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Farmer's Perception on Climate Change and Determinants of Adaptation Measures in Bardiya District, Nepal

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Abstract:- A research on farmer's perception on climate change and determinants of adaptation measures in Kalika VDC Bardiya Nepal was done in 2012. Altogether, 60 respondents from the Kalika VDC were randomly selected for the study. Pre-tested semi-structured interview schedule, direct observation, 1 Focus Group Discussion (FGD), 5 Key Informants Interviews (KII) were used to collect the required information. Most of the farmers perceived the change in climate in terms change in rainfall patterns, rainfall duration, onset of monsoon and change in temperature in terms of hotness and coldness. Most of the problems identified from the focus group discussion were related to climate change issues such as delayed rainfall, erratic rainfall, no rainfall in winter season. Use of irrigation practice was ranked as most common local adaptation measure. Similarly, mulching, agro forestry, cooperative vegetable farming and use of drought tolerant varieties were other adaptation measures in study area. Logit regression analysis showed that a unit increase in education level of household head, if household head is male, if access to information about climate change and if occupation of household head is agriculture it would increase the probability of practicing of different adaptation strategies by 6.95%, 8.91%, 90.7% and 69.2% at 5% level of significance respectively. This study concludes that the farmers perceived the climate change, its negative implication on their farming systems.

Keywords: Climate change; adaptation; Logit

I. INTRODUCTION

Climate change is one of the biggest challenges of our times. It poses an increasing threat to the sustainability of agricultural production and livelihood strategies of poor and rural people worldwide. Nepal's temperature has increased by 1.7 ^{0}C during last 30 years (1975 to 2005) with the average temperature increased by 0.06^{0}C per year [1] and in particular, 0.04^{0}C /year in Terai and 0.08^{0}C/year in Himalayas. A study on aggregated precipitation and average temperature of five meteorological stations (Dhangadi, Surkhet, Pokhara, Kathmandu and Dhankuta) showed an increasing trend in both temperature and total precipitation in Nepal [2] **.** Agriculture is the backbone of Nepalese economy, which contributes 31.7% to GDP and provides employment opportunity to more than 65.0% economically active population in country [3]. Climate change is the global issue at present and has serious impact on food crops and livelihood option of farming community. Agriculture depends strongly on weather and climatic condition, an important part of the economy of the county is sensitive to climate change [4]. Delaying in the initiation of the monsoon resulted in late planting of paddy and rainy season crops with lower crop yield. Lower crop yield due to the unfavorable climatic condition will lead to vulnerability in the form of food insecurity, hunger and shorter life expectancies [5]. Because of the subsistence agricultural production, depends heavily in nature, and based on the traditional knowledge and practices, any changes in climatic condition, therefore, will affect a lot in the food security in Nepal [6]. Late onset of monsoon shifts the cropping calendar of the farmers. Assessing the local impact of climate change is essential to plan coping strategy with emerging uncertainties.

Effect of climate change encompasses all vital system supporting world populations. Human health, agriculture, forest, water resources and biodiversity will suffer at different scales depending on local conditions. If the increase in temperature exceeds by 1.5 ^{0}C to 2.5 ^{0}C, there will be the risk of extinction of plant and animal species by 20-30% [7]. Climate change and its impacts are now clearly visible on both ecosystem health and farmers livelihoods. Smallholder farmers do not have adequate resources for effectively responding to the impacts of climate change, and are highly vulnerable to its negative consequences. This study was conducted to assess on farmer's perception on climate change and explore the local adaptation measures and also to study the determinants of farm level adaptation measures followed by farmers. The study prioritized the potential impacts, and identifies the effective adaptation strategy through participatory approach with the local communities. Studying the impacts of climate change experienced by farmers could form the base for further research and development of adaptation measures for sustainability of agriculture and preparing farming community in alternative agriculture to tackle the emerging problem of food security.

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II. METHODS

A. Selection of the study area:

This study was conducted in the western Terai of Nepal. Bardiya district was selected purposively for the study. During the consultation with district level organization District Agriculture Development Office (DADO) Bardiya, District Development Committee (DDC) and Caritas Nepal suggested to conduct study in Kalika VDC because the climate change events were more frequently observed there.

