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CLIMATIC SHOCKS: AWARENESS, EVIDENCE AND MITIGATING STRATEGIES AMONG COCOA FARMERS IN GHANA'S WESTERN REGION

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ABSTRACT

Cocoa is affected by climatic shocks due to its total reliance on nature thereby lending itself to the inconsistent changes and variations in the weather. The study seeks to investigate climate change and variability awareness, evidence and mitigating strategies cocoa farmers adopt in Ghana's Western Region. Multistage sampling techniques were used during study. Perception on climate change and variability (objective 1) and adaptation strategies employed (objective 3) were qualitatively analyzed using relative frequency of responses of the farmers. Evidence of climate change and variability (objective 2) was analyzed with a paired t-test using climate data from Ghana Meteorological Agency. The fourth objective which identifies the determinants of choice of an adaptation strategy was achieved using the multinomial logit regression model. Most farmers (77.1%) were aware of climate change and variability. Climate has changed with varying levels of variation. About 50% of the farmers adopted on-farm adaptation strategy while 33% adopted off-farm adaptation strategy. About 17% did not adopt any strategy besides cocoa farming. In all, age, gender, education and membership of FBOs significantly affected choice of adaptation strategies to climate change and variability. Climate has changed in the study area and this has been noticed by the cocoa farmers. On-farm adaptation strategy was the most employed strategy. Age, gender, education and FBO membership were important factors affecting farmers' choice of adaptation strategies to climate change and variability. It is recommended that farmers are trained on the use of appropriate adoption strategies against changing climate.

KEY WORDS

Climate change, cocoa farmers, adaptation strategies, perception, Western region of Ghana.

Climate change and variability are among the most pressing issues on the global developmental agenda. Mankind has always had to live with, deal with and adapt to environmental challenges leading Christoplos et al., (2009) to observe "the challenges posed by climatic change are of magnitude that exceed historical experiences". This is likely to result in unprecedented challenges to local communities and the global community at large (Akudugu, 2012). This is because, as opined by Oyekale et al. (2009) changes in the climatic variables could greatly affect the rate and development of pest and pathogens, modifying host resistance and ultimately resulting in crop losses which in the end affect output and has a spiral effect on income, livelihood and farm level decision making.

As observed by COCOBOD (2015), cocoa is greatly affected by climatic shocks due to its total reliance on nature thereby lending itself greatly to the inconsistent changes and variations in the weather. Additionally, the growing and thriving environment of cocoa which is mainly in the semi-deciduous and evergreen rainforest zones experience extreme increases in temperature and decline in rainfall (Fosu-Mensah et al., 2012). The western region, a major cocoa growing area in Ghana lies in this zone and thus not exempted from the current trend of climate change and variability. According to Codjoe and Owusu (2011) these changes have meant changes in the crop calendar which affect agronomic practices such as fertilization, spraying, harvesting etc. While small scale cocoa farmers in the region have and continue to battle with a litany of conventional production and post-harvest challenges confronting the sector, they are now faced with a much bigger issue and the challenges associated with the changes in climatic elements which ultimately affect cocoa production and outputs. The negative effects are further exacerbated by farmers' inability to appropriately adopt useful technology.

Owing to these trends, there is need for cocoa farmers in the region to appreciate the trends in climate change and variability and properly position themselves to adapt to such changes. It is in this vein that Fosu-Mensah et al. (2012) report that farmers make efforts to strategise to mitigate the effects of climate change and variability on the livelihoods. However, as earlier observed by IPCC (2007) the adaptation strategies used by most farmers have been inadequate. The challenge is further aggravated by the absence of well-planned agro- meteorological information communication systems, financial constraint to address most of the adaptation strategies, lack of knowledge and the appropriate technology as well as the high illiteracy rates in the Western Region impedes against them in their quest to control and enhance their adaptation strategies to this pressing challenge of climate change and variability.

