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Farmers' Perceptions and Adaptation to Climate Change: Evidence from Ghana

Henry de-Graft Acquah, Jacob Nunoo and Kwabena Nkansah Darfor

Introduction

Climate change has gained increased attention in recent times due to its perceived negative repercussions on a range of activities, chiefly agriculture. These events are ample evidence of what climate change may unleash if attempts are not made to mitigate and adapt to its impacts. For instance, Dai et al. (2004) and Trenberth et al. (2007) point out that many third world countries have already experienced extreme weather events in terms of floods, droughts, heat waves and tropical cyclones that are more frequent and intense than previously. The resulting impacts point to the consequences for the environment, production systems, and livelihoods from future climate variability and change.

It is important that we shed light on what we mean by climate change in order to put things in the right perspective. The Intergovernmental Panel on Climate Change (IPCC) (2007) defines climate change as a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity.

Agriculture contributes about 35 per cent of Ghana's GDP, generates 30 – 40 per cent of foreign exchange earnings, and employs about 55 per cent of the population. It is envisaged that climate change will pose a serious threat to the environment, agricultural production and food security of most developing countries including Ghana. In particular, rural farmers, whose livelihoods

depend on the use of natural resources, are likely to bear the brunt of adverse consequences. This is largely because most developing countries experience high poverty incidence and as a result are incapable of adapting to climate change. However, the extent of the impact of climate change on agriculture can be ameliorated by the perception and level of adaptation of farmers. Studies have shown that African perceptions and understandings of climate change are poor. For instance, Taderera (2010) reported that South Africans' awareness of climate change was literally interpreted as 'changing weather' and this may influence the extent of adaptation. Adaptation is widely recognised as a vital component of any policy response to climate change. It is a way of reducing vulnerability, increasing resilience, moderating the risk of climate impacts on lives and livelihoods, and taking advantage of opportunities posed by actual or expected climate change.

The way farmers perceive climate change is important for their choice of adaptation and hence their willingness to pay for climate change mitigation action. Perceptions are however influenced by other factors. Gbetibouo (2009) observed that fertile soil and access to water for irrigation decrease the likelihood that farmers will perceive climate change. However, education, experience and access to extension services all increase the likelihood that farmers perceive climate change.

Much as perceptions and adaptations to climate change are important, it is however instructive to note that very few studies have examined farmers' perceptions and adaptation and the consequent effect on willingness to pay for climate change mitigation policy action in the Ghanaian context. This study therefore considers how farmers perceive and adapt to climate change and their willingness to pay for climate change mitigation policy. In investigating this research problem, the following objectives were pursued:

- examine the socioeconomic characteristics of the farmers;
- analyse their level of awareness of climate change;
- analyse farmers' perception of climate change;
- examine the various choice of adaptation measures among the farmers;
- identify the barriers to adaptation among the farmers; and
- analyse the socio-economic determinants of farmers willingness to pay for climate change mitigation policy.

In response to perceived long-term changes in climate, farm households have implemented a number of adaptation measures to reduce their vulnerability to climate change impacts. Analysis of the impacts of climate change and adaptation on food production in Ethiopia by Yesuf et al. (2008) revealed changing crop variety, soil and water conservation, water harvesting, planting of trees and changing planting and harvesting periods as the choices of adaptation measures by the farmers. Among these methods of adaptation, planting trees was the

dominant measure adopted by most of the farmers. However, about 42 per cent of the farmers did not use any adaptation method for climate change impacts. Using two separate models to examine the factors influencing farmers' decision to adapt to perceived climate changes, Yesuf et al. (2008) confirmed that household wealth, represented by farm and non-farm income and livestock ownership, increases the likelihood of climate change awareness and adaptation. Deressa (2008) identified age of head of household, wealth, information on climate change, social capital and agro-ecological settings as having significant impact on farmers' perception of climate change. Farmers in areas with a higher annual mean temperature over the period of survey were more likely to adapt to climate change.

Numerous factors have been identified as barriers to adaptation: lack of information on choice of adaptation options, lack of financial resources, shortage of land, poor potential for irrigation and labour constraints (Deressa et al. 2008). However, lack of information on choice of adaptation options was the major barrier. Madison (2006) and Nhemachena and Hassan (2008) have shown that access to information through extension increases the chance of adapting to climate change.

Climate mitigation strategies must be viewed as a collective concern for the sustainability of agricultural production and livelihoods of many people, especially those in developing countries. Consequently, individual willingness to contribute to climate issues is vital in such endeavour. As a result some studies have analysed willingness to pay for climate change mitigation policy using different models. The impact of uncertainty associated with climate change on individual decisions regarding support for climate change policy was first examined by Cameron (2005). That study used a Bayesian information updating model in a single bounded contingent valuation framework to estimate an individual option price for future climate change using a convenience sample of college students. Empirical results revealed a quadratic relationship between expected future temperature changes and individual support for climate change policy. Thus, the respondents were willing to pay more as expected future temperature change increased but the amount increased at a decreasing rate.

Maddison (2006) reviewed studies on adoption of new technologies and identified farm size, tenure status, education, access to extension services, access to market and credit availability as the major determinants of speed of adoption in Africa. Minimising the impacts of climate change requires perception and adaptation. Farmers' ability to perceive climate change is a key precondition for their choice of adaptation. Maddison (2006) further revealed that adaptation to climate change requires farmers to first perceive that the climate has changed, then identify useful adaptations and implement necessary adaptation responses.

