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Research Paper

Assessment of smallholder farmers' perception of climate change and their response in adoption of adaptation strategies. The case of Karat Zuria Woreda, Konso Zone, Ethiopia

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The main objective of this study was to access smallholder farmers' perception of climate change and their response in adoption of climate adaptation strategies in the case of Karat Zuria Woreda, Konso Zone, Ethiopia. The totals of 153 farmers from three kebeles were randomly selected. Both quantitative and qualitative data were collected using a semi-structured questionnaire survey, key informant interviews, focus group discussions and field observations. Smallholder farmers' perception of climate changes and their response in the adoption of adaptation strategies were presented by frequency table. The results show that most of the interviewed farmers perceived an increase in erratic rainfall, frequent occurrence of heat induced crop diseases, frequent occurrence of animal disease and weed infestation. Majority of the respondents perceived an increase in the shortening of the rainy season, an incidence of a scarcity of water, and an increase in higher temperatures in the past decade (2009-2019). Also, the majority of the respondents use climate adaptation strategies such as improved fodder crops, agroforestry and destocking. Thus, government and NGOs need to design interventions aimed at providing irrigation facilities, prioritizing dissemination of timely weather information, encouraging farmers' cooperatives, and provision of rural credit services.

Keywords: Adoption, Adaptation strategies, Climate variability/change, Perception of climate change.

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INTRODUCTION

Climate change refers to changes that alter the composition of the global atmosphere and which are in addition to natural climate variability observed over comparable periods. Even though climate change is not a new phenomenon, it continues to strongly impact agriculture in Sub-Saharan Africa, where smallholder farmers dominate the agriculture sector and are most vulnerable to the adverse effects of climate change (Oduniyi et al., 2014).

All African countries are vulnerable to climate change and Ethiopia in particular is among the most vulnerable countries to climate change with little adaptive capacity. Recurrent drought, famine and flood are the main problems that affect millions of people in the country almost every year (Kelelew et al, 2016).

In Ethiopia the agriculture sector accounts for about 42.9% of gross domestic product (GDP), 80% of employment, and 88% of export earnings (FDRE, 2018). The land tilled by the Ethiopian 74% small-scale farmer out of the total farmers accounts for 95% of the total area under agricultural use and these farmers are responsible for more than 90% of the total agricultural output. The small-scale farmers produce 94% of the food crops and 98% of the coffee, the latter being the leading export item for the country. The private and state commercial farms produce just 6% of food crops and 2% of the coffee produced (Atsbaha and Tessema, 2010).

Despite its high contribution to the overall economy, the sector is inherently sensitive to climate-related disasters like drought and flood and it is among the most vulnerable sectors to the risks and impacts of global climate change (Amare and Simane, 2017). In Ethiopia heavy reliance on traditional farming techniques and poor complementary services (such as extension, credit, marketing, etc.) reduce the adaptive capacity or increase the vulnerability of smallholder farmers to climate variability, which in turn affects the performance of the already weak agriculture (Amare and Simane, 2017)

To reduce the adverse impacts of climate variability, there is a need for farmers to adopt different adaptation strategies. Thus Ethiopia has the vision to become a middle-income country by 2025 and it is implementing Climate Resilient Green Economy (CRGE) Strategy to underpin this ambition and strengthen its capacity to adapt to the effects of climate change (Deressa et al., 2008).

Understanding local perceptions and adaptive behaviour is useful to identify common patterns, constraints and adaptation strategies of smallholder farmers; also it provides better insights and information relevant to a policy that helps to address the challenge of sustainable agricultural development in the face of variable and uncertain environments (Amare and Belay, 2017).

Practically, over the last 30 years there was climate change experience in the study area that has resulted in climate hazards such as drought during 1977 and 1985, birds swarming on & off during1992-2008, locust infestation during 1992 and 2008 and El Niño rainfall during 1999 which caused the death of many people, disease outbreak, crop and green leaves destruction, lack of forage and pasture, death of livestock, farmlands wash away, migration, destruction of terraces, land sliding, malnutrition. Similarly, since the last 10 years (2009-2019) really the condition is changing, and the time of rainfall is getting variable from time to time (Samuel, 2015).

Earlier studies showed that irrigation, improved crop varieties, crop diversification, farm diversification, change of planting dates, and income-generating activities are among the adaptation practices most frequently deployed by farmers (Francis and Watanabe, 2016).