The research therefore seeks to empirically investigate climate change and variability awareness, evidence and mitigating strategies among cocoa farmers in Ghana. From the foregoing the following research questions becomes pertinent:

1. Do cocoa farmers perceive the presence of climate change and variability?
2. Is there evidence of change in climate variables (rainfall amount, temperature, relative humidity and sunshine duration) over the period 1975 to 2015?
3. In the face varying and changing climate, what are the adaptation strategies employed by cocoa farmers?
4. What determinants influence a farmers' choice of adoption of an adaptation strategy?

MATERIALS AND METHODS OF RESEARCH

The study was conducted in the Western Region of Ghana (now split to include Western North Region), the cocoa belt of the country. The region is geographically divided into 2 broad regions under the COCOBOD demarcation zones, Western North and Western South respectively. There are a total of 23 cocoa districts in the region, 12 from Western North and 11 in Western South. One district each was selected from the North and South, that is, Sefwi Bekwai and Akontombra respectively

The Sefwi Bekwai cocoa district which is located in the Western north is found between Latitude 6.1980° N and longitude 2.3246° as shown in Figure 1. The district is bounded to the North by Boako cocoa district, South by Sefwi Wiawso cocoa district and to the East by Diaso district. The District is characterized by bimodal rainfall pattern with annual rainfall average between 1200mm in March-August and 1500mm in September-October and an annual average temperature of about 26 °C. There is a high relative humidity, averaging between 75 percent in the afternoon and 95 percent in night and early morning. Dansokrom and Ashiem were the communities where the study took place within the Western North, shown in the map of the study area.

The Akontombra cocoa district located between longitude 6.0418° N, and Latitude 2.8752° W in the Western South was the other district where the study took place. It is the second largest producer of cocoa in the Western Region. It produces nearly 6,000 metric

tons of cocoa annually. It shares boundaries with Dadieso A, B, and C cocoa districts on the West, to the South with Aowin district, to the North with Sefwi Wiawso and to the East with Wassa Amenfi West district. The district experiences wet-semi equatorial climatic conditions with an annual average temperature of 26 °C. March and April are the hottest months. The rainfall pattern is bimodal with June and October being the peak seasons. The annual rainfall average ranges between 1700mm and 2100mm. The relative humidity is generally high ranging between 75 percent and 80 percent during the wet season and decreasing to about 70 percent for the rest of the year.

Figure 1 – Map of study area

In order to gather reliable and valid data, the study employed two methodological approaches in which the primary data collected from the field was complimented by secondary data obtained from Ghana Meteorological Agency (GMA) These included data on climatic variables such as, rainfall, temperature, sunshine hours and relative humidity

Adopting a multistage sampling approach, the then Western Region of Ghana (currently divided into Western and Western North Regions) was the focal region for this study for two main reasons. Aside its position as the largest cocoa growing region in the country, it also has a double maxima rainfall pattern with an average rainfall of 1600mm per annum making it the wettest part of Ghana. The region has two main cocoa regions. The second stage involved the random selection of one (1) cocoa district from the cocoa regions after which two farming communities were chosen randomly from each cocoa district. The cocoa districts and farming communities for the study were Sefwi Bekwai Cocoa District (Ashiem and Dansokrom community) and Akontombra Cocoa District (Bronikrom and Bokaso community). A simple random sampling method was then used to target households for the survey using semi structured questionnaire.

In the determination of sample size for the study, the formula was used:

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

Where n is sample size, N is population size of cocoa farmers, and e is level of precision, (0.05) was used.

With a sample frame of 1426 cocoa farmers from the study area (741 from Sefwi Bekwai and 685 from Akontombra), a sample size of 312 was required for the study. Financial and time constraints however led to a sample size of 231 which was proportionally split between Sefwi Bekwai (120) and Akontombra (111).

