Journal of Scientific Research & Reports
11(4): 1-11, 2016; Article no.JSRR.27472
ISSN: 2320-0227

SCIENCEDOMAIN *international*
www.sciencedomain.org

Determinants of Women Adaptation to the Potential Impacts of Climate Change: A Case Study in Assosa Woreda, Benshangul Gumez Region, Western Ethiopia

Martha Kidemu[1*] and Agena Anjulo[1]

[1]Ethiopian Environment and Forest Research Institute (EEFRI), P.O.B 24536 Code 1000, Addis Ababa, Ethiopia.

Authors' contributions

This work was carried out in collaboration between both authors. Authors MK and AA designed the study, wrote the protocol and wrote the first draft of the manuscript. Author MK managed the literature searches and analyses of the study. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JSRR/2016/27472
Editor(s):
(1) Alessandro Pezzoli, Water Supply & Wastewater Engineering, Turin Polytechnic, and Department of Meteorology, Turin University, Italy.
Reviewers:
(1) Jyotsana Shukla, Amity University, Noida, India.
(2) Coster Adeleke Sabitu, Tai Solarin College of Education, Ogun State, Nigeria.
Complete Peer review History: http://sciencedomain.org/review-history/15314

Short Research Article

Received 2nd June 2016
Accepted 23rd June 2016
Published 7th July 2016

ABSTRACT

The aim of this study was to analyze determinants of women adaptation to potential impacts of climate change. Multinomial logit model was fitted to the data from survey of 150 (one hundred fifty) women headed households. The study was conducted in Benshangul Regional State of Ethiopia, Assosa District from January to June 2015. Women perception on climate was assessed using indicators of climate change .The major climate change adaptation measures women practice in the study area were identified and selected by focus group discussion. The different factors affecting the choice of the practices were identified from literature review and researcher's knowledge of the contextual setting. Women headed households were purposively selected from the rural area of the district and 150 (one hundred fifty) sample households were randomly selected. Semi-structured questionnaire was administered and the survey was fitted to Multinomial logit model using stata software. The result of the analysis showed that women perceived the presence of climate change very well. Moreover, wealth status, access to climate change

**Corresponding author: E-mail: maarsiiftokkoo@gmail.com;*

information, average distance from home of rivers and forest, education level, access and control over resources, working condition (length of working hour per day) and, area of land owned were the determinants of climate change adaptations. So, poverty, lack of access to climate information, lack of access to education, lack of agricultural extension service, lack of access and control over resources, long distance women walk to fetch water and fuel, and long working hour conditions were barriers of women climate change adaptation decision. Economical empowering of women, improving access of women to climate information, construction of water schemes near houses, promotion of use of energy saving cook stoves, improving women access and control over resources and minimizing work load by changing women working condition are suggested interventions to increase women climate change adaptive capacity.

Keywords: Climate change; women adaptation; determinants; barriers; Assosa woreda.

ACRONYMS

LEISA: Low External Input Sustainable Agriculture

ACCA: Advanced Capacity to Support Climate Change Adaptation

1. INTRODUCTION

According to LEISA magazine report most rural areas have always experienced climate variability, and farmers have always had to cope with a degree of uncertainty in relation to the local weather [1]. Climate change have impacts on agriculture, forest and water resources. Despite the high contribution to the overall economy, agriculture is challenged by climate-related disasters such as flood and drought which cause a lot of problems to farmers [2]. It is predicted that climate change will profoundly affect forests by causing increasing damage to forest health due to greater incidence of fire, pests and diseases [3]. Depletion of forest resources would be exacerbated by climate change and would increase the burden on women to gather fuel wood, food, fodder and medicinal plants. Climate change also reduces water resources through its effect on rainfall variability.

Different studies were conducted on factors affecting climate change adaptation at different times [4-7]. In all the articles, aggregate adaptation strategies over larger areas were studied and gender issue was not included. But adaptation strategies vary and depend on the different opportunities and constraints faced in specific areas and by different groups of societies-women and men. [8] have shown that the factors that influence the climate change adaptation decisions of female heads are different from those that influence the adaptation decisions of male heads.

