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FARMERS PERCEPTION AND ADAPTATION TO CLIMATE CHANGE: A WILLINGNESS TO PAY ANALYSIS

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ABSTRACT

Climate change and weather patterns are already being experienced as is evident in severe negative impacts on food production, food security and natural resources all over the globe. Farmer adaption to climate change is crucial to combating food insecurity and related problems. This paper, therefore, assesses farmers' perception and adaptation to climate change to enhance policy towards tackling the challenges climate change posses to the farmers in Ghana. With regards to farmers' perception on climate change, majority of the farmers perceived increase in temperature and decrease in rainfall pattern. Farmers' level of adaptation was found to be relatively high with majority of the farmers using changing planting dates, different crop varieties and soil conservation methods as the major adaptation measures. Logistic regression estimation finds age, years of farming experience, farm land owner, farm size and other income generating activity as significant predictors of the probability to pay for climate change policy.

Keywords: Adaptation, Mitigation, Perception, Climate Change, Willingness to Pay, Logistic Regression

INTRODUCTION

Climate change and weather patterns are already being experienced as it is evident in severe negative impacts on food production, food security and natural resources all over the globe. Without the appropriate responses, climate change is likely to constrain economic development and poverty reduction efforts and exacerbate already pressing difficulties especially in countries whose economies are rooted in climate sensitive sectors such as agriculture. Agriculture contributes about 35% of Ghana's GDP, generates about 30-40% of the foreign exchange earnings, and employs about 55% of the population (Diao, X . (2010).

According to Dai et al., 2004; Trenberth et al., 2007, many developing countries have already experienced weather events in terms of floods, droughts, heat waves and tropical cyclones that are more frequent or intense than previous experiences and the resulting impacts point to the consequences on the environment, production systems, and livelihoods from future climate variability and change. Minimizing the impacts of climate change requires perception and adaptation. Farmer's ability to perceive climate change is a key precondition for their choice of adaptation. Works by (Maddison, 2006) revealed that adaptation to climate change requires that farmers must first perceive that climate has changed, then identify useful adaptations and implement necessary adaptation responses.

In order to enhance policy towards tackling the challenges climate poses to farmers, it is important to have knowledge of farmers' perception on climate change, choice of adaptation methods and the barriers affecting adaptation to climate change. Empirical studies measuring the economic impacts of climate change on Agriculture in Africa show that such impacts can be significantly reduced through adaptation. Adaptation to climate change has the potential to substantially reduce many of the adverse impacts of climate change, reduce vulnerabilities and promotes sustainable development through enhancing the welfare of the poorest members of society. For example, by improving food security, facilitating access to safe water and shelter, increasing income and improving sustainability of existing resources.

In effect, adaptation 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. Against this background, the current study seeks to explore farmers' perception and adaptation to climate change. Specifically the paper seeks to (1) analyse the socio-economic characteristics of the respondents; (2) determine farmers perception on climate change (3) identify farmers choice of adaptation measures(s) in response to climate change (4) identify barriers to adaptation measures (5) determine farmers willingness to- pay for climate change mitigation policies.

MATERIALS AND METHODS

Study area description

The Bawku Municipality is one of the nine districts/municipalities in the Upper East Region of Ghana. The district borders Burkina Faso and Togo. 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 11^{o} and 11^{0} 15^{1} North of the Equator and longitude 1^{0} 30^{1} and 0^{0} West of the Greenwich Meridian. The administrative capital town Bawku town is about 880km (550miles) from Accra, the national capital and notably a 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 1215.05 square kilometers and an estimated population of 216,271 at an annual growth rate of 3% with an average of 7 persons per household. Agriculture is the dominant occupation in the district with tomatoes, soya beans and onions being amongst the main crops. The average annual rainfall of the municipality is 700mm, with peak rainfall in August.

The Valuation Approach

The Contingent Valuation Method (CVM) is a direct valuation method in which respondents are asked to express a Willingness To Pay (WTP) or Willingness To Accept in response to a hypothetical market situation (Carson, 2000). CVM is subject to a number of limitations that affect the validity and reliability of results, including embedding, sequencing, information and elicitation effects, and hypothetical and strategic biases (Venkatachalam, 2004). In order to reduce these possible deficiencies, a scenario, which includes sufficient accurate information about the resource being valued is provided to the respondent prior to asking for the amount he or she is willing to pay for public goods (Reynisdottir et al., 2008). A pretest was also done to check the validity and understandability of the contents of the questionnaire, including the scenarios used in the application of CVM (Mmopelwa et al., 2007).