B. Sample size:

Altogether, 60 household were randomly selected. The field survey was conducted in August, 2012. Semi-structured interview schedule was prepared and survey was conducted. Direct observations in the farmer's field, 1 focus group discussion and 5 key informant survey were carried out.

C. Sampling procedure and selection of the respondent:

All the farmers from Kalika VDC were the target population for this study. During the selection of the respondent who has been residing there at least 10 years of settlements within this locality were included in the sample, because they provide valuable and useful information regarding the past trends on climatic variables. Careful attention was given during the selection of the respondents.

D. Field survey:

After the finalization of the interview schedule, the schedule of field visit was prepared to collect information. The field survey was conducted in the month of October and November 2012. Respondents were interviewed by visiting their home. The interview timing was fixed as per the farmer's convenience. Regular checking and validation of the information was done immediately after filling the interview schedule. Focus group discussions, informal discussions and key informants interview were also done during the field survey.

E. Methods and techniques of data analysis:

The information collected from the field survey was coded first and entered into the computer. Data entry and analysis was done by using Statistical Package for Social Science (SPSS 16 version) and Microsoft Excel. The local unit of measurements was corrected in to scientific one. Both descriptive and analytical methods were used to analyze the data. The final analysis was done by using computer software Statistical Package for Social Sciences (SPSS), Microsoft Excel and STATA 12.

➢ *Qualitative Data Analysis:*

Qualitative information obtained during the field survey like emergences of new weeds, disease, pests, loss of indigenous breeds and varieties, occurrences of trends of climatic hazards, felt needs of the adaptation strategies by farmers were qualitatively analyzed and expressed.

➢ *Quantitative Data Analysis:*

Quantitative data were analyzed by using the both descriptive and analytical statistics.

➢ *Descriptive Analysis:*

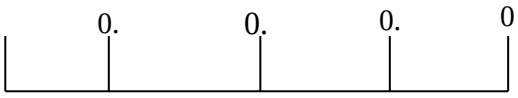
Socioeconomic and farm characteristics of the respondents like family size, age, occupational pattern, change in size of holding, size of the irrigated holding, distribution of economically active population were described by using simple descriptive statistics like frequency count, percentage, mean, standard deviation. Impacts and perception of farmers on the change of climatic variables over the time and their adaptation strategies were studied by estimating frequency, percentage, charts and diagrams.

F. Indexing:

Various problems and reasons were ranked with the use of index. Scaling techniques, which provides the direction and extremity attitude of the respondent towards any proposition [9] was used to construct index. The intensity of production problem being faced by the aromatic rice producers and traders, respectively were identified by using five point scaling technique comparing most important, somewhat important, important, and less important and least important using scores of 1.00, 0.80, 0.60, 0.40, and 0.20, respectively. The formula given below was used to find the index for intensity various problem/reasons.

$I_{prob}=\sum \frac{S_i f_i}{N}$ Where,I_{prob}= Index value for intensity of problem ∑= Summation

Si = Scale value of i^{th} intensity, fi = Frequency of i^{th} response, N = Total number of respondents



Scale value for indexing of adaptation strategies

G. Logit regression model:

In the changing climatic condition, farmers were responding to climate change by practicing different adaptation strategies. Farmers knowingly and unknowingly responding to the changing climate by practicing different coping and adaptation strategies. The decision of farmers to practice different adaptation strategies were estimated through Logit regression to derive the several factors that govern the probability to practicing adaptation strategies (Yi = 1). Maximum likelihood method leads to least square function under linear regression mode (under the conditions of normally distributed error term) and gives value for the unknown parameters which maximize the probability of obtaining the observed set of data.

There were several factors that affect for the practicing different adaptation strategies in the farm level. Decision to practice different adaptation strategies might be influenced by several socioeconomic, demographic, institutional and financial conditions. The logistic model was used to analyze

the binary or dichotomous response and allows examining how a change in any independent variable changes all the outcome probabilities [10]

In the Logit model, suppose Yi be the binary response of the farmers and take only two possible values; Y = 1, if farmer practiced different stronger adaptation strategies and Y = 0 if practicing few (poor) adaptation strategies. Suppose x was the vector of several explanatory variables affecting to practice different adaptation strategies and β, a vector of slope parameters, which measures the changes in x on the probability of the farmers to practice stronger adaptation strategies. The probability of binary response was defines as follows:

If Yi = 1; P (Yi = 1) = Pi
Yi = 0; P (Yi = 0) = 1-Pi
Where, Pi = E(Y = 1/x) represents the conditional mean of Y given certain values of X.

