bodies which often subject them to more frequent illnesses. However, while it is obvious that cocoa farmers' population in southwest Nigeria is ageing (average age being 55 years), there is every indication that many of the farmers have devised some kind of risk-sharing methods, whereby the farm is leased out to young and effective migrant labourer who take care of the farm in anticipation of collecting one-third of the total profits from the harvested cocoa pods. This risk sharing behavior which is very common among the farmers in Ondo state should have neutralized the overall impact of climate change as a result of ageing because a more dynamic labourer is completely in charge.

Furthermore, the parameter (dummy) of cocoa as primary crop is with negative sign and statistically significant ($p<0.01$). This implies that those farmers that primarily cultivate cocoa have lower vulnerability to climate change. This may result from the fact that cocoa is the leading cash crop in the selected villages. However, the parameter of farming as a primary occupation (dummy) reveals that those whose primary occupation is farming have significantly higher vulnerability to climate change ($p<0.10$). This is expected because it had been widely asserted that farmers are going to be more affected by climate change (Morton 2007). However, without any other means of livelihood, vulnerability is expected to increase as the study already revealed.

Out of the health-related variables that were included in the model, only the parameters of other household member sick is statistically significant at ($p<0.01$) with positive sign. These findings go in line with the assertion of Haines et al. (2006) that when household members frequently fall sick and have some tendencies ofhaving ailments that are climate-related, their vulnerability increases.

Those who reported missing regular cocoa spraying due to sickness have significantly lower vulnerability to climate change ($p<0.01$). This, though unexpected can be explained from the fact that the farmers commended efficiency of the chemical (ridomil) that is presently approved by the Cocoa Research Institute of Nigeria (CRIN) for cocoa pod spraying nation-wide. Precisely, results of field trials to determine efficacy of Ridomil, Funguran, Champ and Nordox on the level of development of black pod disease on matured cocoa pods had been reported by Matthews et al. (2003), Norgrove (2007) and Opoku et al. (2007) and it was concluded that Ridomil was more effective for the control of black pod diseases than any of the chemicals.However, in Osun state, some farmers were mixing the chemical with some other pest-killers to enhance efficiency and sustain its efficacy in situation where the farmer is unable to spray cocoa pod at the stipulated time.

Furthermore, the parameter of number of cocoa farms implies that a unit increase in the number of cocoa farms reduces vulnerability by 0.0506 ($p<0.01$). This is expected because the higher the number of cocoa farms, the higher the risk spreading spectrum of the farmers. Also, those farmers that own their farms have lower vulnerability to climate change ($p<0.05$). This can be explained from higher risk sharing capacity that personal owners of cocoa farms possess.

As the proportion of land that is covered with cocoa increases by one unit, vulnerability to climate change increases by 0.0151 units ($p<0.01$). This may have resulted from the need not to put one's eggs in one basket. Also, vulnerability to climate change increases by 0.0142 unit if the age of cocoa increases by one year ($p<0.01$). It should be further noted that average year of cocoa trees is 33.45 years, showing that the trees are aged. In fact, many of respondents did not personally plant the cocoa trees, because the farms were given to them as an inheritance.

Furthermore, those farmers that have access to vehicle have significantly higher autonomous vulnerability ($p<0.10$). While it is expected that access to means of transportation should reduce climate change vulnerability, this may not be the case in rural areas where the villages and cocoa farms may lack adequate access roads. Therefore, in many of such cases, bad roads complicate vehicle maintenance requirements and subject farmers to higher climate change vulnerability.

Ownership of mobile phone increases climate change vulnerability. Therefore, strengthening of telecommunication signals is vital because in many of the rural areas, signals were so poor to the extent that death of someone that climbed a tree in an attempt of searching for signal was reported. The higher the market distance, the higher the vulnerability to climate change. This is so because access to cocoa inputs will be denied when markets are far away from the farmers.

CONCLUSION

Vulnerability of cocoa agriculture to climate change is an important issue given the relevance of the crop in foreign exchange earnings and dependence of many farmers' livelihood on the crop. Recent changes in some weather parameters have serious adverse impacts on cocoa production via cocoa yield reduction due to more prevalent nature of black pod disease, death of cocoa trees and falling cocoa trees. Specifically, this study has shown that too much rainfall is a major threat to cocoa production in all the selected states, although farmers in Ekiti state were generally more vulnerable.

RECOMMENDATIONS

This study has also brought to limelight several policy issues that should be addressed in order to reduce vulnerability of cocoa farmers to climate change. There is need to provide adequate education to reduce climate change vulnerability. This can be in form of more media involvements in providing weather forecasts and other useful information. Channeling of extension contacts towards assisting farmers on climate change problems, an informal media of education, can also serve to reduce vulnerability. Majority of the farmers, having already developed habit of listening to radio in order to get farm-related information can greatly benefit from such programmes.

Ill-health among household members increases vulnerability to climate change. While there are health centers in some villages that were visited, many were not operational due to absence of health personnel. The farmers' major health problem is malaria, which can be further aggravated if climate change promotes breeding of mosquitoes. Strengthening local health centers for treatment of climate change related health problems that farmers face cannot be over-emphasized.

Government should set up a "Special Climate Change Initiative" to address farmers' problems and assist them since they exhibit more vulnerability to climate change. This is very critical because given numerous Agencies and Departments that function under the local and state governments, specific role definition exists and none is presently charged towards rural farmers' climate change related problems. Since farmers are suffering the brunt of climate change problems, a special intervention fund that focuses on assisting them to reduce their vulnerability will go a long way in soothing the pains inflicted on farmers by climate change.

Cocoa farm populations are ageing. Youths and school leavers should be encouraged to get involved in cocoa agriculture because as ages of cocoa trees increase, vulnerability also increases. Provision of adequate incentives to attract youths will go a long way in fulfilling government's goals for the "cocoa rebirth programme".

It was also found higher child dependency ratio reduces vulnerability. The usual practice among cocoa farmers is to engage children in performance of several cocoa farm operations. This contravenes the Nigerian law on child labour. However, channeling of research into development of low cost technologies that can be used in performing some cocoa farm operations will go a long way in reducing child involvement on the farms.

In order to revive cocoa production, government can open some forestlands and ensure their usage for cocoa production in a manner that will not further harm the environment. The study found that ability to spread climate risks over several cocoa farms reduces vulnerability. Therefore, since cocoa cultivation is a kind of agroforestry on its own, expanding its cultivation into available forest lands that belong to government should not further constitute environmental problems.

Provision adequate social infrastructure like good road and telecommunication will reduce vulnerability of cocoa farmers to climate change. The problem of road is paramount to the extent that those with vehicles are more vulnerable to climate change. There were places vehicles could not reach due to bad roads. Government should also look into rural market development.

In conclusion, cocoa farmers in southwest Nigeria are witnessing different forms of climate change. This is affecting different aspects of their social and economic activities. The onus therefore rests on government to provide adequate sensitization on impact mitigation mechanisms as may be required by the cocoa farmers.

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