The contingent valuation method (CVM) is utilized in this study. Various methods of eliciting WTP have been employed previously, including open-ended questions (Bateman et al. 1995; Beltran and Rojas 1996; Bille Hansen 1997), a payments card (Kima et al., 2007; Peters and Hawkins 2009), dichotomous choice (Lockwood et al., 1996; Pollicino and Maddison, 2001), iterative bidding games, and referendums (Dutta et al., 2007). This study draws from previous studies and employs open-ended questions in eliciting farmer's maximum willingness to pay.

Sampling and Data Analysis

The target population was farmers in the Bawku Municipality in the Upper East Region of Ghana. A random sampling technique was used to select 95 farmers in Bawku. An interview schedule was the main tool of data collection while descriptive statistics and logistic regression analysis were the main analytical techniques. Data was analyzed using the Statistical Package for Social Sciences (SPSS) and the R Statistical Programming Language.

The basic model of the logit estimation is as follows:

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

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

Similarly,

$$P_i = \Pr ob(Y_i = 0) = 1 - \Pr ob(Y_i = 1)$$

$$= \frac{1}{1+e^{(\beta_o+\beta_1 X_{1i}+.....\beta_k X_{ki})}} \quad \text{.....(2)}$$

Dividing (1) by (2) we get

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

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

This research uses information criteria as technique for providing the basis for model selection. Most commonly used information criteria such as Akaike Information Criteria (AIC) is 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 is aimed at finding the best approximating model to the unknown true data generating process and its applications draws from (Akaike, 1973; Bozdogan, 1987; Zucchini, 2000).

RESULTS AND DISCUSSIONS

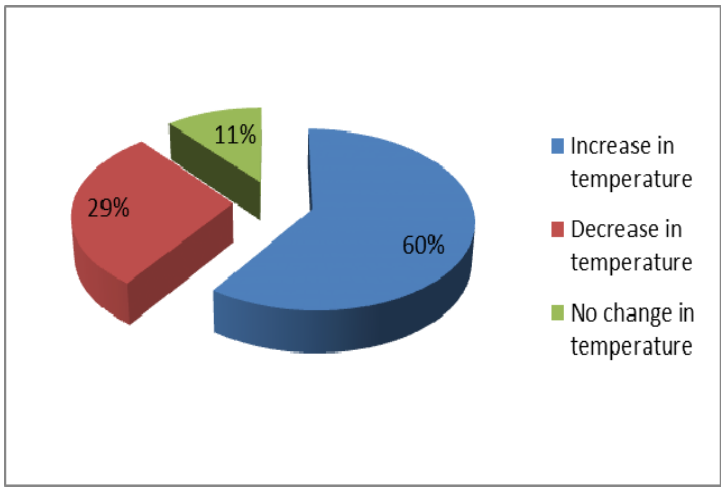
Socio-economic characteristics of respondents

In an attempt to investigate the socio economic characteristics, respondents were asked questions pertaining to that. Of the respondents interviewed, 82.1% were males while the remaining 17.9%, females. 23.2% of the respondents interviewed were between the ages of 24-30 years; 45.3% between 31-40 years; 21.1% between 41-50 years, 8.4 between 51- 60 years and 2.1% were between 61-70 years. Of the respondents interviewed, 64.2% were heads of their families while the remaining 35.8% were not. Though educational levels of the respondents ranged from non formal to the tertiary levels, the number of years spent at these levels differed with the respondents. The results showed that 23.2% of the respondents had no formal education; 12.6% had attained basic education and middle/JHS education respectively, 17.9%, O'level/SHS education and 33.7% acquired education up to the tertiary level. With respect to the household size, 41.1% of the respondents had household size between 1-5, 43.2% between 6-10, 12.6% between 11-15, 2.1% between 16-20 and 1.1% ranged between 21-25.

With regards to their farming experience, 20.0% had 3-10years of farming experience, 47.4% had 11-20years, 20% had 21-30years, 7.4% had 31-40years and 5.3%, 41-50years experience. Of the respondents interviewed, majority constituting 55.8% had farmland size between 1-5 acres, 36.8% had farmland size of 6-10acres, 3.2% had farmland size between 11-15 acres, 3.2% had farmland size between 16-20 acres and 1.1% had farmland size between 21-25. 64.2% of the respondents had other income generating activity while 35.8% only source of income was farming usually done on subsistence level. Majority constituting 56.8% and 18.9% of the respondents interviewed earned annual income between GH¢800-GH¢2000 and GH¢2100-GH¢3000 respectively, 12.6% earned between GH¢3100-GH¢4000, 7.4 % earned between GH¢ 4100-GH¢5000, 2.1% earned between GH¢5100-GH¢6000 and GH¢6100-GH¢7000 respectively.