Akter and Bennett (2009) analysed the determinants of households' willingness to pay for the Carbon Pollution Reduction Scheme (CPRS) in Australia. Willingness

to pay for climate change mitigation was found to be significantly reduced by uncertainty associated with the expectations of future temperature increases. Furthermore, willingness to pay for the CPRS was found to be negatively affected by respondents' lack of confidence in the scheme being effective in slowing down climate change.

Analysis of the perception and willingness of graduate students to pay a gas tax (Viscusi and Zeckhauser 2001) revealed that a major factor that may influence willingness to pay, holding risk estimates constant, is whether a respondent feels scientific uncertainty motivates a more aggressive or less aggressive approach to climate change policy. Han et al. (2010) estimated willingness to pay for environmental conservation by tourists in China, using a contingent valuation method. The results indicated that willingness to pay increases with income, education level and age.

Bamidele et al. (2010) analysed the factors affecting farmers' ability to pay for irrigation facilities in Nigeria. Empirical results from the logistic regression analysis in the paper revealed age of the farmers, education level acquired, farm household income and size of farmers' household as the major factors explaining farmers' ability and willingness to pay for an irrigation scheme.

The study was based in the Dunkwa in the Shama Ahanta East Municipality and the Bawku Municipality of Ghana. These districts are well known farming areas contributing significantly to the food basket of Ghana. The Dunkwa in the Shama Ahanta East Municipality is one of the sixteen districts/municipalities in the Western Region of Ghana. Fante, and Ahanta are the main ethnic groups living in the district. It is bordered to the north by the Mpohor Wassa East District, to the south by the Gulf of Guinea, Sekondi-Takoradi Metropolitan Assembly to the west (all in the Western Region), and Komenda Edina Eguafo-Abirem District to the Erst in Central Region. Its geographical coordinates are 50 7' 0"north and 10 37' 0" west. Relatively mild temperatures are experienced in the district ranging between 22 and 28 degrees centigrade.

The administrative capital is Shama and is located on the West Coast, about 15 kilometres from Sekondi, the regional capital, 130 kilometres east of the Côte d'Ivoire boundary and 280 kilometres west of Accra, the national capital connecting economic activities to the central region. The predominant occupation of the people in the district is farming. The district covers a land area of 215 km2 with an estimated population of 88,314 (2000 census) of which over 1,500 are farmers. Thus 78 per cent of the active labour force in the district is engaged in agriculture with the remaining 22 per cent found in industry, services and commerce. The major agricultural crops cultivated in the district include cassava, oil palm, maize, coconut and vegetables. The district lies within the tropical climatic zone and experiences two rainy seasons with an average annual rainfall of about 138 cm, with peak rainfall in July.

The Bawku Municipality, on the other hand, is one of the nine districts/ municipalities in the Upper East Region of Ghana. The district is bordered by Burkina Faso to the north and Togo to the east. Kusasi, Mamprusi, Bissa and Mossi are the main ethnic groups living in Bawku District. To the south, the municipality is bordered by the Garu-Tempane District and to the west by Bawku West District (Zebilla). It lies between latitude 110 and 110 151 north of the equator and longitude 10 301 and 00west of the Greenwich meridian.

The administrative capital town of the municipality is Bawku which is about 880 kilometres from Accra the national capital and vibrant commercial business centre, connecting economic activities between other West African states such as Togo, Burkina, Niger and Mali. The Bawku Municipality has a total land area of about 1,215.05 km2 and an estimated population of 216,271, an annual growth rate of 3 per cent, with an average of 7 persons per household (2000 census). Agriculture is the dominant occupation in the district with tomatoes, soya beans and onions being the main crops cultivated. The average annual rainfall of the municipality is 700mm, with peak rainfall in August.

The target population was farmers in Dunkwa and Bawku. A random sampling technique was used to select 193 farmers in Dunkwa and Bawku where every farmer was given an equal opportunity to be selected in the sample. An interview schedule was the main tool of data collection while descriptive statistics and logistic regression analysis were the main analytical techniques. Data was analysed using the SPSS and Stata tools.

The basic model of the log it estimation is as follows:

$$\mathrm{P}_i = \Pr ob(Y_i = 1) = \frac{1}{1 + e^{-(\beta_o + \beta_1 X_{1i} + \ldots\ldots\ldots \beta_k X_{ki})}} \qquad \ldots\ldots\ldots(1)$$

$$= \frac{e^{(\beta_o + \beta_1 X_{1i} + \ldots\ldots\ldots \beta_k X_{ki})}}{1 + e^{-(\beta_o + \beta_1 X_{1i} + \ldots\ldots\ldots \beta_k X_{ki})}}$$

Similarly,

$$\mathrm{P}_i = \Pr ob(Y_i = 0) = 1 - \Pr ob(Y_i = 1) \qquad \ldots\ldots\ldots(2)$$

$$= \frac{1}{1 + e^{(\beta_o + \beta_1 X_{1i} + \ldots\ldots\ldots \beta_k X_{ki})}}$$

Dividing (1) by (2) we get

$$\frac{\Pr ob(Y_i = 1)}{\Pr ob(Y_i = 0)} = \frac{P_i}{1 - P_i} = e^{(\beta_o + \beta_1 X_{1i} + \ldots\ldots\ldots \beta_k X_{ki})} \qquad \ldots\ldots\ldots(3)$$

Where Pi is the probability that Y takes the value 1 and then (1-Pi) is the probability that Y is 0 and e the exponential constant.