So this study opens the gates to fill the gap of the missing component gender, in analysis of factors affecting climate change adaptation. In the study, women perception to potential impact of climate change and major adaptation strategies of women were identified and analyzed. The determinant factors that influence women adaptation to climate change were analyzed and the different barriers of women adaptation to climate were identified. The choice of adaptation strategies of women to climate change and variability was hypothesized to be the joint effect of institutional factors, socio-economic and other factors that describe women living conditions.

The findings of this study could contribute to the data base of adaptive strategies as well as to the identifications of the factors affecting strategies of the area. It would be useful for planning gender sensitive development projects in mainstreaming climate change. Moreover, the empirical results on the determinants of adaptation to climate change would assist in targeting interventions toward effective coping mechanisms to reduce the harmful impacts of climatic variability and change. The findings would also contribute to identifying the barriers of women climate change adaptation. This is important to plan interventions which could tackle the barriers. Finally, the study findings possibly used by the scientific community (researchers) and students interested in the area of gender and, climate change adaptation mechanisms.

The study was conducted within six months' time. Due to shortage of time and budget limit relatively smaller precision level (92%) and confidence interval (95%) was chosen to limit sample size.

2. MATERIALS AND METHODS

2.1 Sources and Methods of Data Collection

Focus group discussion was conducted to have deep information on contextual condition (on climate change adaptation strategies of women) of the area. Therefore, adaptation mechanisms were identified and ranked and the dominant adaptation mechanisms were selected. Explanatory variables were, in addition, identified by theory, empirical literature, and researcher's knowledge of the contextual setting. Semi-structured questionnaire was prepared and administered. The data included perception on indictors of climate change (change in temperature, change in rainfall amount and timing, change in extent of flooding, change in plant and animal disease and pest outbreak) and, the selected major climate change adaptations and explanatory variables.

2.2 Sampling Technique and Sample Size Determination

The study followed a combination of purposive and random sampling procedures. In this study, the wet kola (lowland) livelihood area of Assosa district (woreda) was purposefully selected for simplicity and uniformity of sample (this is because information from the woreda agricultural office indicates 85% of the woreda's agro-ecology is in this livelihood zone). The women headed households were selected from each administrative units of the rural areas and from these sample households were selected using simple random sampling.

The sample size was determined using [9] sample size determination. For finite population, sample size when estimating a percentage or proportion for known precision and confidence level is:

$$n = \frac{z^2 . p.q.N}{e^2 (N-1) + z^2 . p.q.} \qquad (1)$$

Where,

- n = size of sample
- e = acceptable error (the precision)
- p = proportion, q = 1 – p;
- z = the value of the standard variate at a given confidence level and to be worked out from table showing area under Normal Curve;

So, using the above formula and taking the value of p = 0.5 and q=1-p= 0.5 (in which case 'n' would be the maximum and the sample would yield at least the desired precision). Here 92% precision level and 95% confidence level were selected. Z value at the specified confidence level was z=1.96 from Z-table. Using this information and taking the data of Assosa woreda for the number of women headed households in rural area to be 18,197; the total sample size (at 92% precision and 95% confidence interval) using [9] formula was 150 (one hundred fifty).

2.3 Data Analysis Methods

2.3.1 Econometric model specification

According to [4] the household decision of whether or not to undertake adaptation strategies for climate change was considered under the general framework of utility or profit maximization. It was assumed that economic agents such as households used adaptation options only when the perceived utility or net benefit from using a particular option was significantly greater than in the base category [6]. In this context, the utility of the economic agents is not observable, but the actions of the economic agents could be observed through the choices they made. Supposing that u_j and u_k represent households utility for two choices, j and k respectively, the linear random utility model could then be specified as follows:

$$u_j = \beta'_j x_i + \varepsilon_j \text{ and } u_k = \beta'_k x_i + \varepsilon_k \qquad (2)$$

Where, u_j and u_k are perceived utilities of adaptation options j and k, respectively, x_i is the vector of explanatory variables which influences the perceived desirability of each option; β_j and β_k are the parameters to be estimated, and ε_j and ε_k are error terms assumed to be independently and identically distributed [10].

