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Perceptions and choices of adaptation measures for climate change among teff (*Eragrostis tef*) farmers of Southeast Tigray, Ethiopia

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This study was conducted in Southeast Tigray of Ethiopia using teff (*Eragrostis tef*) producing farmers. Teff production with regards to climate change has significant implications on food security and poverty in Ethiopia. The aim of this study was to analyze factors influencing choice of adaptation strategies among teff farmers in Ethiopia. A stratified simple random sampling technique was employed to select 210 farm households as respondents from the three agro-ecological zones of the highlands of Endamehoni, and midlands and lowlands of Raya Azebo. A multivariate model was used to analyze the data obtained from farm households. The study found that from the sixteen predictor variables fitted in the model, nine variables including age, education of household head, household size, distance to produce market, farm to farm extension services, access to credit facilities, average temperature, climate information on weather and climate and agro ecology have significant influence on adaptation strategies with model coefficients at p=0.05 or less. It is therefore, recommended that policies of government on adaptation to climate change should be given emphasis in order to enhance the adaptive capacity of teff farming community.

Key words: Teff, climate change, adaptation, Southeast Tigray, Ethiopia.

INTRODUCTION

Climate change is a real global challenge and its impacts are increasingly felt presently, all over the world (Yumbya et al., 2014). There is an increasing agreement in the scientific texts that in the forthcoming years, higher temperatures and reduced rainfall levels triggered by climate change will reduce crop yields in many countries (Yesuf et al., 2008; Di Falco et al., 2011). The impact of climate change is critical in low-income countries, where

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capacity to adapt is alleged to be low (Intergovernmental Panel on Climate Change- IPCC, 2007). With a population of more than 85 million inhabitants, Ethiopia comes second as the most populated country in sub-Sahara Africa (SSA), whose economy is largely built on weather-sensitive agricultural production (Mendelsohn, 2000; IPCC, 2007).

Grains such as teff, wheat and barley are the most essential field crops in Ethiopia, covering 86% of the agricultural fields (CSA, 2015). Teff forms the staple diet of many Ethiopians as the flour is made into *injera* (unleavened bread). Approximately, one million hectare of land is under teff cultivation annually and it occupies about 25 to 32% of the total land under cultivation with cereal crops (CSA, 2015). Teff is adaptive to different agro-ecological zones and grows on diverse soil types, under relatively wide ranging climatic conditions. Teff is a top value crop, which is consumed, and mainly sold to earn income to purchase other cheaper cereals. Given its staple nature, teff production by smallholder farmer in the face of climate change has significant implications for food security and poverty in Ethiopia. Hence, assessing factors that influence choice of adaptation on teff production by smallholder farmers is essential.

The United Nations Framework Convention on Climate Change (UNFCCC) assigned high priority to climate change adaptation for protecting the most vulnerable population. Adaptation is required to reduce the impact of climate change now and in the future. However, resource availability is yet to be transformed into improved adaptation capacity in the farming sector. This failure has been attributed to several factors, one of them being delayed decision-making processes, hence the requirement to understand appropriate and cost effective adaptation strategies. Effective adaptation strategies in the agricultural sector are vital for protection of livelihoods of the poor rural communities and ensuring food security (Bryan et al., 2009). Approaches to investigate the climate change adaptation are therefore essential in to come up with information that is exhaustive enough for effective and informed decisions making.

Several studies carried out in Nicaragua, Zimbabwe and Ethiopia have indicated that farmers do perceive that climate is changing and have developed coping strategies to reduce the negative impacts of climate change on their farming activities (Bayecha, 2013; Zivanomoyo and Mukarati, 2013; Zuluaga et al., 2015). Evidently, attempts have been made by some writers to analyze factors that influence choice of adaptation to impacts of climate change in Africa (Di Falco et al., 2011; Deressa et al., 2009; Nhemachena et al., 2014). Studies have used the Ricardian methodology to estimate the impact of climate change on agriculture (Polsky, 2004; Deressa et al., 2014; Ndambiri et al., 2016). Though the applied approach included adaptation, they did not fully address the influencing factors for choice of adaptation measures in agriculture. Others that attempted to analyze the factors affecting the choice of adaptation methods did not implicitly show how farmers perceived changes to climate and adapt to the changes (Phiri, 2011; Komba and Muchapondwa, 2015).