Although smallholder farmers are likely to be seriously affected by the effects of climate change owing to their lack of capacity to adequately adapt, research shows that only a minority of them take advantage of adaptation options (Mabe et al., 2014).

Hence, this study aimed to explore farmers' perception of climate change and their response in the adoption of climate adaptation strategies in the case of Karat ZuriaWoreda, Konso Zone, Southern Ethiopia.

RESEARCH METHODOLOGY

Description of the study area

Karat ZuriaWoreda is found in the Konso Zone of SNNPRS. The Woreda has 14 Kebeles, where its administrative capital, Karat town, is found about 590km from Addis Ababa and 360km from Hawassa. The Woreda is found in the rift valley experiencing the semi-arid agro-ecological zone, and bordered by DerasheWoreda in the North; SegenZuriaWoreda and Burji Special Woredas in East; Borena Zone of Oromiya Region in the South, and KenaWoreda and Alle Special Woreda in the West. The Woreda covers an area of 784 km^2 and is characterized by hilly, mountainous terrain intersected by gullies and valleys, most of which have been under cultivation for hundreds of years.

According to the data Regional Bureau of Finance and Economic Development the population Size of the Woreda is estimated at 78,623 (male:37,603 and female: 41,019) speaking a Cushitic language “Konsogna or AfaXonso” (WoFED, 2019). The dominant occupation of the inhabitants is mixed farming agriculture (more crop production) supplemented now a day by petty trading and labor work. The climate is dry and the typically steep-sided landscape is highly susceptible to soil erosion. Average land holdings are 0.5-1ha, with annual mean precipitation being 855mm and temperature ranging between 17-31^{o}C. The area is known for its water and soil conservation practices the people are increasingly suffering from environmental changes due to both natural and man-made factors. Erratic rain, frequent drought, rapid population growth, increasing ambient temperatures, flooding, burning of pasture land, land degradation, soil erosion, and deforestation are now all being experienced. These environmental changes within Woreda have impacted lives and livelihoods, causing migration, accelerated poverty, and unhealthy living conditions.