Therefore, probability of practicing stronger adaptation strategies was expressed as [10].
$P(Y_i = 1) = P_i = \frac{1}{1+exp^{-z}}$

$Z = \alpha + \sum \beta_i x_i + €_i$

The Logit transformation of the probability of the practicing stronger adaptation strategies by farmers was represented as follows [11]

$L_i = \ln [\frac{Pi}{1-Pi}] = z_i = \alpha + \sum_{i=1}^{n} \beta i\, xi + €i$

Where Yi = a binary dependent variable (1, if farmers practicing stronger adaptation practices, 0 otherwise), xi includes the vector of explanatory variables used in the model, β_i = parameters to be estimated, €I = error term of the model, exp (e) = base of the natural logarithms, Li = Logit and $[\frac{Pi}{1-Pi}]$ = Odd ratios.

Thus, the binary Logit regression model was expressed as;
$Y_i = f(\beta_i\ x_i)$ = f (Economically active family members, Education, Farm size, Farming experience, Annual household cash earning, Gender, Credit, Training Extension and Information).

Table 1: Description of the variables used in the Logit model

Variables	Description	Value	Expected sign
Economically active members	Number of economically active(15-59) years family members in the household	Number	+
Education	Education of the household head	Number of Years	+
Farm size	Total size of cultivated land	Hectare	+
Experience	Experience of household head in agricultural activities	Year	+
Gender	Gender of the household head(1/0)	= 1 if male; 0 = otherwise	+/-
Training and Extension	Whether farmers received training from different governmental and non-governmental organization about climate change adaptation strategies(1/0)	= 1 if farmers received training and extension; 0 = otherwise	+
Information	Whether farmers know or receive the information about climate change(1/0)	= 1 if farmers know or receive information; 0 = otherwise	+

III. RESULTS AND DISCUSSION

A. Information gain about climate change by the respondents:

The study showed that 33.33% of the respondents know about climate change and 66.67 % of them were unaware about climate change. Out of 20 respondents who were aware about climate change only 15.4% of them knew climate change clearly, 30.8% knew ambiguously and majority of respondents 53.8% of them knew climate change a little bit. The sources of the information to the respondents were self-experiences of farmers, media, others (local leader, neighbor, teachers, and social workers) and different organizations working in that area. The study revealed that 25 % of the respondents know about climate change through their self-experiences by comparing the past and present events of climatic parameters such as change in temperature, rainfall pattern etc. 15 % of the respondent obtained information through media such as local F.M. Majority of respondent i.e. 50 % know about climate change through social organization working in that area such as Caritas Nepal, Community Forest User's Group etc. 10 % of the respondents said that they know about climate change through their relatives, neighbors and local leaders .

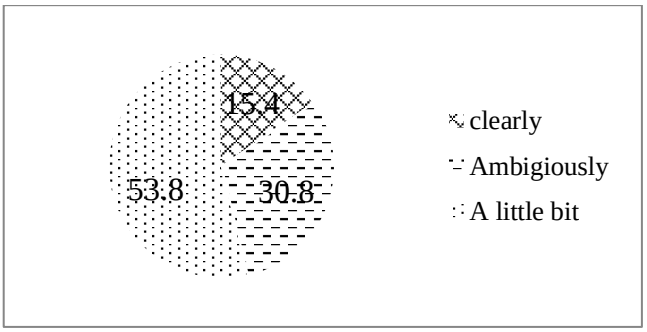


Fig 1: Sources of Information obtained about climate change by the respondents

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B. Perception of farmers on change about change in temperature level:

The study revealed that most of the respondents perceived that the temperature level is increasing. 78.1% of respondents agreed that the level of temperature is increasing with compared to previous years. 10.7% of the respondents did not fell that the temperature is changing, 5.8 % of respondents said that the temperature level is decreasing and 5.4 % of respondents were indifference about the change in level of temperature.