This research uses information criteria as a technique for providing the basis for model selection. Most commonly used information criteria such as Akaike Information Criteria (AIC) are employed. The idea of AIC (Akaike 1973) is to select the model that minimises the negative likelihood penalised by the number of parameters as specified in the equation (4):

$$AIC = -2\log(L) + 2p \quad \text{.....(4)}$$

Where L refers to the likelihood under the fitted model and p is the number of parameters in the model. Specifically, AIC aims at finding the best approximating model for the unknown true data generating process and its applications draw from Akaike (1973), Bozdogan (1987)and Zucchini (2000).

Socioeconomic Characteristics of Farmers in Dunkwa and Bawku

Socioeconomic characteristics of the farmers in Dunkwa were investigated and the results are presented accordingly. Cereals, vegetables and root/tubers are the main crops grown by the farmers in the area; the majority, 73.5 per cent of the sample, are cereal farmers. Almost four-fifths of the respondents, 79.6 per cent, were male; while 20.4 per cent were female. The average age of the farmers interviewed was almost 45 years; 37.8 per cent were in the age range of 34-41 years; 20.4 per cent 42-49 years; and 14.3 per cent 58-65 years. Only 5.1 per cent of the farmers were in the age range of 66-73 years. A tenth of the farmers interviewed had obtained senior high school education; 48 per cent had obtained junior high school education; 35.7 per cent had obtained basic education; while only 6.1 per cent had no formal education. The average annual income of the farmers was GH¢1403.0612, with 48 per cent earning between GH¢100-GH¢1000, 33.7 per cent between GH¢1100-GH¢2000, 10.2 per cent between GH¢2100-GH¢3000; only 8.2 per cent of the farmers had an annual income of between GH¢3100-GH¢5000. Given the farmers' relatively low annual incomes, their adaptation and willingness to pay for mitigation policy may be low. The distribution of years of farming experience revealed an average of 17.816 years of farming with 33.7 per cent having between 1 and 10 years' experience, 32.7 per cent having between 11 and 20 years' experience, 23.5 per cent having between 21 and 30 years' experience, and 10.2 per cent having between 31 and 40 years' experience. The average household size of the farmers was about seven persons, with 88.8 per cent having a household size between 4 and 9 persons; 8.2 per cent having between 10 and15 persons; while only 1 per cent had a household size of between 21 and 25 persons. However, the distribution of farm size revealed an average of 4.306 acres with the majority of the farmers (69.4 %) having 1-4 acres

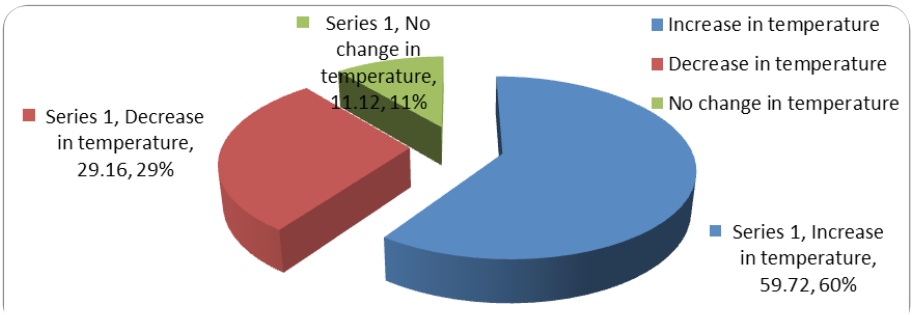
of farmland' 16.3 per cent having 5-9 acres; 9.2 per cent 10-14 acres; and only 5.1 per cent had 15-19 acres of farmland.

From Bawku, the socioeconomic characteristics are presented below. Of the respondents interviewed, males dominated with 82.1 per cent while the remaining 17.9 per cent were females. Of the respondents interviewed 23.2 per cent were between the ages of 24 and 30 years; 45.3 per cent were between 31 and 40; 21.1 per cent were between 41 and 50; 8.4 per cent were between 51 and 60; and 2.1 per cent were between 61 and 70. Of the respondents 64.2 per cent were heads of their families while the remaining 35.8 per cent were not. Though educational levels of the respondents ranged from no formal education through to tertiary level, the number of years spent at these levels differed with the respondents. Of the respondents 23.2 per cent had no formal education; 12.6 per cent had obtained basic education; 12.6 per cent had obtained middle/junior high school education, 17.9 per cent had obtained O'level or senior high school education and 33.7 per cent had obtained education up to tertiary level. Of the respondents 41.1 per cent had a household size of between1 and 5 persons, 43.2 per cent had between 6 and 10 persons; 12.6 per cent had between 11 and 15 persons; 2.1 per cent had between 16 and 20 persons; and 1.1 per cent had between 21 and 25 persons.

With regard to their farming experience, 20 per cent had 3-10 years of farming experience, 47.4 per cent had 11-20years; 20 per cent had 21-30years; 7.4 per cent had 31-40years; and 5.3 per cent had 41-50years' experience. Of the respondents interviewed, the majority, constituting 55.8 per cent, had farmland size between 1-5 acres, 36.8 per cent had farmland size of 6-10 acres, 3.2 per cent had farmland size between 11-15 acres, 3.2 per cent had farmland size between 16-20 acres and 1.1 per cent had farmland size between 21 and 25 acres. 64.2 per cent of the respondents had other income generating activities, while for 35.8 per cent their only source of income was farming usually done at subsistence level. The majority, constituting 56.8 per cent of the respondents interviewed, earned an annual income ofGH¢800-GH¢2000; 18.9 per cent earned GH¢2100-GH¢3000; 12.6 per cent earned GH¢3100-GH¢4000; 7.4 per cent earned GH¢ 4100-GH¢5000; 2.1 per cent earned GH¢5100-GH¢6000; and 2.1 per cent earned GH¢6100-GH¢7000.