In this study, a simple question of whether respondents know about climate change in the area was asked. Their knowledge on changes in temperature and rainfall (easily observable indicators) was then solicited. Relative frequencies of responses of the farmers were summarized using graphs to present the data.

Data on the climate indicators (Rainfall, Temperature, Relative humidity and Bright Sunshine Duration) were obtained from the Ghana Meteorological Agency (GMA) and their mean values computed. This study used paired t-test to compare the decadal means (presented in the Table 1) of the entire climatic variable to establish whether the difference is significant or not for the period 1975 to 2015.

Table 1 – Decadal means for comparison

Number of Decades	Decadal Ranges	Decadal Pairing	Inter-decadal
1	1975-1984	1&2	1975-1984
2	1985-1994	1&3	1985-1994
3	1995-2004	1&4	1975-1984 1985-1994 1995-2004
4	2005-2014	2&3	1975-1984 2005-2014
		2&4	1985-1994 1995-2004
		3&4	1985-1994 2005-2014 1995-2004

The hypotheses tested are:

- $H_0: \hat{X}_{2i} = \hat{X}_{1i}$;
- $H_A: \hat{X}_{2i} > \hat{X}_{1i}$ (for temperature and bright sunshine duration);
- $H_A: \hat{X}_{2i} < \hat{X}_{1i}$ (for rainfall and relative humidity).

The t-calculated was arrived as follows:

$$t - \text{calculated} = \frac{\hat{X}_{2i} - \hat{X}_{1i}}{SE_i} \quad (2)$$

Where, $\hat{X}_{2i} - \hat{X}_{1i}$ are the means for the current and previous decades compared for the i th climate variable respectively and SE_i is the standard error for the i th climate variable.

Decision rule: If the 1-tailed significance value from the test was greater than 0.05 (significance level for the test), then there was no statistical difference between the mean decadal climatic variable in question hence, any difference in means could be due to chance.

A list of adaptation strategies that the small-scale cocoa farmers use in minimizing the effects of climate change and variability on cocoa outputs were pretested and presented to farmers and analyzed using their relative frequencies of responses.

The Random Utility model was the theoretical basis for determining the factors that influence the choice of farmers' adaptation process. The model assumes the choice of an adaptation strategy is to maximize farmer's utility. Assuming a farmer n has to make a choice among J different adaptation strategies. Let Un_j $j=1 \dots J$ represent the utility that farmer n obtains from choosing adaptation strategy j . The farmer will choose strategy i , if and only if he derives a relatively higher utility from that strategy. This can be represented as $Un_j > Un_i$, $\forall j \neq i$. From Random Utility Theory, the utility (Un_j) a farmer derives from using strategy j has two components Vn_j and $n_j\varepsilon$. Vn_j is the properties of the adaptation strategy labeled Xn_j and some household characteristics of the farmer, Hn , with a random error term ε which represents innately random choice behaviours, specification or measurement error as well as attributes of the alternatives that affect the utility (Un_j) that are unobserved but are not captured in Vn_j . The utility function can be represented as:

$$U_{nj} = V_{nj} + \varepsilon_{nj} \quad \forall j \quad (4)$$

$$= V(X_{nj}, H_n) + \varepsilon_{nj} \quad (5)$$

Since the outcomes or choices of adaptation strategy involved in this study are three, the multinomial logit model can be used to estimate the probabilities associated with choosing each adaptation strategy. With the assumption that the error term associated with each utility being identical and independent, the multinomial logit be expressed as:

$$P_{nj} = \frac{e^{(B'X_{nj} + \gamma'H_{nj})}}{\sum_{j=1}^4 e^{(B'X_{nj} + \gamma'H_{nj})}} \quad (6)$$