Furthermore, past studies have argued that climate change adaptation is a two-fold which requires first, the perception that climate change exists and secondly, adaption to existing changes to climate (Wang et al., 2009; Apata, 2011). The IPCC (2007) argues that emphasis should focus on adaptation because anthropogenic activities have already influenced fluctuations in the climate and even the most stringent efforts cannot avoid further impacts in the coming decades. This work has benefited from studies of Maddison (2006) and Deressa et al. (2009) that used a two-fold process on climate change adaptation at regional levels designed for African countries. The methodologies used assisted to advance the model adopted for this research. The main objective of this study therefore, was to examine factors that influence choice of adaptation measures to perceived changes in climate for teff growing farmers in Southeast Tigray, Ethiopia.

The conceptual framework of the study is that agricultural adaptation models involve two decisions, whether to adopt or not. The decisions require the perception on how severe the impacts of climate change are (Deressa et al., 2009). Therefore, adaptation to climate change is two-fold, it starts with the perception first, then the decision to adopt. The basis of the theory is that only those farmers who perceive the risk will respond to the risk provided that the benefits of adaptation compensate for the presumed costs.

Probit and logit models are the most commonly used models in climate change adaptation in agriculture (Hausman and Wise, 1978; Wu and Babcock, 1998). Binary probit or binomial logit models are employed when the choices available are only two (adopt or not). Multivariate probit is employed when choices available are more than two. It has some advantages over binary probit and binomial logit in two facets. They explore both factors, that is, according to specific choices or a combination of them but also self-selection and interactions between alternative choices. To this effect, a multivariate probit model was employed to determine farmers' decisions to adapt to impacts of climate change. It is hypothesized therefore, that household characteristics, socio-economic, climate factors, access to institutional support, production factors (land size, seed, fertilizer) and agro-ecological settings influence farmers' decisions to adapt to impacts of climate change.

These models have also been employed in climate change studies because of the conceptual similarities with agricultural adaptation studies. For example, Nhemachena et al. (2014) employed a multivariate