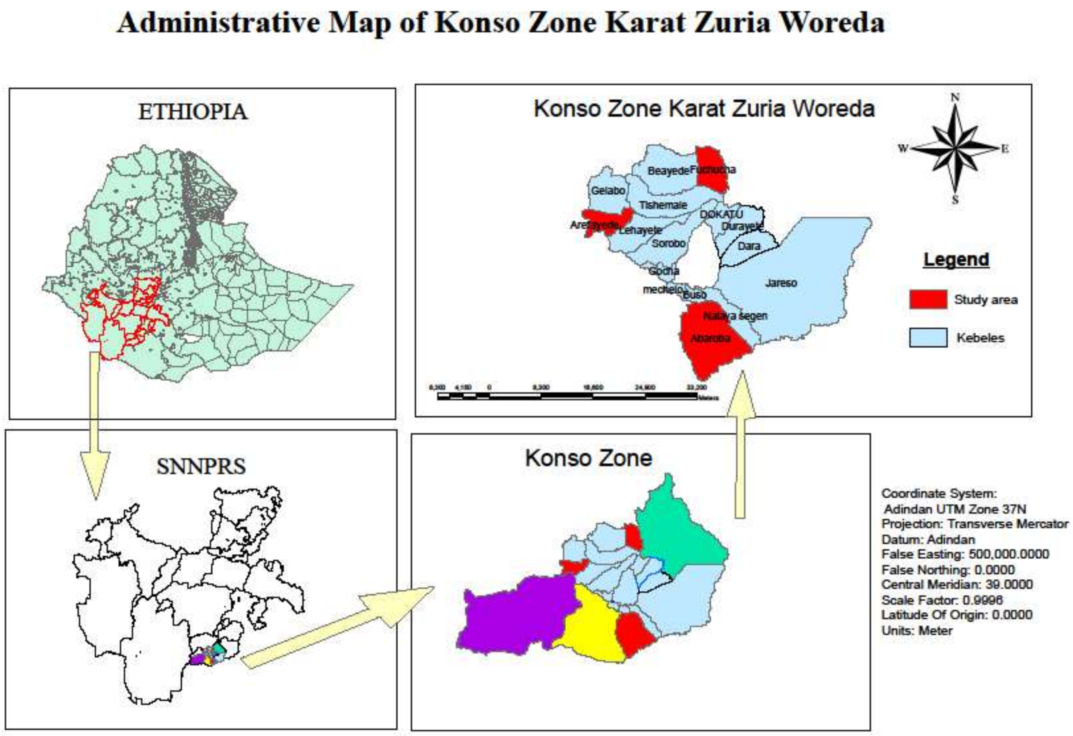


Figure 1: Geographic location of the study area

The research design of the study

A cross-sectional survey design was employed to collect primary data on household heads using a pretested structured questionnaire. The questionnaire particularly consisted offarmer's perception and their adoption of climate adaptation strategiesas well asissues related to the household, institutional, farm and related factors. The sampling frame was obtained from the kebele administrations. Qualitative data type was collected to obtain information from the selected respondents.

Sample and sampling techniques

The study employed a multi-stage sampling procedure in which sample respondents from the available target population were selected from different stages. Over the sample size determining strategies such as (Green's (2000)) formula that only depend on a number of the explanatory variable of the study and (Yamane's (1970)) formula that depends on total population and standard error, (Kothari's (2004)) formula was preferred because farm household social unit of sample size can be estimated easily from the finite target population and is more accurate and precise; this formula considers sampling error and confidence level. Thus Samples size of this study was estimated by using (Kothari's (2004)) formula

$$n = \frac{Z^2*N*p*q}{e^2(N-1)+Z^2*p*q} n = \frac{1.96^2*2852*0.88*0.12}{0.05^2(2852-\quad)+1.96^2*0.88*0.12} = 153$$

where 'n' is the desired sample size, 'N' is the total target population, 'Z' is the standardized normal deviation set at confidence level 95%=1.96 at e=0.05 from both sides, 'p' is the estimated proportion of an attribute that is present in the population (88%), 'q' is the estimated proportion of an attribute that is not present in the population (1 − p) =12% because it can range from 10% up to 20% , and 'e' is a degree of accuracy or acceptable error (allowable error); required normally set at 0.05 alpha level.

Since the population of the study target was 2,852; using (Kothari's (2004)) formula the sample size of the study was 153.

Data sources, type, and methods of data collection

Both primary and secondary data sources were used for this study. For this study primary data were collected by using semi-structured interview schedule, key informant interview, focus group discussions and field observations. Semi-structured interview schedule were pre-tested and administered by well trained and experienced enumerators who have knowledge of the farming system and the study area.

I. Household Survey

For the household survey, a semi-structured questionnaire that contained both open and close-ended questions was prepared to gather data from a total of 153 sampled household heads.

II. Focus Group Discussion (FGDs)

Focusing group discussions were carried out with the kebele administration, government representatives, elders, religious leaders, and agricultural extensions to collect opinions, and qualitative descriptions about the types of adaptation strategies used by farmers'. One focus group discussion hadeight persons per kebele and a total of three focus group discussions with selected 24 participants were held.

III. Key Informant Interview

Intensive interviews were conducted with nine development agents' three agents per kebele and two subject matter specialists (SMS) from agricultural office by which one from Zonal and other from Woreda level.

IV. Field Observation

Specifically, field observation was carried out to gather pictorial data on crop pests (birds, locust, army worm),weeds like Striga tolerant crop variety used, early mature and drought tolerant crop varieties used, water sources for irrigation, irrigation techniques used, common forage used and currently induced forage grass in the study area that enables to understand the reality of the research problem.

Data analysis

Processes of data analysis were done by correcting collected raw data through editing then, reliable data was provided to a computer program using the assigned numerals at the stage of the questionnaire. The qualitative information from focus group discussions and key informants was narrated and interpreted to back up or for an in-depth description of the results. Based on research questions;

First, to analyze the smallholder farmers' perception of climate change bar chart and table were used to describe the frequency and percentage of farmers perceived climate change regarding rainfall, temperature, and occurrence of climatic disasters.

Second, to identify adaptation strategies for climate change implemented by smallholder farmers only a table was used to describe the frequency and percentage of farmers' responses to implement adaptation strategies for climate variability.