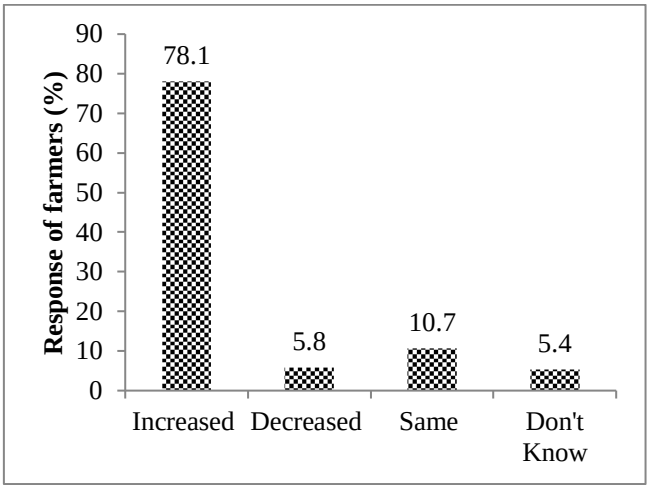

Fig 2: Perception of farmers about change in temperature level

C. Perception of farmers on change in rainfall pattern in major monsoon season (June- September):

Farmers perceived that there was wide variation in the rainfall patterns as compared to the past. Majority of the farmers, 75.7% perceived that the numbers of rainy days in monsoon season (June-September) are decreasing. Only the 3.5% of them perceived that the monsoon season rainy days are increasing. 20.8% of them were indifferent about change in number of rainy days.

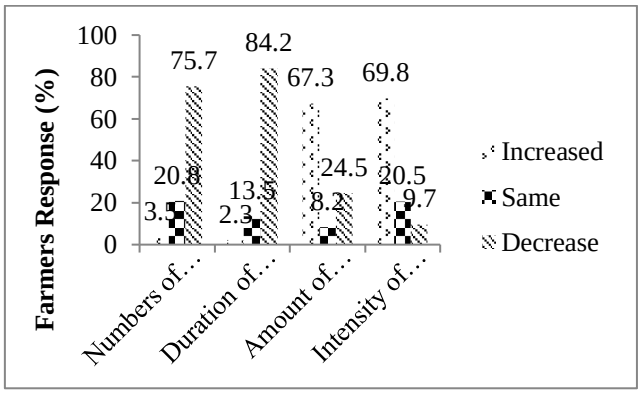

Fig 3: Farmer's perception on change in rainfall pattern in monsoon season

Majority of the farmers, 84.2% perceived that there was the duration on monsoon season rainfall was decreasing and 13.5% of respondents observed that there was no change in duration of monsoon season rainfall. Majority of respondents, 67.3% and 69.8% perceived that the amount and intensity of rainfall respectively at monsoon season is increasing. While, 24.5% and 9.7% of them were perceived that the amount and intensity respectively is in decreasing order.

D. Perception of farmers on change in rainfall pattern in winter season (Oct-May):

The study showed that the similar response of the farmers about the trend of winter seasonal rainfall except its intensity as like that of rainy seasonal rainfall. Majority of the respondents stated that there was decrease in number of rainy days, duration of rainfall, amount rainfall and intensity of rainfall in winter season. Farmers showed the some example of crop yield reduction in wheat, lentils, mustard etc.

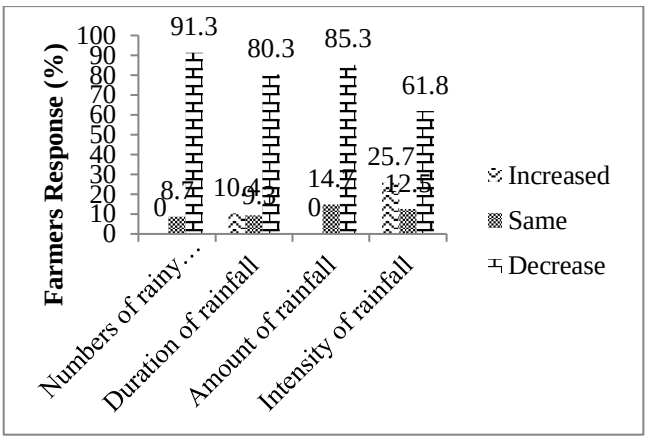

Fig 4: Perception of farmers about the change in rainfall parameter (In other season, October- May)

E. Perception about numbers of hotter and colder days:

This study revealed that most of the respondents perceived that the numbers of hotter days are in increasing orders 92.1% of respondent said that the numbers of hotter days are increasing as compared with previous years. Where the numbers of colder days are decreasing 70.3% of the respondents perceived that the colder days are decreasing, 13% of respondent perceived that the colder days are increasing and 15.3% of respondents said that there was no change in the numbers of colder days as compared with previous years. 1.4% of respondents were unable to say about number of colder days.