Perception of changes in temperature

Figure 1: Perception on Changes in Temperature

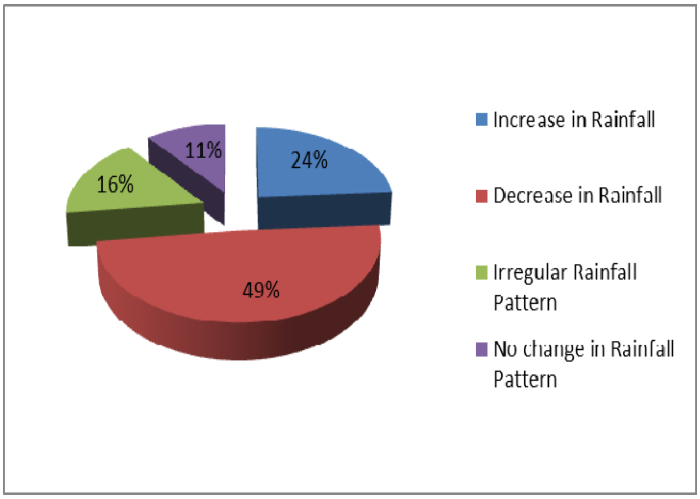


When asked about the perception of changes in temperature, majority constituting 60% of the total respondents perceived an increase in temperature as shown in Figure 1. 29% of the respondents indicated a decrease in temperature while the remaining 11% of the respondents were contrary to this opinion i.e. perceived no change in temperature.

Perception of changes in rainfall

Of the farmers interviewed with respect to changes in rainfall, 24% perceived an increase in rainfall as shown in Figure 1. However, 49% of the total respondents perceived decrease in rainfall. Although 11% of the total respondents perceived no changes in rainfall, up to 16% were contrary to this view since they perceived irregular rainfall pattern.

Figure 2: Perception of Changes in Rainfall

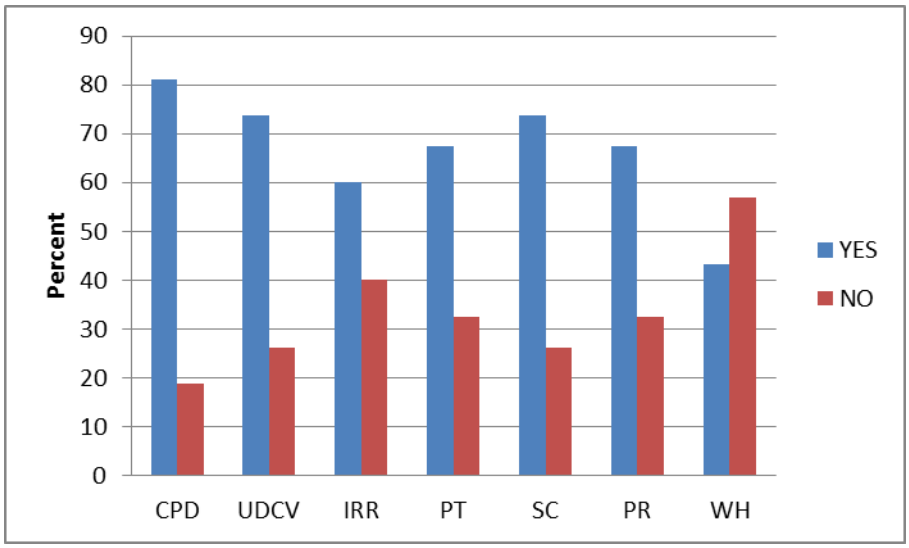


Choice of adaptation methods

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

From the Figure 3, 81.1% of the respondents interviewed adapted changing planting dates while 18.9% did not. 73.7% of the respondents adapted using different crop varieties while the remaining did not. With irrigation as an adaptation method, 60% of the respondents used it while the remaining 40% did not. 67.4% 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 remaining did not. Prayers surprisingly gained popularity as an adaptation method with 67.4% of the respondents using it while the remaining 32.6% did not see its benefits. Water harvesting on the contrary had a lower percentage of adaptation (43.2%) while the majority 56.8% did not employ it as an adaptation strategy.