Setting the β 's and γ 's to zero for a strategy (let's say No-adaptation strategy) which was used as the base category, the multinomial logit for each strategy ($j \neq$ strategy R) can be represented as:

$$P_{nj, j \neq 1} = \frac{e^{(B'X_{nj} + \gamma'H_{nj})}}{1 + \sum_{j=2}^4 e^{(B'X_{nj} + \gamma'H_{nj})}} \quad (7)$$

$$P_{n1} = \frac{1}{1 + \sum_{j=1}^4 e^{(B'X_{nj} + \gamma'H_{nj})}} \quad (8)$$

The above equation can be estimated using the maximum likelihood method. The explicit form of the model is specified as:

$$P_{ij} = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + \dots \dots \dots + B_9X_9 + \varepsilon \quad (9)$$

Where P_1 = Probability of a farmer choosing income strategy j and ' j ' is any of the four available income strategies a rice farmer can choose; B_0 = Constant term; B_k = Coefficients X_i = Set of independent variables hypothesized to affect the choice of income diversification strategy; ε = Error term.

Table 2 – Exogenous variables

Variable	Measurement	A priori Expectation
Age of farmer	Years	+
Gender of farmer	Male=0 Female=1	+/-
Household size	Head	+/-
Output	MT	+
Educational	Years	+
FBO member	Yes=1 No=0	+
Source of Labour	Family=1 Hired=0	+
Extension service	Yes=1 No=0	+/-
Farm size	Hectare	+/-

Hypothesis Test (T-test):

- Ho: Gender does not affect a farmers' choice of an adaptation strategy;
- Ha: Gender affects a farmers' decision to choose an adaptation strategy.

The hypothesis is repeated for all variables in Table 2.

RESULTS AND DISCUSSION

Farmers' perception on climate change variables (mainly rainfall, temperature and extreme events) over 5-10 years was assessed. A total of 178 respondents representing 77 percent had heard of "climate change", however, many could not explain what climate change was, therefore there was need to explain this in other words.

Figure 2 – Farmers' perception and knowledge about climate change (Source: Field data, 2016)

This observation is in line with the findings of Fosu-Mensah et al. (2012), who argued that male farmers are more informed about climate change happening than the females because of their easy access to information due to their frequent participation in training and educational programs. More men small-scale farmers, representing 65 percent, were knowledgeable about climate change than women farmers, who represented 35 percent.

Figure 3 – Perception of farmers on temperature and rainfall change (Source: Authors computation from field data, 2016)

Majority of the farmers (67%) perceived that the amount of average annual temperature had increased over the past ten years as shown in Table 3. About 6 percent perceived that the amount of average annual temperature had not changed over the past ten years. Sixty two (27%) out of the 231 respondents perceived that amount of average annual temperature had decreased over the past ten years. Additionally, a greater percentage of the respondents (57%) had the perception that total amount of annual rainfall had decreased over the past ten years. Only 20 percent farmers out of the 231 interviewed perceived that the total amount of rainfall had remained unchanged over the past ten years. Meanwhile, 23 percent of farmers thought that total amount of annual rainfall had increased over the past ten years. The findings of this research is consistent with the work of Deressa et al. (2008) who concluded that farmers were aware that temperature was increasing and the level of precipitation was decreasing.

The t-statistics and the p-values indicate that none of the two decades' means of total annual rainfall values compared is statistically significant. This implies that though there were changes in rainfall between 1975-1984 and 1985-1994; 1975-1984 and 1995-2004; 1975-1984 and 2005-2014, none of these observed changes were statistically significant. Hence, there were no climate change and variability with respect to rainfall between 1975 and 2014. This contradicts the report of IPCC (2014) which suggests evidence of variability in rainfall. Moreover, the decades' means between 1985-1994 and 1995-2004; 1985-1994 and 2005-2014; and 1995-2004 and 2005-2014 are much closer to each other that none of them show significant differences as shown in the Table 3.

This can be concluded that for the past four decades, annual rainfall amounts in the study area have changed but not significant based on the p-values. Though, none of the test is significant, the difference in means between 1975- 1984 and 1995-2004; 1975-1984 and 2005-2014; 1985-1994 and 1995-2004; 1985-1994 and 2005- 2014; and 1995-2004 and 2005-2014 were inconsistent with a priori expectations, rainfall levels have increased over the decades but not statistically significant.