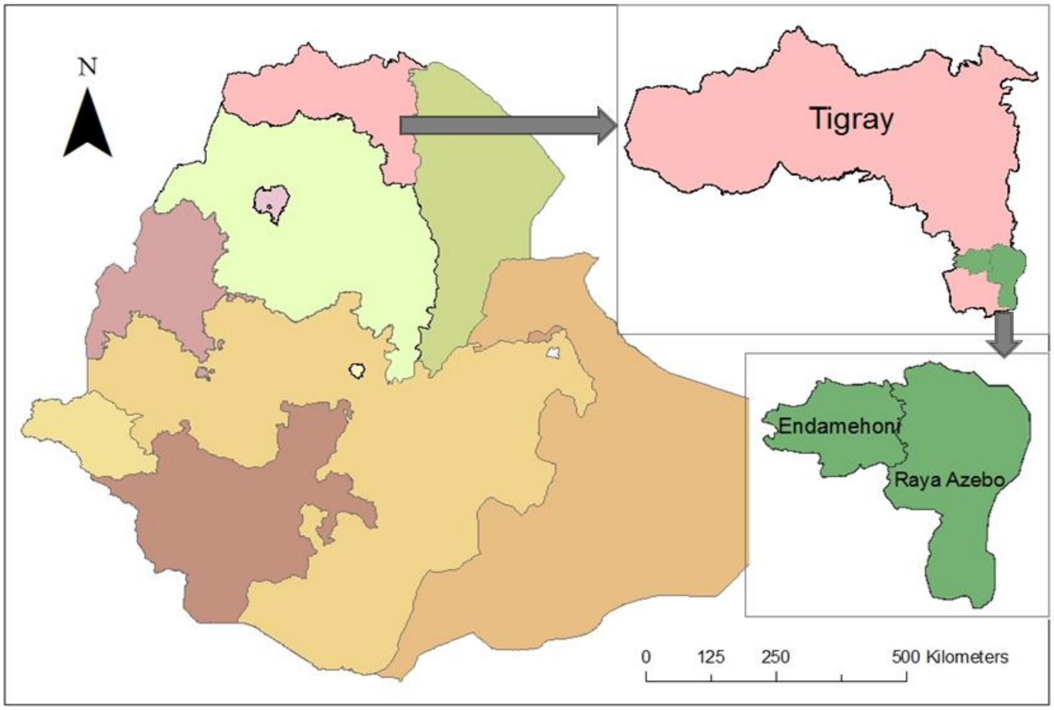

Figure 1. Map of Ethiopia showing the location of Tigray and the study site.

discrete choice model to analyze determinants of farm household adaptation strategies. Similarly, Deressa et al. (2009) adopted the multinomial logit model to analyze factors that affect the choice of adaptation methods in the Nile basin of Ethiopia. Additionally, Deressa et al. (2014) used multivariate model to investigate climate change adaptations of smallholder farmers in South Eastern Ethiopia to see if farmers perceived climate change and how they adapted. The study therefore used multivariate probit regression to analyze factors influencing choice of adaptation measures for climate change impacts among teff farmers in Southeast Tigray.

METHODOLOGY

Study area

Tigray is located in the northern part of Ethiopia with an altitude ranging between 400 to almost 4,000 m above mean sea level. It is located between 12° 15' N and 14° 57' N, and 36° 27' E and 39° 59' E. It covers an area of about 53,000 km² (CSA, 2015). Administratively, Raya Azebo is subdivided into 18 *kebeles* at an altitude ranging from 930 to 2,300 m above mean sea level (Tesfay et al., 2014). The climate is predominantly semi-arid with irregular rainfall accompanied by frequent drought periods. Average annual rainfall ranges from 800 to 1,000 mm per year reducing to 400 mm (Edwards et al., 2006). In most parts, it averages between 600 and 400 mm per year. The study was conducted in Endamehoni and Raya Azebo *weredas* of the Southeastern part of Tigray (Figure 1).

Data sources and sampling techniques

Both quantitative and qualitative data were used. The data used in the study was mainly obtained from a survey conducted at the three villages using a structured questionnaire. In designing the survey, a stratified sampling with purposive random technique was employed. At first, two out of 35 *weredas* were selected from the three agro-ecological zones of highlands, midlands and lowlands. The two *weredas* were Endamehoni and Raya Azebo. Secondly, three villages were purposively selected from the two *weredas* because of their vulnerability to climate change but also teff growing areas. Thirdly, purposive random sampling technique was used to select only teff growing farmers in the study area. Respondents were randomly selected from across the three villages. Finally, a questionnaire was administered to the 210 sampled households selected from the study area. This was proportionally allocated to the three agro-ecological zones as follows: 70 farm households from the Endamehoni highlands, 70 from the midlands and 70 from the lowlands of Raya Azebo. The survey included perceptions of farm households on climate change and adaptation methods. Farmers were specifically asked questions on changes in rainfall pattern and temperature over the past 30 years.

Econometric model

The study used multivariate probit regression model to analyze factors affecting choice of adaptation methods. This model is normally used to analyze the determinants of adaptation measures (relationship between adaptation measures and explanatory variables). The multivariate probit analysis models the influence of a set of explanatory variables on every different adaptation measure while allowing the unobserved or unmeasured factors (error terms)

Table 1. Description of the explanatory variables included in the econometric models.