Figure 3: Choice of Adaptation Methods



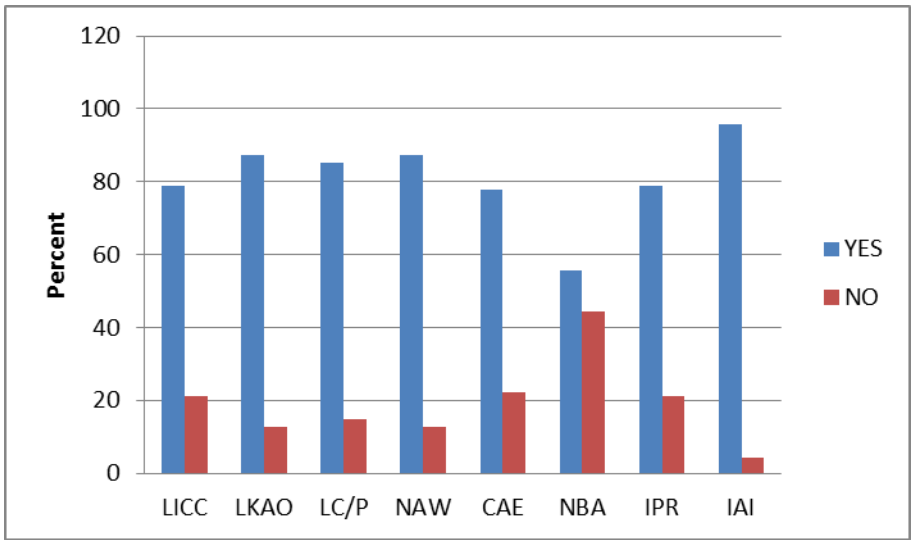
NOTE: CPD = Changing Planting Dates **IRR** = Irrigation **UDCV =** Using Different Crop Varieties **PT** = Planting Trees **PR** = Prayers SC = Soil Conservation **WH**= Water Harvesting

Barriers to adaptation methods

With regards to barriers to adaptation methods, insufficient access to inputs, lack of knowledge about adaptation options and no access to water dominated the response. Other constraints included changes being expensive, insecure property rights, lack of credits and lack of information about climate change.

From Figure 4, 78.9% of the respondents perceived lack of information about climate change to be a barrier to adaptation while 21.1% were contrary to this opinion. 87.4% of the respondents attributed lack of knowledge about adaptation options to be a barrier to adaptation methods while 12.6% did not. While 85.3% the respondents interviewed attributed lack of credit and poverty as a barrier to adaptation method, the remaining 14.7% did not perceive so. Majority (87.4%) indicated no access to water as an important barrier to adaptation method while the remaining 12.6% did not perceive so. 77.9% of the respondents affirmed changes are expensive while 22.1% perceived otherwise.

Figure 4: Barriers to Adaptation Methods



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 Right **IAI**= Insufficient Access to Inputs

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

Willingness to-pay for climate change mitigation policies

Of the respondents interviewed, 71.6% were willing to pay for climate change mitigating policies while 28.4% despite the associated benefits of these policies were unwilling to pay. From Figure 5, the respondents were willing to pay for four mitigating policies at a total amount of GH¢ 5073. Out of the total respondent's, majority (32%) were willing to pay GH¢1618 for massive tree planting (MTPE), 27% were willing to pay GH¢ 1351for provision of irrigation facilities to farmers (PIFF), 22% were willing to pay GH¢ 1117 for training volunteers to guard against unauthorized cutting of trees and 19% were willing to pay GH¢ 987 for organizing annual education programme for the farmers (OEP).