For climate change adaptation options, if a household decides to use option j, then it follows that the perceived utility or benefit from option j is greater than the utility from other options (say, k) depicted as:

$$u_{ij}(\beta'_j x_i + x_j) > u_{ik}(\beta'_k x_i + \varepsilon_k), \; j \neq k \qquad (3)$$

Based on the above relationship, we could define the probability that a household used option j from among a set of climate change adaptation options as follows:

$$p(A_i = 1/x) = u_{ij} > u_{ik} \quad (4)$$

Equation (4) could be expressed and simplified in the following manner:

$$p(\beta'_j x_i + \varepsilon_j - \beta'_k x_i - \varepsilon_k) > 0/x \quad (5)$$

$$p(\beta'_j x_j - \beta'_k x_i + \varepsilon_j - \varepsilon_k) > 0/x \quad (6)$$

$$p(\beta^*_j x_i + \varepsilon^* > 0/x) = F(\beta^*_k x_i) \quad (7)$$

Where,

P is a probability function;

u_{ij}, u_{ik}, and x_i are as defined above

ε^* is a random disturbance term

$\varepsilon^* = \varepsilon_j - \varepsilon_j$ is a random disturbance term

$\beta^* = \beta'_j + \beta'_k$ is a vector of unknown parameters that can be interpreted as a net influence of the vector of independent variables influencing adaptation; and $F(\beta^*_k x_i)$ is a cumulative distribution function evaluated at $\beta^* x_i$.The exact distribution of F depends on the distribution of the random disturbance term ε^*.

Given that we investigate several adaptation choices, the appropriate econometric model would, thus, be either a multinomial logit (MNL) or multinomial probit (MNP) regression model. Both models estimate the effect of explanatory variables on a dependent variable involving multiple choices with unordered response categories. In practice many researchers choose the logit model because of its comparative mathematical simplicity [11]. The main drawback of using the MNP is the requirement that multivariate normal integrals must be evaluated to estimate the unknown parameters. This complexity makes the MNP model an inconvenient specification test for the MNL model [12].

In this study, therefore, multinomial logit (MNL) model was used for quantitative analysis of determinants of women climate change adaptation. The main limitation of the model is the IIA (independence of irrelevant alternatives) property, which states that the ratio of the probabilities of choosing any two alternatives is independent of the attributes of any other alternative in the choice set [13].

To describe the MNL model, let A_j be a random variable representing the adaptation measure chosen by any household. We assumed that each farmer faces a set of alternatives, mutually exclusive choices of adaptation measures. These measures are assumed to depend on a number of socio economic characteristics and other factors, x . The MNL model for adaptation choice specifies the following relationship between the probability of choosing option A_j and the set of explanatory variables x as follows [10]:

$$pro(A_j = j) = \frac{e^{\beta'_j x_i}}{1 + \sum_{k=0}^{j} e^{\beta'_j x_i}} \quad j = 0,1 \ldots\ldots J, \quad (8)$$

Where β_j is a vector of coefficients on each of the independent variables x . Equation (8) can be normalized to remove indeterminacy in the model by assuming that β_0 =0 and the probabilities can be estimated as:

$$\Pr o(A_j = j) = \frac{e^{\beta'_j x_i}}{1 + \sum_{k=0}^{j} e^{\beta'_j x_i}} \quad j = 0,1 \ldots J, \beta_0 = 0 \quad (9)$$