Variable	Code	Variable typ	Expected sign
Gender of household (HH) head (1=male, 0=female)	sex	Dummy	+/-
Education of HH head (years of schooling)	sch	Continuous	+
Age of HH head (years)	age	Continuous	+
Household size (number of individuals in a HH)	hh_size	Continuous	+
Access to climate information (1=yes, 0=no)	ac_info	Dummy	+/-
Access to formal extension (1=yes, 0=no)	form_ext	Dummy	+/-
Farm-to-farm extension (1=yes, 0=no)	fam_fam	Dummy	+/-
Access to credit (1=yes, 0=no)	acc_credit	Dummy	+/-
Livestock (number of animals)	animl	Continuous	+
Land size in hectares (ha)	land_s	Continuous	+
Seeds (Kg/ha)	seed	Continuous	+
Fertilizer (Kg/ha)	fertliz	Continuous	+
Labour(no. of individuals engaged in farming)	labour	Continuous	+
Distance to market (Km)	mkt_dist	Continuous	+
Temperature (°C)	avg_temp	Continuous	-
Rainfall (mm)	ann_rain	Continuous	+

to be freely correlated (Greene, 2003). The presence of unobservable farm specific factors that affect choice of adaptation option that is not easily measurable (indigenous knowledge) could be a source of error. The correlations are taken care of in the multivariate probit model.

This study uses multivariate probit technique to overcome the shortfall of using other models like binary probit and multinomial probit models. Following Lin et al. (2005), the multivariate probit approach is characterized by a set of *n* binary dependable variables Y_i such that:

$$Y_i = 1 \; if \; X'\beta_i + \varepsilon_i > 0, = 0 \; if \; X'\beta_i + \varepsilon i \; \leq 0, i = 1, 2, \ldots, n, \qquad (1)$$

Where X is a vector of explanatory variables, β_1, β_2,…. B_n are random error terms, ε_1, ε_2, …, ε_n are distributed as multivariate normal distribution with zero means, unitary variance and n x n correlation matrix R = [ρ_{ij}], with density $\Phi(\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_n; R)$. The likelihood contribution for an observation is the *n* – variance normal likelihood:

$$P_r\left(Y_{1,\ldots,}Y_n \middle| X = \int^{(2y1-1)x'\beta 1} \int^{(2y2-1)x'\beta 2} .. X \int^{(2y2-1)x'\beta 1} \Phi\left(\varepsilon_1, \varepsilon_2, .., \varepsilon_n; Z'RZ\right) d\varepsilon_n, .., d\varepsilon_2 d\varepsilon_1\right) \qquad (2)$$

Where, Z = diag [$2y_1$-1,…$2y_n$-1]. The maximum likelihood estimate maximizes the sample likelihood function, a product of probabilities (equation 2) across sample observations. Calculation of maximum likelihood function using multivariate normal distribution involves multi-dimensional integration. The indicator (direction) effect of the explanatory variables on the susceptibility to adopt each of the different adaptation strategies are estimated as:

$$\frac{\delta L_i}{\delta X_i} = \Phi(X'\beta)\beta_{i,} \; _i = 1,2, \ldots..n \qquad (3)$$

Where L_i is the likelihood (probability) of event $_i$ (increased use of each adaptation strategy), $\Phi(X'\beta)$ is the standard univariate normal distribution function, *X* is the regression vector and *β* is the model parameter (Hassan, 1996).

Definition of the model variables

The multivariate probit analyzed whether a farmer adopted a specified adaptation strategies or not. The dependent variables therefore, are the adaptation strategies adopted by farm households. The adaptation strategies include: soil and water conservation, improved crop variety, planting trees, selling livestock, changing farming type from crop to livestock, early and late planting, etc. The independent variables are household characteristics, climatic factors, formal and non-formal institutional support, production inputs and outputs and agro-ecological settings. These explanatory variables indicated were chosen from literature based on impact of climate change on agriculture and adaptation strategies (Apata, 2011; Di Falco et al., 2011; Deressa et al., 2014), available data and previous knowledge on the area.

Based on the theoretical and empirical literature and considering household head characteristics, climatic factors, socio-economic, production factors and agro-ecological settings, households' choice of adaptation strategies to climate change with their expected signs are summarized in Table 1.