Figure 5: Willingness to pay for Climate Change Mitigating Policies

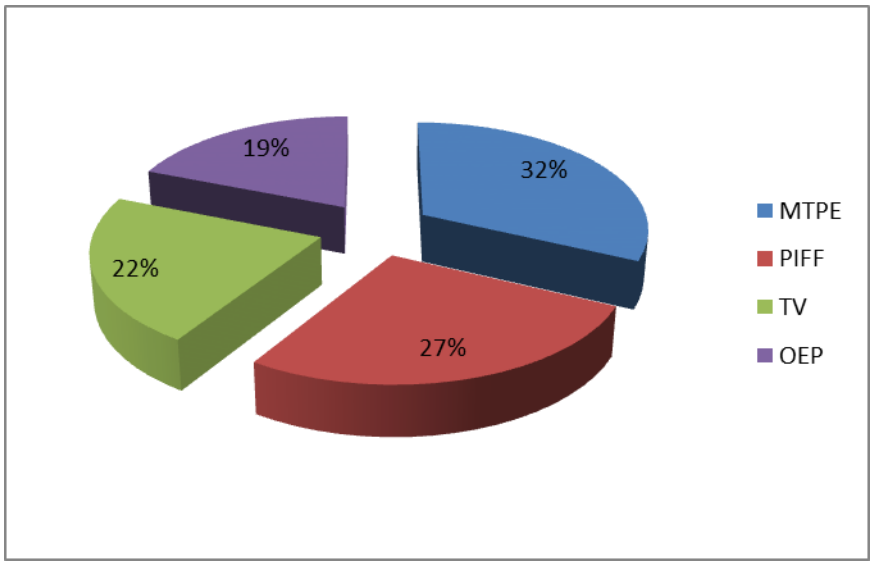


Table 1: The Statistics of Willingness-To-Pay (WTP)

N=61	
Mean	55.2947
Median	36.0000
Std. Deviation	74.51
Skewness	2.809 (std. error 0.247)
Kurtosis	9.848 (std. error 0.490)

Table 1 and 2 shows the summary statistics of the willingness to pay responses of farmers. Seventy-two percent of the sample were willing to pay; moreover, Gh¢ 36, 48, and 60 were the most popular responses of the Willingness to Pay as illustrated in the frequency distributions in Table 2. Just over a quarter (27%) were not willing to pay anything at all. The mean willingness to pay (WTP) and median are Gh¢ 55.29 and 36.00, respectively (Table 1). The median is 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 is skewed by a limited number of high bidders.

Table 2: The Frequency of the Bids of Willingness to Pay

Bids of WTP (GH¢)	Frequency	Percent	Bids of WTP (GH¢)	Frequency	Percent
0	26	27.4	84	2	2.1
10	1	1.1	96	2	2.1
24	4	4.2	97	1	1.1
25	1	1.1	108	1	1.1
27	1	1.1	120	2	2.1
30	4	4.2	144	1	1.1
32	1	1.1	150	1	1.1
35	1	1.1	180	1	1.1
36	14	14.7	200	2	2.1
42	3	3.2	204	1	1.1
46	1	1.1	240	1	1.1
48	11	11.6	267	1	1.1
54	3	3.2	330	1	1.1
60	5	5.3	450	1	1.1
72	1	1.1	-	-	-
			Total	**95**	**100.0**

Model Estimation Results of the Logistic Regression Analysis

A logistic regression analysis was employed to analyze 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.

The model specification with willingness to pay for climate change mitigation policy as the dependent variable and age, household size, years of education, years of farming experience, owner of farm land, farm size and other income as the covariates provided the best fit with AIC of 96.68. Empirical results from the logistic regression analysis in Table 3 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, owner of farm land and other income generating activity positively influenced the willingness to pay for climate change mitigation policy. The regression analysis finds age, years of farming experience, owner of farm land, farm size and other income as significant predictors of the probability to pay for climate change mitigation policy.

Table 3: Parameter estimates of the logistic model.

Variables	Estimates	Std. Error	z value	Pr (>|z|)
Intercept	2.626	1.654	1.587	0.112
AGE	-0.164	0.058	-2.801	0.005**
HHS	0.127	0.082	1.557	0.119
EDU	0.077	0.055	1.416	0.157
EXP	0.115	0.057	2.036	0.042*
OFL	1.458	0.701	2.078	0.037*
FS	-0.178	0.084	-2.104	0.035*
OINC	1.476	0.589	2.504	0.012*

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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 parameters of years of farming experience, owner of farm land, farm size and other income were significant at 5% level while age of respondents was significant at 1%. It should be emphasized 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.

CONCLUSION

Farmer adaption to climate change is crucial to combating food insecurity and related problems. Against this background, this paper assesses farmer's 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 characterized by active labour force, small farm sizes, low income distribution, high farming experience, large household size, and low level of formal education. With regards to farmers' perception and methods of adaptation, majority of the farmers perceived increases in temperature and decreases in rainfall pattern. Farmers' level of adaptation was found to be relatively high with 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, majority of the farmers supported massive tree planting exercise.

Logistic regression estimation finds age, years of farming experience, owner of farm land, farm size 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 program 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 significant predictor of their willingness to pay.

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