RESULTS AND DISCUSSION

Smallholder farmers' perception of climate change

Farmers' perception of change in rainfall

Results in table 1 shows 58.82 % of respondent's perceived decrease in rainfall past decade, whereas 41.18 % of the sample household heads perceived an increase in rainfall in the past decade. These results reflect during the past decade farmers' were perceiving change of rainfall patterns in the study area.

Table 1: Result of farmer's perception of rainfall change during past decade

Farmers' perception on rainfall change during past decade		
Response	Frequency	Percentage
Decreased	90	58.82
Increased	63	41.18
Total	153	100.0

The result in table 2 shows that most of the respondents perceived climate change symptoms to precipitation such as erratic nature of rain fall, shortening of the rainy season, early onset and early exit of the rain season in the study area over the last 10 years/2009-2019. Out of 153 household respondents who perceive erratic rainfall, most of respondents82.4% perceived an increase, about 13.1%of respondent's perceive a decrease, and a small number 3.9% of respondents perceive no change. Only 0.7 % of respondents did not perceive erratic nature of rain fall. As for shortening of rainy season, the majority 51.0% of respondents perceived an increase, about 45.1% of respondent's perceive a decrease, small number 3.3% of respondents perceived no change, and only 0.7% of respondents did not perceive a shortening of the rainy season.

Also, the results indicate that the majority (58.8 %) of the respondents perceived an increase, about 31.4% of the respondent's perceive a decrease, 9.2% of respondents perceive no change, and only 0.7% of respondents did not perceive early onset and early exit of rainy season. These results implies that farmers are facing challenges of climate change events in their farming system because the nature of rainfall become unpredictable and the normal rain season changes overtime.

These results coincides with the empirical findings where a change in the timing of rains, late onset and early cessation of the rainy season, a decreasing trend of rainfall as well as an increasing trend of temperature were shown (Amogne et al., 2013) ; (Tesfaye, 2016).

Table 2: Result of farmer's perception of rainfall indicators

Rainfall indicators	Erratic nature of the rainfall		Shortening of the rainy season		Early onset and early exit of the rainy season	
Response	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Increased	126	82.4	78	51.0	90	58.8
Decreased	20	13.1	69	45.1	48	31.4
No change	6	3.9	5	3.3	14	9.2
Do not know	1	0.7	1	0.7	1	0.7
Total	153	100.0	153	100.0	153	100.0

Farmers' perception of variability in temperature and heat

Results in table 3 shows 27.45 % of respondents perceived a decrease of variability in temperature during the past decade, while 72.55% of respondents perceived an increase of variability in temperature the past decade. These results line with results showed by Paulos and his colleague in the Dabus watershed, North-West Ethiopia in which farmers perceive temperature has been increasing over time and the rainfall has been decreasing. Erratic nature of rainfall increase, crop failure increased due to water shortage and late onset of the rainy season (Paulos and Simane, 2018).

Table 3: Farmers' perception of temperature change during past decade

Farmers' perception on temperature change during past decade		
Response	Frequency	Percentage
Decreased	42	27.45
Increased	111	75.55
Total	153	100.0

Results in table 4 shows that majority of respondents(70.6 %) perceived an increase, while 27.5% perceived a decrease of variability in higher temperature over the past 10 years. Also, 1.3 % of farmers perceived of variability in higher temperature while 0.7% could not indicate if there was higher temperature or not. As regards frequent occurrence of heat induced crop disease, an overwhelming most of farmers (90.8 %) perceived an increase infrequent occurrence of heat induced crop diseases, whereas 7.2 % of respondents perceived a decrease and 2.0 % perceived no variability in frequent occurrence of heat induced crop diseases. The results also showed that most of farmers (81.7 %) perceived an increase in frequent occurrence of heat induced animal diseases, whereas 17.0 % of respondents' perceived decrease and 1.3 % perceived no change in frequent occurrence of heat induced animal a diseases. As regards frequent occurrence of heat induced human diseases, most of farmers (85.0%) perceived an increase, whereas (12.4%) of respondents perceived a decrease and 2.6% perceived no change in frequent occurrence of heat induced human diseases. The results also shows that majority of farmers (72.5%) perceived an increase in an incidence of drought or scarcity of water, whereas 26.1% of respondents perceived a decrease; only 0.7% perceived no change and also 0.7% could not indicate if there was an incidence of drought or scarcity of water or not. These results reflect that crop failure due to drought, incidence of crops, animals, and human diseases happen from time to time in the study area.