Table 3 – Paired t-test for comparing decade's means of annual rainfall

Decades	Mean Rainfall	t statistics	t critical (one tail)	P value (one tail)
1975-1984	1394.41	0.4414	1.8331	0.3347
1985-1994	1349.72			
1975-1984	1394.41	-0.3254	1.8331	0.3761
1995-2004	1420.83			
1975-1984	1394.41	-0.5188	1.8331	0.3082
2005-2014	1431.92			
1985-1994	1349.72	-1.1391	1.8331	0.1420
1995-2004	1420.83			
1985-1994	1349.72	-1.1774	1.8331	0.1346
2005-2014	1431.92			
1995-2004	1420.83	-0.1424	1.8331	0.4449
2005-2014	1431.92			

Source: Authors computation based on GMA data (2016).

Table 4 – Paired t-test for comparing decades' means of annual temperature

Decades	Mean Temperature	t statistics	t critical (one tail)	P value (one tail)
1975-1984	26.4008	-2.1618	1.8331	0.0589*
1985-1994	27.5183			
1975-1984	26.4008	-1.2497	1.8331	0.1215
1995-2004	27.2550			
1975-1984	26.4008	-0.1658	1.8331	0.4360
2005-2014	26.5833			
1985-1994	27.5183	0.8809	1.8331	0.2006
1995-2004	27.2550			
1985-1994	27.5183	1.1937	1.8331	0.1316
2005-2014	26.5833			
1995-2004	27.2550	0.8867	1.8331	0.1992
2005-2014	26.5833			

Source: Authors computation based on GMA data (2016).

The t-statistics and the p-values in Table 4 indicate that only one of the two decades' means of total average temperature values compared is statistically significant. The difference between 1975-1984 and 1985- 1994 means of decade temperature is statistically significant at 10% and inconsistent with the a priori expectation.

This means there is significant difference between decade mean temperature of 26.40°C and 27.52°C. The difference in decadal means between 1975- 1984 and 1995-2004; 1975-1984 and 2005 and 2014 are not statistically significant but also inconsistent with the a priori expectation. They show the average annual temperature for the study area is falling, contradicting the report by IPCC (2007) that global temperatures are raising.

The study found the difference between 1995-2004 and 2005-2014 means of relative humidity to be statistically significant at 10% as evidenced by a t-test value of 1.66. This difference between the mean is not consistent with the apriori expectation as the test does

not support that relative humidity is decreasing. Even though difference in decade means between 1975-1984 and 1985-1994; 1975-184 and 1995-2004; and 1985-1994 and 1995-2004 are not statistically significant (Table 5), they are consistent with the a priori expectation. They show that relative humidity had decreased over these decades with the mean been 72.9%, supporting the assertion of IPCC (2014) that there has been variability in precipitation across the African continent. A decline in relative humidity means less pest and disease infestation to the cocoa crop particularly to blackpods, caused by *phytophthora palmivora* or *megakaya* which is known to cause significant losses in the regions of 20-30% annually and in some plantation where humidity is high, losses up to 90% have been recorded Vanegtern (2015).

Table 5 – Paired t-test for comparing decades' means of relative humidity

Decades	Mean Relative Humidity	t statistics	t critical (one tail)	P value (one tail)
1975-1984	73.9167	-0.4917	1.8331	0.3174
1985-1994	75.9667			
1975-1984	73.9167	-0.6547	1.8331	0.2645
1995-2004	76.6417			
1975-1984	73.9167	0.2309	1.8331	0.4111
2005-2014	72.9000			
1985-1994	75.9667	-1.1913	1.8331	0.1320
1995-2004	76.6417			
1985-1994	75.9667	1.2911	1.8331	0.1144
2005-2014	72.9000			
1995-2004	76.6417	1.6640	1.8331	0.0652*
2005-2014	72.9000			

Source: Authors computation based on GMA data (2016).