RESULTS AND DISCUSSION

Farmers' perceptions of climate change

Figure 2 presents the results of farmers' perception of long-term temperature and rainfall in the study area. The results indicate that 92% of respondents perceived decreasing annual rainfall over the past thirty years; 2.5% perceived increasing rainfall and 5.5%, no change (same). Similarly, 90% of respondents perceived increasing mean temperatures over the same period; 4% perceived decreasing temperatures and 6%, no change (same). Increasing temperatures and declining rainfall

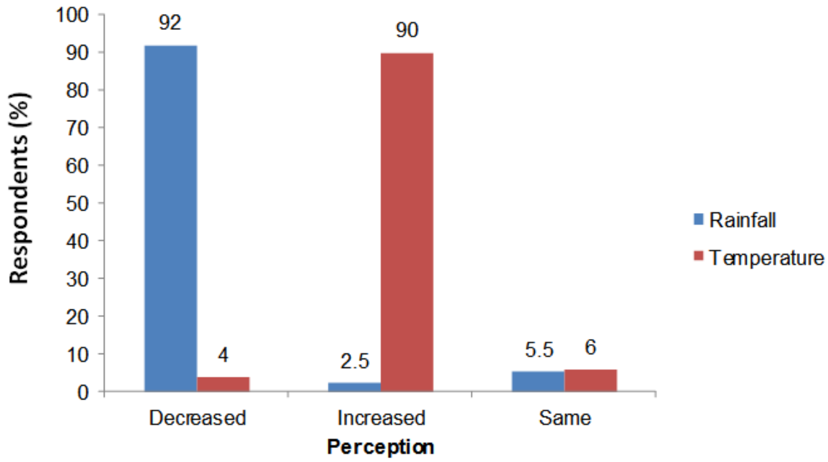

Figure 2. Farm households' perceptions of rainfall and temperature.

Table 2. Households' noticed indicators of climate change variability.

Variables	Minimum	Maximum	Mean	Std. Dev.
Increased uncertainty	0	1	0.875	0.331
Decreased rainfall	0	1	0.995	0.071
Reduction in teff yield	0	1	0.955	0.208
Decreased water availability	0	1	0.920	0.272
Frequent droughts	0	1	0.740	0.439
Famine	0	1	0.020	0.140
Shortage of rangeland	0	1	0.985	0.122
Poverty	0	1	0.885	0.319

are the leading perceptions among farm households in the study area.

Farmers' perceptions of noticed indicators of climate change variability

About 90% of farmers noticed the indicators of climate change over the past three decades as summarized in Table 2. Increased uncertainty in climate change (87%), frequent droughts (74%), decreasing rainfall (99%), reduction in teff yields (95%) and poverty (85%) were key indicators of climate change variability among the perceptions of teff farming households. Perception of indicators of climate change variability was very strong (>70%) among teff farmers.

Variability in temperature trend

Average temperatures indicate an increasing trend of 0.1°C as shown by the trend line from 1980 to 2010 (Figure 3). The increasing temperatures have a negative impact on teff growth. Yumbya et al. (2014) found ideal climatic limit for teff growth to be 13°C minimum and 25°C maximum annual temperatures. Currently, temperature conditions for the study area are ideal for teff growth. But if the increasing trend in temperature (0.1°C) continues, it will reach a critical limit for teff growth before 2050. The increasing average temperatures bring much stress on teff growth, hence reducing the yields.

Variability in rainfall trend

Figure 4 indicates a decreasing trend in amount of annual rainfall by 0.029 mm from 1980 to 2010. The ideal annual rainfall for teff growth ranges between 600 mm and 1,900 mm (Yumbya et al., 2014). Currently, the rainfall conditions are ideal for teff growth but already affected by frequent droughts (e.g. 1990; 1991; 1999; 2000; 2011; 2014). If the current decreasing trend in annual rainfall

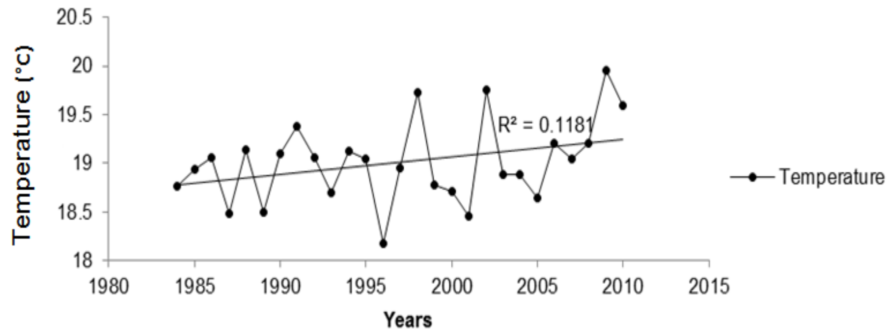

Figure 3. Increasing trend in average temperature of Maichew Meteorological Station.
Data Source: Government of Ethiopia (2016).