These results align with study results of farmers' perception of temperature and heat patterns by rice farmers of Mbarali and Kyela districts in Mbeya region of Tanzania (Peter , Shiwei and Wen 2018).

Table 4: Results of farmer's perception on variability in temperature and heat indicators

Temperature and heat indicators	Higher temperature		Frequent occurrence of heat induced crop disease		Frequent occurrence of heat induced animal disease		Frequent occurrence of heat induced human disease		Incidence of scarcity of water	
Response	Fre	%	Fre	%	Fre	%	Fre	%	Fre	%
Increased	108	70.6	139	90.8	125	81.7	130	85.0	111	72.5
Decreased	42	27.5	11	7.2	26	17.0	19	12.4	40	26.1
No change	2	1.3	3	2.0	2	1.3	4	2.6	1	0.7
Do not know	1	0.7	0	0	0	0	0	0	1	0.7
Total	153	100.0	153	100.0	153	100.0	153	100.0	153	100.0

Farmers' perception on variability in occurrences of climatic disasters

Table 5 presents that respondents perceive climatic disasters in terms ofcrop damage by pests, lack of feed for cattle due to drought, drying up rivers, loss of soil and soil fertility due to floods and weed infestation. The results indicate that 95.4 % of respondent's perceived an increase, 3.3% of respondent's perceived a decrease and 1.3% of respondents perceived no change in crop damage by pests. The majority 73.2% of respondent's perceived an increase, 26.1 % of respondent's perceived a decrease and 0.7 % of respondents perceived no change in a lack of feed for cattle due to drought. As regards drying up of stream and rivers due to climate variability of precipitation about 54.9 % of the respondents perceived an increase,42.5 % of the respondents perceived decrease and few (2.6%) of the respondents perceived no change in drying up of stream and rivers. The results indicate that almost 69.9% of respondents' perceived an increase, 29.4 % of respondent's perceived a decrease and only 0.7 % of respondents perceived no change in a loss of soil and soil fertility due to floods. Likewise, the results show that most of respondents (92.8 %) perceived an increase; 6.5% of respondents perceived a decrease and only 0.7 % of respondents perceived no change in a weed infestation. These results reveal that crop damage by pests, occurrence of drought, lack of feed, and drying up of water sources events affect farmers' livelihood in the study area. Similarly study result of Ensaro in North Showa Zone of Amhara Regional State in Ethiopia showed that majority of the farmers confirm drying up of rivers and streams, crop damage by pests, newly introduced human and animal disease, and introduction of new plant species occursin their locality due climate change (Cherinet and Mekonnen, 2019).

Table 5: Result of farmer's perception on occurrence of climatic disaster indicators

Climatic disaster indictors	Crop damage by pests		Lack of feed for cattle due to drought		Drying up rivers		Loss of soil and soil fertility due to floods		Weed infestation	
Response	Fre	%	Fre	%	Fre	%	Fre	%	Fre	%
Increased	146	95.4	112	73.2	84	54.9	107	69.9	142	92.8
Decreased	5	3.3	40	26.1	65	42.5	45	29.4	10	6.5
No change	2	1.3	1	0.7	4	2.6	1	0.7	1	0.7
Total	153	100.0	153	100.0	153	100.0	153	100.0	153	100.0

Focusing on group discussions results show that climate variability has become a challenge for their farming system in which over the past 10 years conditions of climate were highly variable from year to year, season to season, decade to decade that rainfall became increasingly erratic, including decreased reliability and less predictability, temperature and heat intensity were increasing, droughts appear to be increasingly frequent. Results of key informants' interviews showed that crop damage by crop pests such as birds, locusts and army worm increased from year to year and the researchers observe that at field of study area (figure 2 a and b).

(a) Locusts in the field

(b) Birds in the field

Also, during focus group discussion respondent farmers report that animals such as goats, cattle, sheep and donkey death increasedue todrought related outbreak diseases such as anthrax and opasturalosis. In addition, focus group discussions resulted in reports that the number of extreme events is likely to increase such as theloss of soil and soil fertility increase due to flood from erratic and unexpected rain fall. On the other hand, farmers indicated that weed infestation is increasing in recent times (figure 3).