The paired t-test for the difference in bright sunshine duration between 1975-1984 and 1985-1994 is statistically significant at 5%. This is supported by the p-value of 0.0369 as shown in Table 6. This implies that there is a significant difference between the mean decadal bright sunshine values of 7.4 hours and 7.1 hours. The difference between the means is not consistent with the apriori expectation as the test does not confirm that bright sunshine duration is increasing. The finding however corroborates that of Mabe et al. (2013) for the same period. Hence, the average bright sunshine duration had decreased from 7.4299 hours (1975-1984) to 7.1.83 hours (1985-1994).

There also exist a significant difference between the decades' means of bright sunshine duration of 1985-1994 and 2005-2014. The p-value of 0.0274 indicates that the test is significant at 5%. The positive figure for the difference in the decadal means compared here supports the assertion by Mabe et al. (2013) who reported significant difference and increasing bright sunshine duration from 1980 to 1989 and 2000 to 2009 decades.

Table 6 – Paired t-test for comparing decades' means of bright Sunshine

Decades	Mean Sunshine Duration	t statistics	t critical (one tail)	P value (one tail)
1975-1984	7.4299	-2.0269	1.8331	0.0369**
1985-1994	7.1083			
1975-1984	7.4299	-1.2924	1.8331	0.1205
1995-2004	7.2045			
1975-1984	7.4299	-0.9654	1.8331	0.1819
2005-2014	7.3585			
1985-1994	7.1083	0.9511	1.8331	0.1929
1995-2004	7.2045			
1985-1994	7.1083	1.2911	1.8331	0.0274**
2005-2014	7.3585			
1995-2004	7.2045	1.0424	1.8331	0.1639
2005-2014	7.3585			

Source: Authors computation based on GMA data (2016).

The study categorized the adaptation strategies adopted by the cocoa farmers to mitigate the negative effect of climate change on cocoa production into three main groups (namely on-farm, off-farm and no adaptation strategy). On-farm adaptation strategy was the

most (about 50%) used strategy adopted by the cocoa farmers' whilst off-farm strategy was used by about 33 percent of the respondents (Table 7). Only about 17% claim to adopt the no adaptation approach.

Table 7 – Adaptation strategies of the small-scale cocoa farmers

Adaptation Strategies	Cocoa Districts				Total Freq	Total %
	Akontombra		Sefwi Bekwai			
	Freq	%	Freq	%		
No adaptation	18	46.2	21	53.8	39	16.9
On- farm	52	44.8	64	55.2	116	50.2
Off-farm	41	53.9	35	46.1	76	32.9

Source: Author computation (2016).

On-farm adaptation strategies were the most employed strategy by the majority (116) representing 50.2% of the small-scale cocoa farmers. These strategies include shade management, farm size strategies, soil fertility management, land preparation strategies, crop diversification and lining and pegging strategies. It was revealed from the study that most farmers (111), representing 87% of the farmers in this grouping mainly adopted shade management as an on-farm adaptation strategy which further depict the benefits of Farmer Based Organizations (FBO's), Farmer Field School (FFS) and largely the crucial role extension plays in disseminating good agricultural practices with respect to the optimal level of shade requirement for hectare.

A varied number of reasons such as lack of access to recommended seedlings, finance among others accounted for about 15 farmers, representing 13% who did not adopt shade management. It also came to the fore, that majority (68%) of the farmers strongly relied on organic materials like cocoa leaf-litter, pod husk, crop residue and cleared weeds as soils fertility management practice. Use of inorganic fertilizers such as Asaase Wura, Sidalco liquid fertilizer etc. formed the remaining 32% of farmers who relied improving soil fertility. The high cost associated with these inorganic fertilizers accounted for the difference in percentage. As part of land preparation, respondents who slash, gather and burn were in the majority (65%). The logic is that the released potassium serves as rich nutrients for plant growth. To the farmers, dangerous animals are killed by this practice as well. Quite interestingly, a number of farmers (35%) allow the slashed bush to rot and mulch the farm soil increasing the soil organic matter content and consequently improving soil water conservation.