Estimating equation (9) yields the J log-odds ratios

$$\ln\left(\frac{p_{ij}}{p_{ik}}\right) = x'_i(\beta_j - \beta_k) = x'_i \beta_j, \text{ if } k=0$$

and because β_0 =0 (10)

or

$$y_j = x'_i \beta_j \quad (11)$$

Where, y'_j is dependent variable here the major adaptation measures practiced by women

y_1 = Crop diversification and use of pesticides

y_2 = planting trees

y_3 = crop rotation

y_4 = shifting cultivation

y_5 = shifting to non-farming (here gold mining, daily labor, selling of fuel wood and Charcoal) and, x_i is independent variables here it is the common factors affecting adaptation to climate change of women:

x_1 = wealth

x_2 = access to weather information

x_3 = distance from home of river/forest

x_4 = education level

x_5 = access to agricultural extension service

x_6 = access to agricultural credit

x_7 = access and control over resources

x_8 = working condition (working hour per day)

x_9 = area/size of land owned

Unbiased, consistent parameter estimates of the MNL model in equation (10) require the assumption of independence of irrelevant alternatives (IIA) to hold. More specifically, the IIA assumption requires that the probability of using a certain adaptation method by a given household must be independent of the probability of choosing another adaptation method. [14] used the Hausman test to check for the validity of the IIA assumption, to analyze crop choices as methods for adapting to the negative impacts of climate change using Stata software. The validity of the IIA assumption could be tested using Hausman's specification, if the choice set is irrelevant, eliminating a choice or choice sets from the model altogether will not change parameter estimates systematically [12]. In this study Hausman test was used to check for the validity of the IIA assumption using stata.

The parameter estimates of the MNL model only provide the direction of the effect of the Independent variables on the dependent (response) variable; estimates represent neither the actual magnitude of change nor the probabilities. Differentiating equation (10) with respect to the explanatory variables provides marginal effects of the explanatory variables, given as:

$$\frac{\partial p_j}{\partial x_k} = p_j(\beta_{jk} - \sum_{j=1}^{j-1} p_j \beta_{jk}) \quad (12)$$

The marginal effects, or marginal probabilities, are functions of the probability itself. They measure the expected change in probability of a particular choice being made with respect to a unit change in an independent variable from the mean [13].

Descriptive statistic was used to summarize women farmer perceptions on climate change as well as various adaptation measures being used using Microsoft Excel. To evaluate determinant factors of climate change adaptation multinomial logit (MNL) model was fit to survey data using Stata 11. Stata is a modern and general command-driven package for statistical analyses, data management, and graphics [15]. In addition, the barriers women face to adaptation were identified from the model analysis result and discussed.

3. RESULTS AND DISCUSSION

3.1 Women Perception on Climate Change and Variability

Women perceptions regarding climate change were assessed using indicators of climate change (Table 1). Regarding perception of women towards long term change in temperature, most (85%) of the respondents observed an increase in temperature over past 20 years. In case of the change in amount of rainfall during the main rainy season, 73% of the respondents noticed decrease in amount of rainfall in rainy season over the past 20 years. Assessments of perception on changes in the timing of rainfall concerning the onset and secession of rainfall showed that 94% of the respondents observed changes in the timing of rainfall.

Perception of women concerning changes in events of flood indicated that 35% of the respondents observed increase in problems due to flood, 26% observed decrease in frequency of flood, 35% of them observed no change. The decrease in frequency of flood may due to different interventions made on soil and water conservation by SLM (sustainable land management) project where farmers give weight to the recent change. Perception of women on changes in livestock and plant pest and disease outbreak showed 98% observed increase in incidence of the disease and pest.

3.2 Dependent and Independent Variables and Empirical Specifications of the Model

The existing adaptation mechanisms practiced in the study area (dependent variables) were identified from focus group discussion. Accordingly, the factors affecting the adaptation mechanisms (independent variable) were identified from empirical literature and researcher knowledge of contextual setting (Table 2). In the table there are many adaptation options practiced by women in the study area such as changing planting dates, irrigation, veterinary service use, reduction of consumption levels, and soil and water conservation practices. Although all might be important, only the five dominant adaptation mechanisms (ranked by focus group) were considered in this study. The selected major adaptation options and their frequency is presented in Table 5.