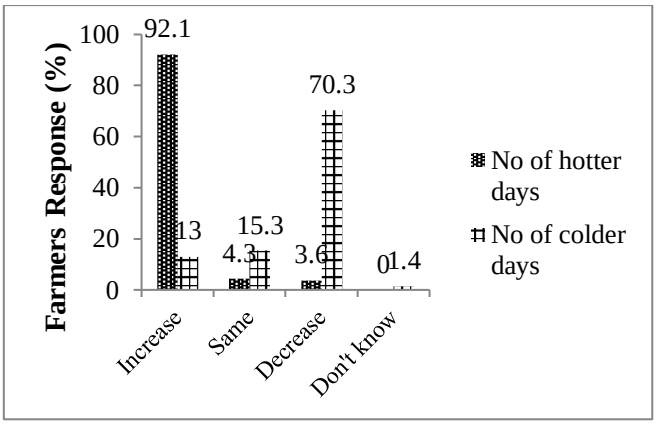

Fig 5: Perception of respondents about numbers of hotter and numbers of colder days

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F. Any adverse effect on farming system in past 10 years:

A Focus Group Discussion (FGD) was organized to find out the VDC level major problem related to climate change. Farmers present at the FGD were asked about they have felt any adverse effect on farming system over 15 years. They had informed that the drought and floods were the major problems they had been facing. They provided the information about ecological hazard in following ways. Drought and flood are the two major hazard of Kalika VDC; drought was seemed to be most important problem.

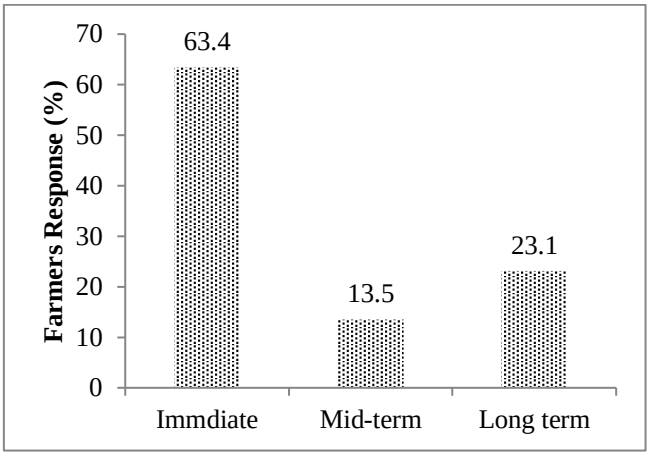

Fig 6: Measurement level of drought required

This study revealed that rice was the major crop that got failure due to both drought and flood. This is due to rice is most dependent on monsoon season in this rain fed condition. The drought cause the delayed nursery establishment, delayed transplanting and forced farmers to transplant old aged seedlings. If farmers managed its transplantation, the erratic and short duration rainfall doesn't favor its vegetative and reproductive growth. That's why drought affects the rice production.

In another way, heavy rainfall at the time of seedling establishment, flowering and harvesting stage swept way the rice crop, hence reduce the crop yield.

The major crop failure due to drought and flood are as follows:

- Paddy(drought and flood at each and every stage)
- Chili (drought at flowering stage)
- Wheat (lack of winter rainfall at vegetative stage)
- Fish production (flood swept away from pond)

G. Indexing of the local adaptation measures:

Farmers in the study area adapt the changing climate and its impact in their farm. Use of irrigation practice was ranked as most common local adaptation measure. Similarly, mulching, agro forestry, cooperative vegetable farming and use of drought tolerant varieties were other adaptation measures in study area. Use of hybrid crop varieties, they were willing to use short duration crop varieties in order to respond the impacts of pronounced drought. They are changing the varieties of rice such as Sukha rice rice-1, Sukha rice-2 and Sukha rice-3 varieties.