From the socioeconomic characteristics of farmers in Dunkwa and Bawku, the majority of the farmers had some form of education. More than two-thirds had more than a decade of experience in farming. Again, the majority of the farmers had small farmlands to work on in both areas. Even though general income accrued from agriculture in the country is generally low, the study reveals that those in the northern region have relatively higher incomes than their southern counterparts.

Figure 3.1: Perception of climate change (Bawku)

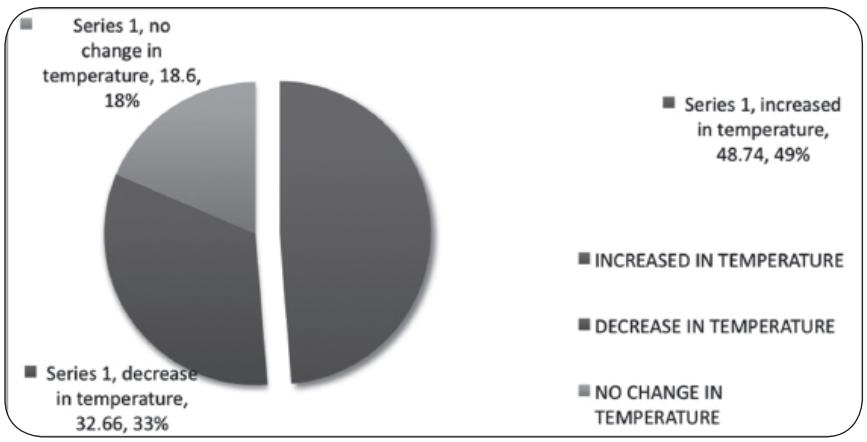


When asked about the perception of changes in temperature, the majority, constituting 60 per cent of the total respondents, perceived an increase in temperature. Of the respondents 29 per cent indicated a decrease in temperature while the remaining 11 per cent went contrary to this opinion and perceived no change in temperature.

Farmers' Perception of Temperature Changes in Dunkwa

About 49 per cent of the farmers perceived increases in temperature whilst 33 per cent perceived a decrease in temperature. However, 18 per cent did not perceive any change in temperature.

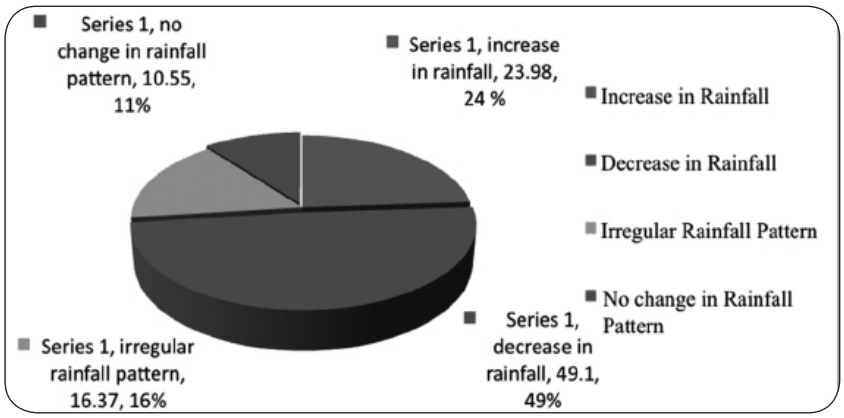
Figure 3.2: Farmers' perception on temperature changes in Dunkwa



Perception of Changes in Rainfall in Bawku

Of the farmers interviewed, 24 per cent perceived an increase in rainfall. Up to 49 per cent of the total respondents perceived decrease in rainfall. Although 16 per cent of the total respondents perceived no changes in rainfall, up to 11 per cent were contrary to this view since they perceived irregular rainfall pattern.

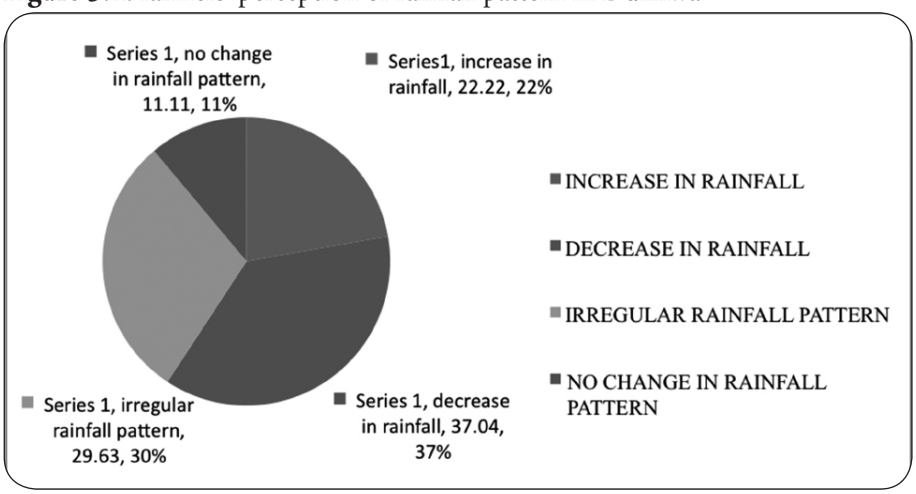
Figure 3.3: Perception of changes in rainfall in Bawku



Farmers' Perception of Changes in Rainfall Pattern in Dunkwa

The distribution of farmers' perceptions concerning changes in rainfall pattern revealed that 22 per cent perceived an increase in precipitation; 37 per cent perceived a decrease in precipitation; 30 per cent perceived an irregular rainfall pattern. Despite the higher perception of the farmers interviewed on changes in rainfall pattern, 11 per cent of the farmers interviewed did not see any change in rainfall pattern.