The summary of independent variables is presented in Table 4 (their description is presented in Table 3). The number of observations for each variable the mean, standard deviation, minimum and maximum values of dummy and continuous variables used in the study area presented in Table 4.

In Table 4, the mean, maximum and minimum average distance from home of rivers and forest is 6.34, 25 and 1 kilometer, respectively. In case of working condition (length of time woman work per day), the average, maximum and minimum is 12.4,18 and 5 respectively. The other independent variables were likewise summarized and presented in the same table.

The summary of dependent variable (the dominant adaptation measures) in Table 5 shows that crop diversification and pesticide use is least frequent (9.33) and the risky shifting to non-farming activity (here to fire wood collection to sell, daily labor and manual mining of gold) is most frequent (28%). As per the findings women are rarely involved in capital intensive adaptation measures such as irrigation.

3.3 Econometric Estimation of Empirical Model Parameters

To explore potential multi-collinearity among the explanatory variables, the correlation between continuous independent variables was calculated and presented (Appendix 1). For dummy variables an Ordinary Least Squares model was fitted and multi-collinearity was tested using the variance inflation factor (VIF) [11] and presented in Appendix 2. The variance inflation factors of all included variables were less than 10, which indicated that multi-collinearity was not a serious problem in the reduced model.

Table 1. Assessment of women perception on climate change

Variables	Number of respondents (%)	Variables	Number of respondents (%)
Change in temperature		**Changes in rainfall amount during 'kiremt'**	
Increased temp	85%	Decreased	73%
Decreased temp	10%	Increased	15%
Do not know	5%	No change	4%
		Do not know	8%
Changes in timing of rainfall		**Changes in livestock disease**	
changed	94%	increased	98%
Do not know	6%	Do not know	2%

Table 2. Climate change adaptation and, factors affecting the adaptation measures

Adaptation strategies	Factors affecting the adaptation strategies
Changing planting dates	Poverty
Using different planting dates	Access to agricultural extension
Irrigation, change crop variety	Access to credit
Change crop type	Access to trainings
Switching/shifting from farming to non-farming (gold mining, daily labour, sell of fuel wood and charcoal),	Average distance from home to river and fuel Access and control over resources Access to information media/ agro-meteorological services/weather information
Use of pesticides	
Reduction of consumption levels	Source of off-farm income sources
Soil and water conservation practice	Education level,
Planting trees, shifting cultivation	Age, family size

Table 3. Definition and expected signs of independent variables used in the empirical analysis

No	Variable	Code	Description	values	Type of variable	Expected sign
1	Wealth status	Wealth	Wealth status [a] classification	Rich=2 Medium=1 Poor=0	Dummy	+ve
2	Access to weather/climate information	Acctoinfo	access to information/ agro-meteorological services/	Yes=1 No=0	Dummy	+ve/-ve
3	Area of land ownership	Landarea	Area of land owned	Area in ha	Continuous	+ve/-ve
4	Education level	Educlev	Educational level of the respondent	Illiterate=0 Read and write =1 Primary school complete =2	Dummy	+ve/-ve
5	Access to agricultural extension	Acctoagrext	use agricultural extension service	Yes=1 No=0	Dummy	+ve/-ve
6	Access to agricultural credit	Acctocredit	Can borrow money to buy agricultural inputs	Yes=1 No=0	Dummy	+ve/-ve
7	Access and control over resources	Accecontres	Decision on resource use and participation in decision making activities	Yes=1 No=0	Dummy	+ve
8	Working conditions	Workcond	Length of time woman work per day	Time in hour	Continuous	-ve
9	Distance from home of river /forest?	Distance	Average distance of river and forest from home	km	Continuous	-ve

Note[a]: rich=who have television and dish, those who have>4 donkey, who can buy inputs, who have greater than 2 oxen. Medium= who have television, those who have less than 4 donkey, who can buy inputs, who have 2 oxen Poor= who have no television/radio, who cannot use agricultural input, has no oxen (dig by hand)