Table 2: Indexing of major local adaptation measures in Kalika VDC Bardiya (2012)

Particular	Index value	Rank
Irrigation practices	0.74	I
Agro forestry	0.65	II
Mulching	0.61	II
Cooperative farming	0.58	IV
Use of resistant varieties	0.42	V

Source: Field survey 2012

H. Factors affecting adoption of local adaptation measures:

There were number of adaptation strategies practiced by farmers so that it was difficult to study the determinants of practicing different adaptation strategies separately. So, categorization of the adaptation strategies practiced by farmers was done into the binary response. Adaptation strategies practiced by farmers in the study area were categorized into binary response by practicing stronger and more adaptation measures = 1, (> 4 of stronger adaptation measures) and 0 otherwise (by practicing poor or few adaptation measures).

Table 3.Factors affecting the adoption of climate change adaptation strategies

Variable	Coefficients	P>|z|	Standard error	dy/dxb	S.Eb
Age of HH (years)	-0.02265	0.639	0.483	-0.0027	0.00583
Education of HH (Numbers of Years)	0.5836**	0.039	0.283	0.0695	0.0368
Economically active members (No.)	-0.5227	0.229	0.435	-0.062	0.0548
Training (Dummy)	02.108	0.229	1.872	0.0304	0.301
Gender (Dummy)	7.476**	0.260	3.988	0.0891	0.369
Credit (Dummy)	-1.687	0.395	1.983	0.192	0.209
Information (Dummy)	6.898**	0.011	2.702	0.907	0.1145
Occupation (Dummy)	5.81**	0.048	2.932	0.692	0.399
Constant	-17.086	0.045	8.532	-	-

Source: Field survey 2012

Number of observation(N)	60
Log likelihood	-13.28
LR $chi^2(8)$	54.20 (Prob>chi^2 = 0.000)
Prob >chi^2	0.000
Pseudo R^2	0.671
Cases predicted correctly (%)	85.76
Goodness of fit test	Pearson chi^2 (49) = 26.20. Prob> chi^2 = 0.9961

According to the Logit regression analysis Education level of household head, gender of household head, access to information about climate change and occupation of household head were positively significant ($p<0.05$) to practicing the local adaptation measures. According to this finding keeping other factor constant, if a unit increase in education level of household head, it would result in 6.95% increase in probability of practicing more adaptation strategies. Similarly, if household head is male the probability of practicing more adaptation measures increased by 8.91%. This finding is similar to that by [12] and [13] who noted that male headed households were more likely to perceive changes in the surrounding than female headed households. The possible reason is that male headed households have a higher probability of acquiring information than female headed households and in Nepal the decision of household is entirely based on the male if present. If the household head has access to information the probability of practicing more adaptation measures increased by 90.7%. This might be due to increasing awareness and realization of positive benefits from practicing different adaptation strategies after receiving information. [14] in South Western Nigeria and [15] in Africa also reported that provision of extension facilities increases the probability of practicing different adaptation strategies by farmers. The household access to extension services were more likely to plant trees as an adaptation strategies [16]. A number of studies agree with these results such as those by [14], [15], [17] and [18] who have separately noted that farmer's access to information on climate change is likely to enhance their probability to perceive climate change, and enhance adopt of new technologies and take-up adaptation techniques. If the major occupation of household head is agriculture it would increase probability of practicing more adaptation measures by 69.2% at 5% level of significance respectively.

IV. CONCLUSION

Most of the farmers perceived the change in climate in terms of change in rainfall pattern, rainfall duration, onset of monsoon, and change in temperature in terms of hotness and coldness. Most of the problems identified from the Focus group discussion were climate related issues such as delayed rainfall, erratic rainfall in monsoon season, no rainfall in winter season and irrigation problems at critical stages of crops. There was limited awareness, knowledge and capacity at local level to understand climate change scenario and address issues. Some farmers are practicing different coping and adaptation strategies in their farm level based upon their experience to tackle changing climate but it seems important to plan sustainable adaptation strategies. Education level of household head, if gender of household head is male, access to information about climate change and main occupation of household head is agriculture, and then it would increase the probability of practicing more adaptation strategies.

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