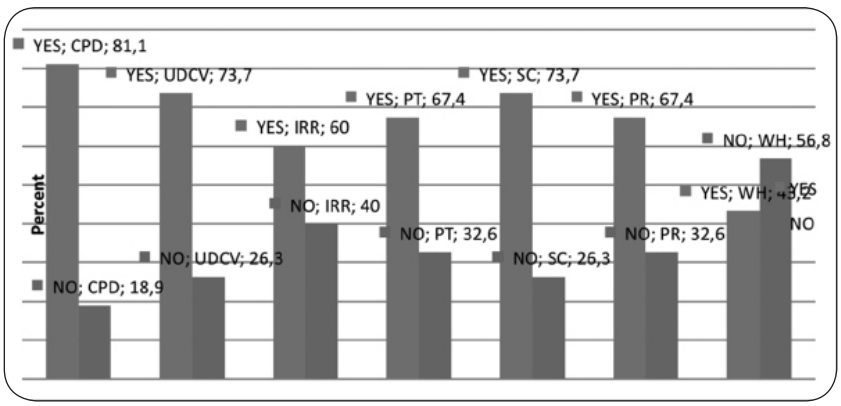
Figure 3.4: farmers' perception of rainfall pattern in Dunkwa



Choice of Adaptation Methods in Bawku

When asked if these farmers had introduced adaptation methods due to the perceived changes in climate, the majority, forming 87.4 per cent of the total population, had adapted methods while the remaining 12.6 per cent had not. Changing planting dates, soil conservation and using different crop varieties were the major methods. The other methods included planting trees, prayers and irrigation, with water harvesting being the method least adapted despite its numerous benefits.

Figure 3.5: Choice of adaptation methods in Bawku



Note: CPD = *Changing Planting Dates*; IRR = *Irrigation*; UDCV = *Using Different Crop Varieties;* PT = *Planting Trees*; PR = *Prayers*; SC = S*oil Conservation*; WH= *Water Harvesting.*

From Figure 3.5, 81.1 per cent of the respondents interviewed adapted changing planting dates while 18.9 per cent did not. Of the respondents, 73.7 per cent adapted using different crop varieties while the remaining did not. With irrigation as an adaptation method, 60 per cent of the respondents used it while the remaining 40 per cent did not. 67.4 per cent of the respondents adapted to planting trees while the others did not. Most respondents (73.7 %) adapted to soil conservation during changes in climate while the remainder did not. Prayers surprisingly gained in popularity as an adaptation method with 67.4 per cent of the respondents using it while the remaining 32.6 per cent did not see the benefits. Water harvesting on the contrary had a lower percentage of adaptation (43.2 %) while the majority 56.8 per cent did not employ it as an adaptation strategy.

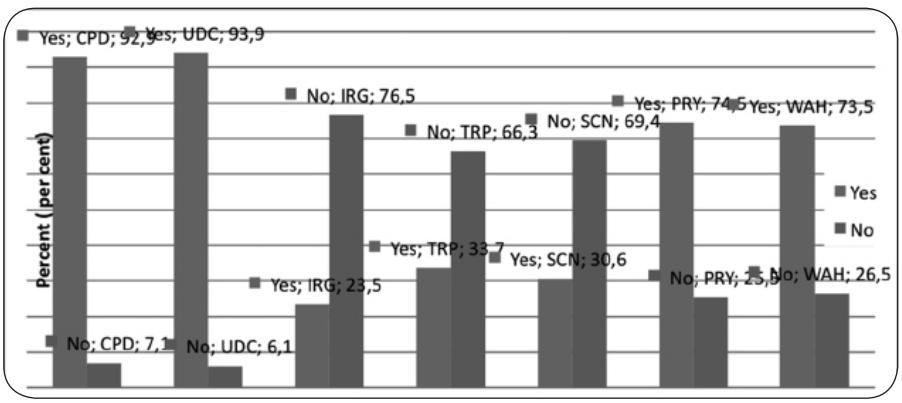
Choice of Adaptation Methods in Dunkwa

Attempts were made to find out whether the farmers used some climate change adaptation measures and subsequently the types and reasons for their choice of adaptation. Of the farmers interviewed, 60.2 per cent used some form of climate change adaptation options, whilst 39.8 per cent did not use adaptation measures. Changing planting dates, using different crop varieties, tree planting, irrigation practices, soil conservation, water harvesting and prayers were the main adaptation measures used by the farmers. Of the farmers interviewed, 92.9 per cent used changing planting dates as their method of adaptation whilst 7.1 per cent did not use this method. Of the farmers 93.9 per cent used different crop varieties to reduce climate change impacts whilst 6.1 per cent have never used this measure before. 73.5 per cent of the farmers use water harvesting as an adaptation measure whilst 26.5 per cent do not use this method.