(a) Striga weeds under local sorghum crop

Furthermore, focus group discussions result in reports that over the past 10 years/2009-2019 farmers attributed the perceived change of temperature, rain fall, and extreme events occurred due to factors such as deforestation, charcoal, firewood, farmland expansion, open and over grazing and deteriorating culture of water and soil conservation practices.

Also, study result of key informants' interview and focus group discussions report the major rainy season (March, April and May) and short rain season occurring from September to November in which all farmers concentrate on farming activities, and trend has become changed from year to year to shorter, earlier onset and earlier exit.

Adaptation strategies to climate change implemented by smallholders

This analysis shows that 153 farmers have adoption of one or more of the major adaptation options identified through the research survey (Table 6).

Results of this study present that about 58.8% farmers plant drought tolerant crops such as BH140 maize, humera-1 seasame, however about farmers 41.2% do not plant drought tolerant crops.

The result also present that about 46.4% of the respondents are involved in use of small-scale irrigation techniques like use of water pump pound, construction and divert streams/river; however, 53.6% of the respondents are not involved in use of these small scale irrigation techniques.

As regards, changing the planting date, the results show that 47.1% respondents practice while 52.9% of the farmers do not practice changing the planting date.

As regards agroforestry,the results present that majority (72.5%) of respondents use agroforestry measures, but 27.5% of the farmers do not use this adaptation option. The results also present that 59.5% of the respondents use afforestation and 40.5% of the respondents do not use afforestation.

In addition, results indicated that 63.4% of the respondents adopt adjusting planting dates, but 36.6% of the respondents do not adopt climate variability by adapting adjusting planting dates.

Also, the results present that an overwhelming majority of 85.6% of the respondents use soil and water conservations; however, few 14.4% of the farmers do not use soil and water conservations. The results also present that about 51.0% of the respondents adapt to climate variability by labour migration to urban areas, whereas 49.0% of respondents do not adapt to climate variability by this option.

In addition, the results indicate that only a small number of 16.3% of the respondents adapt to climate variability by engaging in off-farm such as petty trade, whereas most 83.76% of the respondents do not engage in off-farm jobs.

Likewise, the results present that most of respondents 88.9% adapt to climate variability by using of improved fodder crops and hay for livestock feed, but only small number of the respondents 11.1% did not implement this strategy.

Finally, the results present that the majority 74.5% of the respondents reduces livestock animals, however about 25.5% of the farmers do not reduce their livestock animals.

These results reveal the practical evidence in the study area that the farmers are usually used practices are stone terracing, fattening of livestock using cut and carry system from the agroforestry practice, and diversion of floods for irrigation. Also, the farmers in the study area are sowing the seeds before rain seasons. In addition farmers in the study area are engaging in petty trades and use seasonal migration options to adapt climate change and to diversify their livelihood.

A similar finding was reported by AmogneAsfaw, and his colleagues who identified that the most widely practiced land management strategy carried out at household level was stone/soil bund, agroforestry, changing the farming calendar, switching to short maturing varieties, growing drought-resistant varieties, using water resources (irrigation and water harvesting) and reducing the number of domestic animals (Asfaw et al., 2018).

Also, similar finding of researchers study in Muger River sub-basin of the Blue Nile River Basin of Ethiopia revealed that farmers' respond to change climate stresses by using stone bund, soil bund, check dam, terrace, use of an on-farm activity, non-farm activity, off-farm activity, use of drought-tolerant crop varieties, crop diversification, improved crop varieties diverted streams, pond construction, and use of water pump as major adaptation stratagies of climate change (Amare and Simane, 2017).

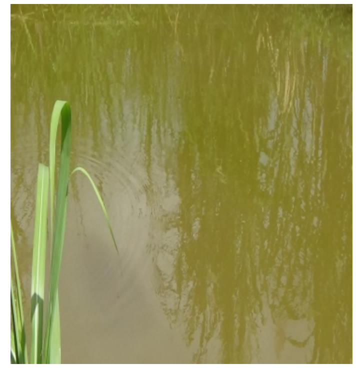
Table 6: Results ofrespondent's distribution by the response to the use of adaptation strategies