Table 4. Summary of independent variable

Variable code	Obs	Mean	Std. Dev.	Min	Max
Wealth	150	0.84667	.6925943	0	2
Acctoinf	150	0.45333	.4994852	0	1
Distance	150	6.34	4.191442	1	25
Educlev	150	0.59333	.5567965	0	2
Acctoext	150	.66	.4752957	0	1
Acctocred	150	0.4	.4915392	0	1
Acccontrores	150	0.22667	.4200778	0	1
Workcond	150	12.4	3.544539	5	18
Area of land	150	3.768333	2.06787	0.5	10

Table 5. Summary of dependent variables

Variable	Freq.	Percent	Cum.
Crop diversification and use pesticide	14	9.33	9.33
Planting trees	31	20.67	30
Crop rotation	28	18.67	48.67
Shifting to non-farming	42	28	76.67
Shifting cultivation	35	23.33	100
Total	150	100	

The model was run and tested for the validity of the independence of irrelevant alternatives (IIA) assumption by using Hausman specification test. The test failed to reject the null hypothesis of independence of the climate change coping strategies, indicating that the multinomial logit model (MNL) specification is appropriate to model the adaptation strategies of women farmers (χ2 ranged from 15.65 to 11.67 with probability values ranging from 0.7899 to 0.9989).

The parameter estimates and Marginal effect estimation from multinomial logit are presented in Table 6 and Table 7, respectively. In these analysis shifting to non-farming activities/ was taken as the base category for no adaptation and evaluates the other choices as alternatives to this option. The first column of the tables for instance, compares the choice of crop diversification and pesticide use with no adaptation where the marginal effects (Table 7) and their signs reflect the expected change in probability of preferring to practice the crop diversification and pesticide use to shifting to non-farming activities (the base) per unit change in an explanatory variable.

The chi-square (χ2) distribution is used as the measure of overall significance of a model in Multinomial logit model estimation. The result of our Multinomial logit model shows that (Table 6), the probability of the chi-square distributions less than the tabulated counterfactual is less than 1%. So, it can be concluded that, the variables included explaining choice of climate change adaptation strategies fits the multinomial logit model well. This implies that the joint null hypothesis which states that coefficients of all explanatory variables included in the model are zero is rejected at less than 1% level of significance.

In Table 7, the% likelihood of adopting the adaptation measures for a unit increase of (continuous variable) and discrete change (dummy variables) in independent variable was presented.

Table 6. Parameter estimates from the multinimial logit adaptation model

Variable	Cropdivpes		Plantre		Croprot		Shcult	
	coefficient	p-level	coefficient	p-level	coefficient	p-level	coefficient	p-level
Wealth	3.1376**	0.046	.5842774	0.373	1.39499**	0.021	.9047873*	0.057
Acctoinf	2.7858	0.116	3.2871***	0.001	.66274	0.512	.2342993	0.795
Distance	-.4412	0.106	.009785	0.925	-.2767*	0.053	-.0468056	0.646
Educlev	7.5942***	0.003	3.5403***	0.001	3.7055***	0.000	1.9506 **	0.024
Acctoext	1.5323	0.541	.9094	0.383	3.2496***	0.008	.3023543	0.664
Acctocred	.6380	0.710	-.6342	0.511	-.2237	0.809	.2717995	0.742
Acccontrores	2.7755	0.214	-1.3901	0.264	-.8510	0.470	.5142833	0.529
Workcond	-1.4854**	0.011	-.2653*	0.062	-.2138311	0.136	-.0281632	0.806
Land area	-1.14096*	0.099	.1120546	0.642	.0393222	0.872	.78457***	0.000
Constant	3.26973	0.593	-1.687001	0.531	-1.558984	0.584	-4.96410**	0.034
No of observations =150								
LR $chi^2(40)$ =252.17								
Pro>chi2=0.0000								
Pseudo R^2 =0.5400								
Log likelihood =-107.39068								