Majority (72%) of the farmers practice farm extension with new and improved seedlings and also replanting existing farms with cocoa and other food crops. This is a means of diversifying crops as a way of mitigating against the varying climatic conditions. Crop diversification in essence involves farmers using production activities that make optimum use of the prevailing temperature and water conditions as well as using drought tolerant and or temperature stress resistant varieties. 28% of the farmers, being the remaining number were engaged in increasing intensification practices specifically through replanting missing stance.

In order to adapt to crop failure, 53% of the cocoa farmers adopted lining and pegging strategy whereas the remaining 47% were not practicing lining and pegging. The farmers who subscribed to lining and pegging were of the view that the practice prevent rapid pest and disease infestation and easy to control when they exist. It also helps maintain the required number of plants thus overcoming the problem of overestimating or underestimating the input requirement thus preventing financial and crop nutrient loss or under optimal control of pest and disease. It was revealed that lack of technical knowledge was the main reason for the non-adopters to subscribe to this strategy.

These strategies broadly include alternative livelihood sources for the cocoa farmers in the face of climatic challenges outside of the farm sector. Out of the 32.9% who adopted off-farm strategies, 24% were engaged in working on other people's farms, 8% were involved in trading in agricultural commodities whiles the remaining 2.6% were into agricultural processing. Wage employment from non-agricultural sources (mainly from petty trading, masonry and carpentry) (7%), migration to the cities (4%) and remittances from family and

friends (1.6%) were the most used off-farm adaptation strategy used the cocoa farmers in the study area. The above findings are consistent with the work of Anim-Kwapong and Frimpong (2005) whose study concluded that off-farm adaptation strategies are anticipatory adaptive measures (insurance) against loss of livelihood as a result of loss of income from cocoa production caused by climate change.

Table 8 – Multinomial logit for determinants¹ of adaptation strategies

Number of observation	231	
Wald chi2(18)	1586.5700	
Prob > chi2	0.0000	
Pseudo R2	0.4140	
Log pseudo likelihood	-224.0949	
Variables	Adaptation Strategies	
	On-farm	Off-farm
Age	-0.0009* (-1.8900)	-0.0009* (-1.7)
Household size	0.0120 (-0.5700)	-0.0114 (-0.63)
FBO	0.2982*** (-13.01)	-0.2378 (-0.29)
Farm size	0.0001 (-0.27)	-0.0001 (-0.64)
Output	0.0000 (-0.38)	0.0000 (-0.48)
Gender	-0.1324*** (-23.65)	0.2316*** (-23.78)
Education	0.2240*** (-13.24)	0.0436*** (-9.21)
Extension	-0.0094 (-1.06)	0.0025 (-0.52)
Source of labour	0.0000 (-0.52)	-0.0000 (-1.06)

Source: Author computation (2016).

The results for the determinants of choice of adaptation strategy are presented in Table 8. The estimates presented are the marginal effects with their corresponding standard errors in parenthesis. For a multinomial logit, the coefficient estimates can only be used to predict the direction of effect of the independent variables but not the probabilities. The problem of heteroscedasticity was addressed in the model by estimating a robust model that computes robust variance of the error term. This generated error terms which were homoscedastic. The study checked for multicollinearity by fitting an Ordinary Least Square model and checking the Variance Inflation Factor (Appendix).

In all age, gender, education and membership of FBOs were statistically significant determinants of choice of adaptation strategies to climate change and variability as presented in Table 8.