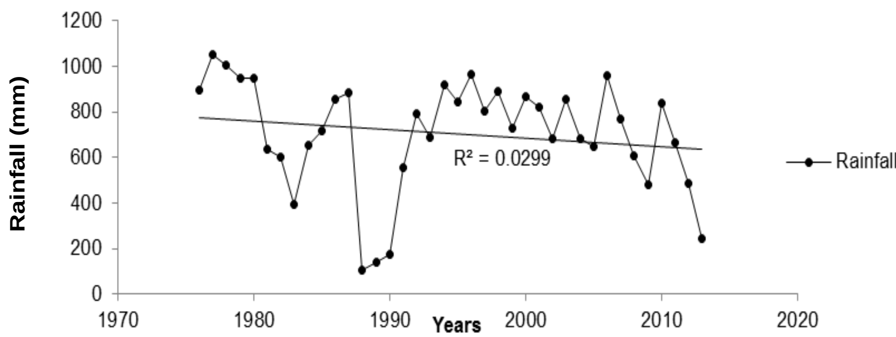

Figure 4. Decreasing trend in annual rainfall of Maichew Meteorological Station.
Data Source: Government of Ethiopia (2016).

continues, it will reach a critical limit for teff growth before 2050. The declining trend in annual rainfall exposes farm households to poor teff production.

Multivariate probit regression analysis

For the multivariate probit model, it was first run and tested for its appropriateness over the standard model. The outcome of this operation show that most of the explanatory variables and their marginal values are statistically significant at 5% or less and the signs are as expected on most variables except for a few as indicated in Table 3. The regressed marginal effects measure the expected changes in the probability of climate change adaptation option with respect to changes in the independent variables.

The results from the multivariate probit model indicates that age of farm household head is statistically significant and has a positive influence on early and late planting (p=0.017), and improved crop variety (p=0.010). The results suggest that age of household head increases farmers' use of early and late planting techniques and use of improved crop variety, keeping other factors constant. This is an indication that the likelihood of changing planting dates and use of improved crop variety was higher among older farm households. As the age of the household head increases, it is assumed that the farmer is expected to acquire more experience in changing planting dates and use of improved crop varieties which influences the likelihood in older farmers practicing adaptation strategies. A study by Deressa et al. (2014) found that one unit increase in age of household head results in 9% increase in growing improved crop variety.

Household size is statistically significant with positive influence on soil and water conservation (p=0.034), planting trees (p=0.041), off-farm activities (p=0.046), and early and late planting (p=0.034). The results suggest that a large farm household increases farmers' use of soil and water conservation, off-farm activities, planting trees and early and late planting, keeping other factors constant. A bigger household size therefore is an important factor in the study area because it provides increased work-force on soil and water conservation, tree planting, off-farm activities and the probability of shifting

Table 3. Estimates of probit adaptation regression.