*significant at 10% ** significant at 5% *** at 1%*

Table 7. Marginal effect estimation from the multinimial logit adaptation model

Variable	Cropdivpes[a]	Plantre[b]	Croprot[c]	Shcult[d]	Shiftnon[e]
	Marginal effect	Marginal effect	Marginal effect	Marginal effect	Marginal effect
Wealth	8.08E-11**	-0.035203	0.12826	0.0397	0.0198
Acctoinf	0.000776	0.5156***	-0.06819	0.01904	-0.0456*
Distance	-0.00017	0.00782	-0.0409*	0.00992	0.00872
Educlev	.00245***	0.27585**	0.29152**	-0.0558	-0.0562***
Acctoext	0.000254	0.01345	0.3596***	-0.0991	-0.0100
Acctocred	0.000346	-0.11429	-0.03095	-0.434	-0.43289
Acccontrores	0.00388	0.2011	-0.11556	-0.03384**	-0.42787
Workcond	-0.0006**	-0.0330*	-0.02072	0.01611	0.01561*
Land area	-0.00067	-0.04708	0.0013	0.1737***	-0.0012**

*significant at 10% ** significant at 5% *** at 1%*

Note: a=crop variety diversification and pesticide use
b=planting trees
c=crop rotation
d=shifting cultivation
e=shifting to non-farm activities

3.3.1 Wealth

From the analysis a discrete change of wealth status had significant (P<.05) positive influence on crop variety selection and pesticide use by 8.08E-09% (a very small number). This implies that women who can afford to buy inputs necessary for improved crop variety production and at the same time who can afford the price of the improved seed variety can practice the adaptation measure. This supports the findings of [4] who stated that wealth influence adaptation decision.

3.3.2 Access to climate and weather information

Better accesses to weather and climate information had strong positive (P<.01) influence in planting trees by 51%. So, better awareness on climate change impact and the use of trees for climate change adaptation and mitigation have strong positive influence on the probability of adopting adaptation measures. This supports the findings of [7] who stated that, good climate information are fundamental to reducing vulnerability and anticipating climate risks which will in turn help take adaptive measures.

3.3.3 Land area

Ownership of larger land area have positive influence (p<.01) on shifting cultivation by 17%. Ownership of larger area of land favors shifting cultivation. This is because a farmer who own large area can shift from one farm to another, so that the fallow land can have enough time to regenerate. So, woman headed household owning large land area are less probable to shift to non-farm activities.

3.4.4 Distance

Longer average distance from home to river/forest had negative significant influence (p<.1) by 4% on crop rotation. This may be due to longer distance from home to river/forest that competes the time of practicing the adaptation option. It has shown [8] that the factors that influence the climate change adaptation decisions of female heads are different from those that influence the adaptation decisions of male heads.

3.3.5 Education

Better Education level had positive and significant influence on all the adaptation options except shifting cultivation. Higher education level have positive influence on changing crop veriety and pesticide use by 0.25% (at p<.01). And it had positive significant influence on planting trees by 27.6% and crop rotation by 29.2% (at p<.01 level both). Learning creates awareness on environment, in addition, education enables to read information on climate change adaptation, so it increases adaptation capacity to climate change.

3.3.6 Access to agricultural extension service

Better access to agricultural extension service had strong (p<.01) positive influence on crop rotation. That is a better farmer to farmer as well as farmer to agricultural extension services of government helps information exchange. Similar results have been found by [4,7] better farmer-to-farmer extension that enhanced adaptation to climate change.

3.3.7 Work condition

Women's longer hour working condition had negative and significant influence on crop variety selection and pesticide use, and planting trees at (p<0.05) and (p<0.1) significance level respectively. This may be due to the fact that longer hour working condition competes women time to participate in decision making activities, which intern implies less access to climate change adaptation mechanisms.

The study would be a base data for the area but with such small sample size and limitation of time, it is difficult to generalize and limit the determinants of women adaptation to only those identified in this study. But the research opens new gates for further research.