With regard to irrigation and tree planting, 23.5 per cent of the farmers interviewed use irrigation to adapt to climate impacts whilst 76.5 per cent do not use this method; 33.7 per cent of the farmers use tree planting as an adaptation measure whilst 66.3 per cent do not use this measure. Soil conservation was used by 30.6 per cent of the farmers interviewed to adapt to climate change impacts. However, 74.5 per cent of the farmers used prayers as a measure of adaptation. Figure 3.7 depicts the distribution of various measures of adaptation used by farmers in Shama in the Western Region of Ghana.

When asked why they preferred their choice of adaptation over the other options, 67.8 per cent indicated that their choice of adaptation was most economical or less costly to use; 16.9 per cent said their choice of adaptation improved land fertility and prevented erosion; 10.2 per cent said their choice was environmentally friendly; only 5.1 per cent said their choice led to early maturity of crops.

Figure 6: Choice of adaptation methods in Dunkwa

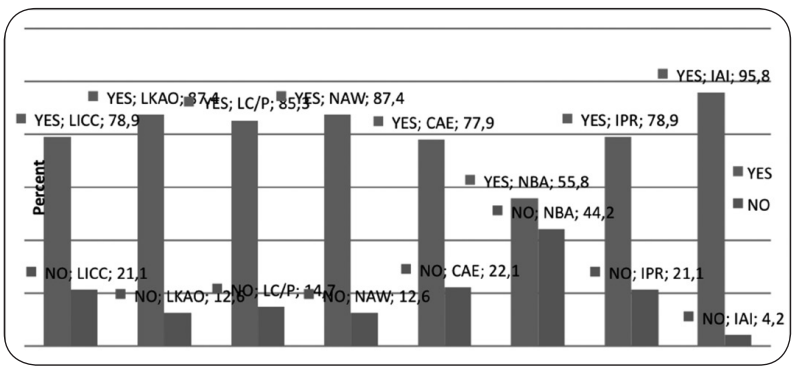


Note:CPD= *Changing Planting Dates;* UDC= U*se of Different Crop varieties;* IRG= *Irrigation Practices,* TRP= *Tree Planting,* SCN= *Soil Conservation*, PRY= *Prayers,* WAH= *Water Harvesting.*

Barriers to Adaptation Methods in Bawku

With regards to barriers to adaptation methods, insufficient access to inputs, lack of knowledge about adaptation options and no access to water dominated the responses. Other constraints included expensive changes, insecure property rights, lack of credits and lack of information about climate change. From Figure 7, 78.9 per cent of the respondents perceived lack of information about climate change to be a barrier to adaptation while 21.1 per cent went contrary to this opinion. 87.4 per cent of the respondents attributed lack of knowledge about adaptation options to be a barrier to adaptation methods while 12.6 per cent did not. While 85.3 per cent of the respondents interviewed attributed lack of credit and poverty as a barrier to adaptation methods, the remaining 14.7 per cent did not perceive that to be so. The majority (87.4 %) indicated no access to water as an important barrier to adaptation method while the remaining 12.6 per cent did not perceive that. Of the respondents 77.9 per cent affirmed changes are expensive while 22.1 per cent perceived otherwise.

Figure 3.7: Barriers to adaptation methods in Bawku



Note: LICC = *Lack of Information about Climate Change;* LKAO = *Lack of Knowledge about Adaptation Options*; LC/P = *Lack of Credit/Poverty* ; NAW= *No access to Water*; CAE = *Changes are Expensive* ; NBA = *No Barriers to Adaptation* ; IPR = *Insecure Property Rights* ; IAI= *Insufficient Access to Inputs*.

When asked if there were no barriers to adaptation, 55.8 per cent, representing more than half of the total respondents, indicated in the affirmative while the remaining 44.2 per cent perceived barriers. Of the respondents 78 per cent perceived insecure property rights as a barrier while 21.1 per cent did not. Most (95.8 %) attributed insufficient access to inputs as a major barrier to adaptation methods while only 4.2 per cent of the total respondents (95) did not perceive that.

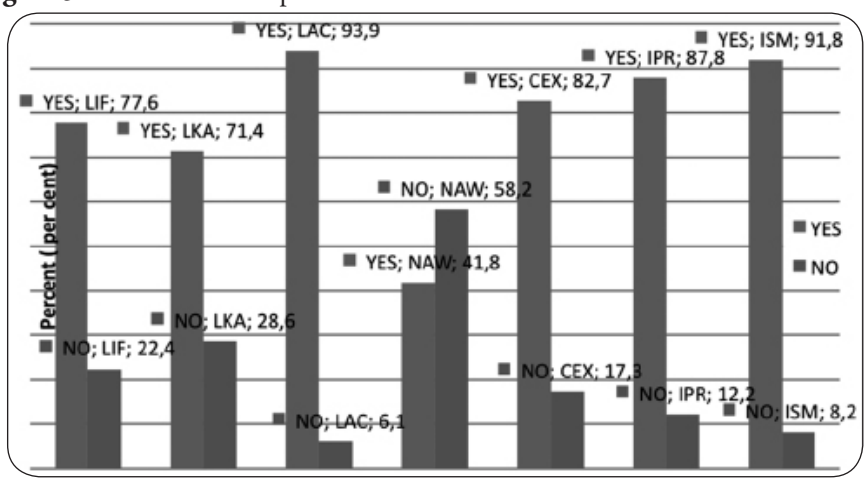
Barriers to Adaptation Methods in Dunkwa

Barriers preventing farmers from adapting to climate change in Dunkwa were investigated. Results as shown in Figure 8 identified lack of information on climate change impacts and adaptation options; lack of knowledge about adaptation measures; lack of access to credit; no access to water, high cost of adaptation; insecure property rights and insufficient access to inputs as the major barriers inhibiting their ability to adapt to climate change impacts.