Variable	Soil conservation		Improved crop variety		Early /Late plant		Planting trees	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
Gender of hh head	0.547	0.204	-0.172	0.716	-0.166	0.706	-3.675	0.986
Age of hh head	-0.002	0.907	0.002	0.010*	0.027	0.017*	-0.030	0.046*
Marital status	0.417	0.469	-0.264	0.684	0.057	0.919	-3.366	0.979
Education hh head	0.104	0.042*	0.106	0.015*	0.122	0.632	-0.136	0.637
Household size	0.146	0.034*	0.102	0.332	0.146	0.034*	0.205	0.041*
Distance to market	0.055	0.679	0.095	0.025*	0.007	0.851	-0.038	0.536
Labour	0.013	0.500	0.012	0.454	-0.022	0.006*	0.013	0.253
Livestock	0.079	0.313	-0.014	0.596	0.000	0.963	0.001	0.964
Formal ext	-0.126	0.529	-3.821	0.984	0.162	0.658	-5.149	0.999
Farm-to-farm ext	-0.088	0.651	0.506	0.000*	0.161	0.374	0.352	0.216
Access to credit	-0.147	0.507	-0.486	0.391	1.336	0.024*	-0.674	0.138
Climate info	0.560	0.423	0.075	0.001*	1.005	0.001*	0.149	0.700
Average temperature	-3.492	0.716	1.676	0.031*	1.729	0.003*	1.729	0.004*
Rainfall	0.236	0.679	0.147	0.798	0.063	0.861	-0.206	0.703
Highland	-1.235	0.278	0.830	0.278	1.547	0.011*	0.857	0.158
Midland	0.709	0.360	0.362	0.508	-0.262	0.394	0.144	0.728
	Sell livestock		**Off-farm act**		**Changing farm type**		**New technology**	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
Gender of hh head	-0.294	0.531	-0.574	0.216	3.659	0.990	0.651	0.257
Age of hh head	-0.140	0.296	-0.005	0.542	-0.034	0.046*	-0.002	0.002*
Marital Status	-0.290	0.639	0.547	0.353	-0.897	0.171	1.015	0.125
Education hh head	3.732	0.967	-0.095	0.652	0.728	0.025*	0.341	0.446
Household size	0.155	0.164	0.102	0.046*	0.068	0.440	0.062	0.535
Distance to market	-0.079	0.423	-0.054	0.182	-0.079	0.377	0.063	0.507
Labour	0.016	0.468	0.007	0.320	0.005	0.712	0.089	0.030
Livestock	0.112	0.103	0.059	0.007*	0.024	0.236	0.028	0.459
Formal extension	0.171	0.401	-0.065	0.743	-0.069	0.845	0.092	0.850
Farm-to-farm ext	0.318	0.110	-0.075	0.681	-1.634	0.039*	0.025	0.941
Access to credit	0.234	0.304	0.286	0.316	0.303	0.397	1.278	0.021*
Climate infor	0.358	0.081	0.272	0.179	0.298	0.443	0.664	0.064
Average temperature	-3.850	0.999	0.040	0.874	0.349	0.472	0.072	0.090
Rainfall	0.153	0.771	-0.102	0.743	0.041	0.933	0.442	0.292
Highland	2.305	0.999	0.795	0.035*	-0.339	0.492	-0.474	0.759
Midland	0.663	0.282	-0.862	0.000*	-0.433	0.283	0.761	0.319

Likelihood ratio test of rho21 = rho31 = rho32 = 0: chi^2 (3) = 20.1099 Prob > chi^2 = 0.0002; hh: household; *significance at 5%.

planting dates due to changes in climate. The findings are in line with the argument which assumes that larger farm household provides extra earnings through creation of additional labour gained from other activities outside farming.

Education of farm household head is statistically significant with positive influence on soil and water conservation (*p*=0.042) and improved crop variety (*p*=0.015). The results suggest that farm households with better education have increased chances of practicing soil and water conservation measures and growing improved crop variety, keeping other factors constant. The argument could be that higher education is likely to expose farm households to better information on soil and water conservation and improved crop variety. Higher levels of education in farm households are more likely to increase information access and assumed to improve farmers' capacity to perceive, understand and translate information necessary to make innovative decisions in practicing soil and water conservation and using improved crop variety.

Distance to produce market is statistically significant with positive influence on improved crop variety (*p*=0.025). The results suggest that shorter distance to produce market increases farmers' use of improved crop variety, keeping other factors constant. If farm households are located far away from produce markets, the possibility of obtaining latest information on improved crop variety is reduced, experience sharing among farmers is reduced and it is difficult for farm households to acquire new technology on improved crop variety. A produce market is therefore, an important factor because it serves as a place where farmers obtain information on newly introduced improved crop varieties on the market.