Age was found to be statistically significant when it came to adopting both on-farm and off-farm farm adaptation strategy. An increase in age increased the probability of a farmer adopting on-farm. This finding is consistent with the findings of Etwire et al. (2013), who found that older people were more probable to adopt the use of chemical and fertilizers which are on-farm adaptation strategies. This could be attributed to the fact that older farmers had more access to resources to invest into their farming activities as compared to 95 younger ones. These resources could be the reason they could easily get involved into other off-farm activities than rather not adopt any adaptation strategies.

Membership of FBO makes a farmer 29.82 percent more likely to adopt on-farm adaption strategies. The FBO's identified in the study area were organizations that were privileged to get access to basic training on modified and advanced farming practices which will help farmers increase their yield. These FBO trained farmers on adaptation strategies to help them mitigate the negative effect of climate change. Due to the fact that members of these FBO had information on farming practices which will increase their yield they channeled their efforts into on-farm adaptation strategies. They undertook good agricultural practices at the right timing such as chemical and fertilizer application at the right time and dosage, shade management practices timing of the seasons as well as agro forest practices.

Males are 13.24% less likely to choose on-farm adaptation strategies. This suggests males would rather engage in other agricultural activity or engage in off-farm strategy than engage in activities to improve the current farm based activity. Bryan and Kandulu (2009) found similar results in their study which revealed that males were more likely to rear animals on their farms as adaptation strategies as compared to females. In rural African settings where males have dominance in resources than females. Males, are easier for males to adapt compared to females where resources are needed to carry out a strategy. It was found in the study also that males were 23.16% more likely to choose off-farm adaptation strategies than their female counterparts. Clearly this can confirm the pattern that males had more access to resources and could invest as compared to females who will not invest.

Education makes a farmer more likely to choose both on-farm and off-farm adaptation strategy. Educated farmers had easier access to information as to adaptation strategies as compared to uneducated farmers. These educated farmers could easily monitor weather forecast. These added advantages makes it easier for them to pick up practices both on and off the farm which will help them in mitigating losses which they might have incurred due to the weather or climate failure. Instead of not adapting, they engage in practices such as timing the weather, application of fertilizer, diversifying the crops they cultivate as well as addition of animal farming to their livelihood sources.

CONCLUSION AND RECOMMENDATIONS

The following conclusions were drawn from the results of the study:

- Most of the cocoa farmers in the study area had noticed and were aware of climate change and variability but more men considered changes and variation in temperature and rainfall than women;
- Climate has changed with strong variability over the past 40 years in the study area in terms of significant changes in decade temperature, relative humidity and bright sunshine duration;
- On-farm adaptation strategy was the most employed strategy by the small-scale cocoa farmers;
- Important factors that affect cocoa farmers' choice of adaptation strategy to climate change and variability were age, gender, education and membership of FBOs.

These recommendations are thus proposed:

- Climate change awareness programmes should target both sexes, in order to build their capacity to cope with climate change stresses and uncertainties on local livelihoods as few women were aware about climate change than men;
- Government and existing NGOs in the study area should design policies and programs to improve upon the identified adaptation strategies. Based on the findings that majority of the farmers were involved in on-farm adaptation strategy, they should be empowered in order to attain high adaptive capacity status;
- Adult education programmes must be instituted to encourage farmers to enroll since education was an important factor for adaptation;
- Farmers must be encouraged to join FBOs to form social capital and leverage that to learn appropriate on-farm and off-farm strategies.

APPENDIX – VARIANCE INFLATION FACTOR FOR THE INDEPENDENT VARIABLES USED IN THE MULTINOMIAL MODEL

Variable	VIF	1/VIF
Age	1.17	0.851856
Household size	1.15	0.866806
FBO	1.15	0.870259
Farm size	1.14	0.875714
Output	1.13	0.884668
Gender	1.07	0.935653
Education	1.05	0.95602
Extension	1.03	0.973225
Source of labour	1.02	0.98386
Mean VIF	1.1

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