4. CONCLUSION

The major existing adaptation strategies practiced by women in the area were crop diversification, pesticide use, planting trees, crop rotation, shifting to nonfarm activities (fuel wood and charcoal sale), and shifting cultivation. The result from the fitted multinomial logit model indicated that wealth, access to climate information, average distance to river and forest, education level of women, access to agricultural extension service, access and control over resources, working condition of women and area of land owned were the identified determinants of women adaptation to climate change.

From the analysis it is revealed that women always perceived climate change very well. So, it can be concluded that lack of access to education, lack of frequent visit from agricultural extension agent, lack of access and control over resources and long working condition of women were barriers of climate change adaptation. So, government policies and implementing bodies should work on tackling the barriers. Support and empowering women's economy, improving access to climate information such as training, construction of water schemes near houses and afforestation and reforestation endeavors to save their time of fuel wood collection and fetching water, access to technologies and improved participation in development decision activities are suggested interventions. In addition, minimizing work load of women by improving their working condition and access and control over resources by changing community attitudes are also suggested interventions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. LEISA. Dealing with climate change. LEISA Magazine. 2008;5.
2. Deressa T. Measuring the economic impact of climate change on Ethiopian agriculture: Ricardian approach. World Bank Policy Research Paper. 2007;4342: 1-40.
3. Gaye I. Gender and climate change: Women matter. Economic Commission for Africa: U.S.A; 2009.
4. Deressa T, Hassen RM, Alemu T, Yesuf M, Ringler. Analyzing the determinants of farmers' choice of adaptation methods and perceptions of climate change in the Nile Basin of Ethiopia. IFPRI Discussion Paper. 2008;00798:1-38.
5. ACCCA. Improving decision-making capacity of small holder farmers in response to climate risk adaptation in three drought-prone districts of Tigray, Northern Ethiopia. Advancing Capacity to Support Climate Change Adaptation. 2010;093:1-25.
6. Tazeze A, Hajil J, Mengistu K. Climate change adaptation strategies of smallholder farmers: The case of Babilie District, East Harerghe Zone of Oromia Regional State of Ethiopia. Afr J Eco Sus Dev. 2012;3:1-12.
7. Tessema YA, Chanyalew AS, Getachew SE. Understanding the process of adaptation to climate change by small-holder farmers: The case of east Hararghe Zone, Ethiopia. Afr J Foood Agric Econ. 2013;1(13):1-17.
8. Nhemachena C, Hassen R. Micro-level analysis of farmers' adaptation to climate. IFPRI Discussion Paper. 2007;00714:1-40.
9. Kothari CR. Research methodology: Methods and techniques. New Age International Publishers, India. 2004;418.
10. Greene W. Econometric analysis. 5th ed. Upper Saddle River, New Jersey: Prentice Hall, New York University; 2003.
11. Gujarati DN. Basic econometrics 4th ed. McGraw-HiII/lrwin: New York; 2003.
12. Hausman J, McFadden D. Specification tests for the multinomial logit model. Econometrica. 1984;5(52):1219-1240.
13. Greenc WH. Econometric analysis. Upper Saddle River: Prentice Hall, NJ; 2000.
14. Hassen R, Nheachena C. Determinants of African farmers' strategies for adapting to climate change: Multinomial choice analysis. Afr J Agric. 2008;2(1):1-22.
15. Weesie J. Introduction to stata. Utrecht: Utrecht University, Dept. of Sociology; 2000.

APPENDICES

Appendix 1. Correlation analysis of continous explanatory variable included in study

Variable	Distance	Workcond	Area of land
Distance	1		
Workcond	-0.06568	1	
Area of land	0.04109	0.043402	1

Appendix 2. Correlation analysis of dummy explanatory variable included in study

Variable	VIF	1/VIF
Educlev	1.77	0.565655
Acctoinfo	1.49	0.669802
Acctoext	1.32	0.756797
Wealth	1.29	0.775519
Electricity	1.24	0.808453
Acctocred	1.21	0.823738
Acccontrores	1.17	0.855804
Mean VIF	1.33	

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/15314