Access to information on weather and climate is statistically significant and positively influence improved crop variety (*p*=0.001) and early and late planting (*p*=0.001). The results suggest that access to weather and climate information increases the probability of using improved crop variety and adjustments of planting time (early and late planting), keeping other factors constant. Access to information on weather and climate in the study area equips farm households with knowledge on use of improved crop variety and shifting planting dates to better cope with impacts of climate change.

Farm-to-farm extension services were found to be statistically significant and positively influence improved crop variety (*p*=0.000) and negatively influence changing farming type (*p*=0.039). The results suggest that farm households with better access to farm-to-farm extension services have an increased probability of using improved crop variety and a decreased probability of changing farming type from crop production to livestock, keeping other factors constant. Sharing information among farm households is very essential as different farmers have different skills, different experiences on crop varieties and farming habits. It is an important factor because farm households enhance their knowledge by sharing experiences on improved crop varieties.

The results of the study showed that access to formal credit services is statistically significant and influence new farming technologies (*p*=0.010) positively. The results suggest that farm households with better access to formal credit services have the probability of increasing new farming technologies in response to impacts of climate change, keeping other factors constant. Access to formal credit services is an important factor in the area because it increases the likelihood of farm households to have sufficient money to purchase the most needed farm inputs to increase teff produce. Hence, access to formal credit influences decisions on use of farming technologies that would improve teff yields to enable food security among farm households.

Average temperature was found to be statistically significant with positive influence on planting trees (*p*=0.004), improved crop variety (*p*=0.031) and changing (early and late) planting dates (*p*=0.003). The results suggest that increasing average temperature leads to the probability of planting more trees, increased use of improved crop variety, and changing planting dates (early and late planting), keeping other factors constant. This is evident in the highlands of Endamehoni where farm households are reported to be used to red teff plating, but due to increasing temperatures, farmers have changed to growing white teff (improved variety) which is tolerant to higher temperatures. Average temperature is an important factor in the area because it influences farmers' use of improved crop variety, growing of more trees, and changing planting dates to cope with changes in temperature.

Agro-ecology

The study found variation in the use of adaptation strategies among households living in different agro-ecological zones. The results found that highlands were statistically significant with positive influence on shifting planting dates (early and late) (*p*=0.011) and off-farm activities (*p*=0.055), while midlands were found to be statistically significant with negative influence on off-farm activities (*p*=0.000). The results suggest that farm households in highlands (as compared to lowlands) have an increased probability of shifting planting dates (early and late planting) and off-farm activities, while farm households in the midlands have decreased probability of off-farm activities, keeping other factors constant. Agro-ecological setting is an important factor because it influences shifting of planting dates and practicing off-farm activities due to changes in climate.

Conclusion

The descriptive analysis found that most farm households were aware of the long term change in rainfall and temperature. Increasing temperatures and declining rainfall are the leading perceptions among farm households in the study area. Farm households also noticed the indicators of climate change variability of frequent droughts, reduction in teff yield, poverty and shortage of rangeland. Meteorological data shows increasing average temperatures for about 0.1°C and decreasing annual rainfall by 0.029 mm between 1980 and 2010. Sixteen explanatory variables were hypothesized to affect decision on choice of adaptation strategies. Results concluded that education, age of household head, access to weather and climate information, access to formal extension services, access to credit, average temperature, distance to produce market and livestock were statistically positive and significantly influenced the likelihood of practicing adaptation measures. However, negative influence was noticed with the adoption of off-farm activities in the midlands, suggesting a decreased probability of the adaptation measure in the midlands. Older farmers have better opportunity to practice crop diversification (improved crop variety) and adjustment of planting time (early and late) measures than younger farmers. Better access to climate information was found to increase the probability of early/late planting in response to adverse effects of climate change. Similarly, education of household head, household size and access to credit facilities appeared to be strong determinants of adaptation strategies for impacts of climate change. It was therefore recommended that policies of government on adaptation to climate change should be given priority in the study area in order to enhance the adaptive capacity of the rural farming community. Government should invest on improved teff varieties (temperature stress tolerant) and improved production technologies to reduce adverse impacts of climate change. Further research is recommended to analyze cost of adaptation to assist in making sound decisions effecting only those adaptation strategies that are economically cost effective.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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