With regard to lack of information, 77.6 per cent of the farmers identified this as the main barrier to effective adaptation to climate change; whilst 22.4 per cent did not think that was the case. 71.4 per cent of the farmers identified lack of knowledge regarding adaptation measures whilst only 28.6 per cent were aware of adaptation options. 93.9 per cent of the farmers interviewed indicated that access to credit was very low and this had constrained many of them from effective adaptation of climate impacts.

No access to water for irrigation and other farming activities was identified by 41.8 per cent of the farmers as a barrier to adaptation; however, 58.2 per cent did not see access to water as a problem. Cost involved in adapting to climate change impacts was identified by 82.7 per cent of the farmers as the reason explaining their poor adaptation ability whilst 17.3 per cent disagreed. Insecure property rights over land constrained about 87.8 per cent of the farmers from using any adaptation measure. About 91.8 per cent of the farmers indicated that inadequate access to inputs was a barrier to adaptation. This was attributed to lack of access to credit as well as the expensive nature of adaptation measures.

Figure 3.8: Barriers to adaptation methods in Dunkwa

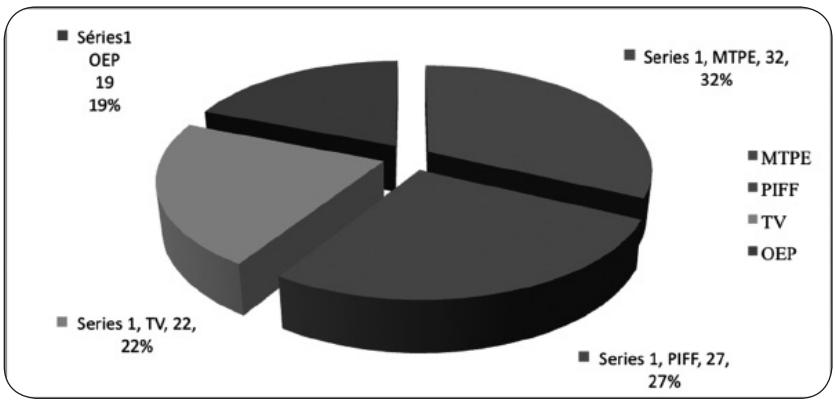


Note: LIF= *Lack of Information on Adaptation Options*; LKA= *Lack of Knowledge on Adaptation options*; LAC= *Lack of Access to Credit*; NAW= *No Access to Wate*r; CEX= *Changes are Expensive*; IPR= *Insecure Property Rights*, ISM= I*nsufficient Access to Inputs*.

Willingness to Pay for Climate Change Mitigation Policies in Bawku

Of the respondents interviewed 71.6 per cent were willing to pay for climate change mitigating policies while 28.4 per cent, despite the associated benefits of these policies, were unwilling to pay. From Figure 9, the respondents were willing to pay for four mitigating policies at a total amount of GH¢ 5,073. Out of the total respondents, 32 per cent were willing to pay GH¢1,618 for massive tree planting (MTPE), 27 per cent were willing to pay GH¢ 1,351for provision of irrigation facilities to farmers (PIFF), 22 per cent were willing to pay GH¢ 1,117 for training volunteers (TV) to guard against unauthorised cutting of trees and 19 per cent were willing to pay GH¢ 987 for organising an annual education programme for the farmers (OEP).

Figure 3.9: Willingnesstopay for climate change policies in Bawku



Willingness to Pay for Climate Change Mitigation Policies in Dunkwa

Climate change mitigation policies are necessary if long term agricultural productivity, food security and the growing needs due to increasing population growth are not to be compromised. As a result, the farmers were asked if they were willing to pay for climate change mitigation po.licies.

Of the farmers interviewed, 55.1 per cent were willing to pay for mitigation policy whilst 44.9 per cent were not. The study identified massive tree planting exercises, provision of irrigation facilities to farmers, training of volunteers to guard against unauthorised cutting of trees and organisation of education programmes on climate change as strategies for mitigation action. Figure 10 shows the distribution of the farmers' willingness to pay for these climates mitigation policies. From the data, it is obvious that farmers' willingness to pay for tree planting was high (35.68 %); followed by provision of irrigation facilities to farmers constituting about 30 per cent of the farmers. About 17 per cent of the

farmers interviewed were willing to pay for training of volunteers whilst about 17 per cent were willing to pay for climate change education programmes.

Figure 3.10: Willingness to pay for climate change mitigation policies in Dunkwa

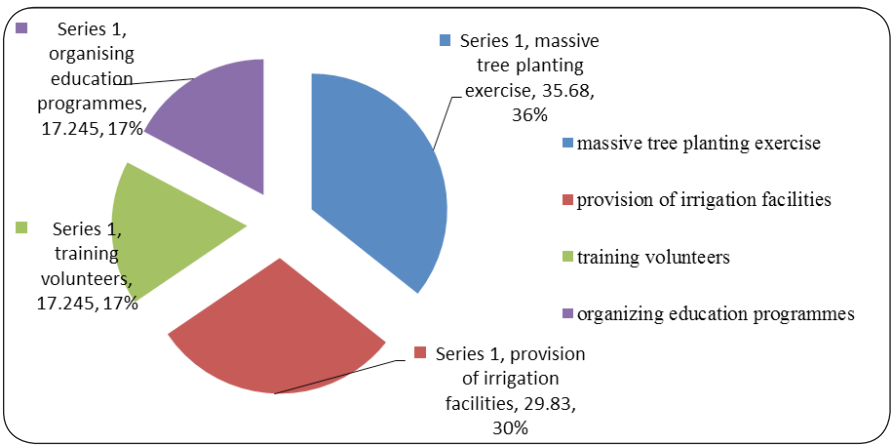


Table 3.1: The statistics of willingness to pay (WTP)

N=61	
Mean	12.3519
Median	9.00000
Std. Deviation	9.60573
Skewness	1.840 (std. error 0.325)
Kurtosis	2.915 (std. error 0.639)

Table 3.1 shows the summary statistics of the willingness to pay responses of farmers. The mean and median were GHS 12.3519, GHS 9.00 respectively. The median was lower than the mean, indicating that the majority of the farmers were willing to pay less than the mean willingness to pay, and that the response distribution was skewed by a limited number of high bidders.

Model Estimation Results of the Logistic Regression Analysis

A logistic regression analysis was employed to analyse the socio-economic factors that influence farmer's willingness to pay for climate change mitigation policy. The Akaike Information Criteria (Akaike 1973) provided the basis for selecting the model that provided the best fit to willingness to pay for climate change mitigation policy.

Table 3.2: Parameter estimates of the logistic model

		Robust		
Variables		**Coef.**	**Standard Error**	**P>z**
age -.338		.123	-2.75	0.006***
hhs .066		.044	1.51	0.132
edu .073	.	031	2.37	0.018**
exp.003		.001	2.54	0.011**
ofl1.065	.	357	2.99	0.003***
fs -.013		.044	-0.30	0.766
oinc .577	.	344	1.68	0.094*
cons6.784		2.838	2.39	0.017**

***1 per cent; ** 5 per cent; * 10 per cent

Note: AGE= Age of Respondent; HHS= Household Size; EDU= Years of Education of Respondent; EXP = Farming Experience in Years; OFL= Own Farmland; FS = Farm Size; OINC= Other Income Generating Activity.

The model specification, with willingness to pay for climate change mitigation policy as the dependent variable and age, years of education, years of farming experience, ownership of farm land, farm size and other income as the covariates provided the best fit with AIC of 244.95.

Empirical results from the logistic regression analysis reveals that age and farm size negatively influence willingness to pay for climate change mitigation policy whilst household size, years of education, years of farming experience, ownership of farm land and other income generating activity positively influenced willingness to pay for climate change mitigation policy. The regression analysis finds age, years of farming experience, ownership of farm land and other income as significant predictors of the probability to pay for climate change mitigation policy.

The parameters of years of farming experience, and other income were significant at 5 per cent and 10 per cent levels respectively while age of the respondent and ownership of farm land were significant at 1 per cent. It should be emphasised that a negative sign of a parameter indicates that high values of the variables tends to decrease the probability of the willingness to pay for climate change mitigation policy. A positive sign implies that high values of the variables will increase the probability of willingness to pay for climate change mitigation policy. The results of the odds ratio are presented below in Table 3.3.

Table 3.3: Parameter estimates of the logistic model with odds ratio

Variables	Odds Ratio	Robust Std. Err.	z	P>z
age	.713	.088	-2.75	0.006***
hhs	1.068	.047	1.51	0.132
edu	1.075	.033	2.37	0.018 **
exp	1.003	.001	2.54	0.011**
ofl	2.899	1.034	2.99	0.003***
fs	.987	.043	-0.30	0.766
oinc	1.781	.613	1.68	0.094*

***1 per cent, ** 5 per cent, * 10 per cent

Conclusion

Farmers' adaption to climate change is crucial to combating food insecurity and related problems. Against this background, this paper assessed farmers' perception and adaptation to climate change. Specifically, the study investigated farmer perception of changes in temperature and precipitation, choice of adaptation methods, barriers to adaptation and socio-economic determinants of willingness to pay for climate mitigation policies.

Results from the descriptive analysis of farmers interviewed revealed that the farmers were characterised by comprising an active labour force, small farm sizes, low income distribution, high farming experience, large household size, and low levels of formal education. With regards to farmers' perception and methods of adaptation, the majority of the farmers perceived increases in temperature and decreases in rainfall pattern. Farmers' level of adaptation was found to be relatively high with the majority of the farmers using changing planting dates, different crop varieties and soil conservation methods as the major adaptation measures to climate change impacts. However, access to water, high cost of adaptation, lack of knowledge on adaptation, insecure property rights and lack of credits were identified as the major barriers to adaptation. Results revealed high level of willingness to pay for mitigation policies among the farmers. However, the majority of the farmers supported massive tree planting exercise.

Logistic regression estimates finds age, years of farming experience, ownership of farm land, and other income as significant predictors of the probability to pay for climate change mitigation policy. Implications for policy will be to implement a public education programme on climate change adaptation strategies. There is the need for government to embark on massive implementation of mitigation policies since most farmers are willing to pay for these policies. Additional income generating activities should be encouraged among farmers since it is a positive and a significant predictor of their willingness to pay.

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