Respondent's distribution by the response to the use of adaptation strategies				
List of adaptation options	Yes		No	
	Freq	%	Freq	%
A. Using weed competitive, drought and disease tolerant varieties	90	58.8	63	41.2
B. Planting short season/early maturing varieties	72	47.1	81	52.9
C. Agroforestry: Rising of food crops and valuable trees that could be used to produce feed, conserve soil & produce fruits for human consumption.	111	72.5	42	27.5
D. Afforestation: planting trees as a way of adapting to the effect of climate events like flood, etc.	91	59.5	62	40.5
E. Adjusting planting dates: sowing the seeds earlier or later than in previous years.	97	63.4	56	36.6
F. Use of small-scale irrigation techniques likeuse of water pump, constructionanddivert streams/river	71	46.4	82	53.6
G. Use of soil and water conservations such asuse of stone bund, use of soil bund, use of check dams and use of terrace	131	85.6	22	14.4
H. Labour migration (seasonal migration) to urban areas	78	51.0	75	49.0
I. Engage in off-farm jobs like petty trade	25	16.3	128	83.7
J. Use of improved fodder crops and hay for livestock feed	136	88.9	17	11.1
K. Reduced livestock animals	114	74.5	39	25.5

During thekey informants interview it was reported that water sources for irrigation like rivers and springs, and water harvesting techniques such as pounds are used for irrigation options as one type of adaptation strategy to climate change. Some water sources for irrigation in the study area (figure 4 a to f).


(a) Delbena river in Arfayedakebele


(b) Segen river in Abarobakebele

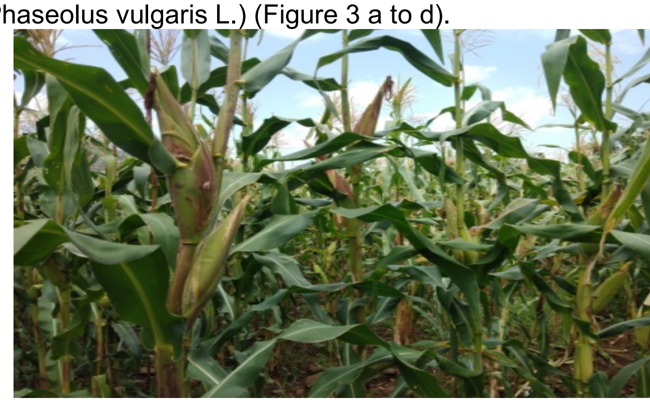

(c) Spring water in Fuchchakebele


(d) Small irrigation in Arfayedakebele


(e) Water harvesting in Fuchchakebele


(f) Local pond in Abarobakebele

During FGDs farmers reported that kinds of adaptation options used by the farmers were mainly autonomous and based on accumulated knowledge and experiences over the years Study result of key informants' interviews and field observations reported that nowadays other types of adaptation strategies exercised in the study area include using weed competitive, drought and disease tolerant , and early maturing crop varieties like, BH140 maize (*Zea mays L*.), DZ-CE37 tef(*Eragrostiszucc.)* , humara-1sesame(*Sesamumindicum L*.), Mung been(*Vigna radiate L*.), common been(Phaseolus vulgaris L.) (Figure 3 a to d).


(a) Maize (*Zea mays L.)*


(b) *Eragrostis*mtef(*Zucc*.)

(c) Sesame (*Sesamumindicum L.)*

(d) Common been (*Vigna radiate L.)*

Also, during FGDs farmers reported that they are partly engaged in petty trade; daily labor work and destock their livestock animals in times of feed or water deficit as other adaptation strategies practiced in the study area. In addition focus group discussions reported commonly known climate adaptation option which is soil and water conservation techniques, especially stone terracing used to avoid the risk of flooding as well as improve soil moisture and organic matter retention. Regarding the agroforestry option, key informants interview reported that rising of forage crops and valuable trees such as pigeon pea(*Cajanuscajan*) and a local tree named Oybata (*Terminaliabrownii)* are common agroforestry practices used in the community, and the researcher observes at field observation of the study (figure 4 a and b).

(a) Pigeon pea(*Cajanuscajan*)

(b) Terminalia (*Terminaliabrownii)*

Furthermore, during key informants' interviews and field observations result showed that farmers usually protect and conserve the forage (grass) around the farmland by planting Rhodes grass (*Chlorisgayana*),Elephant grass (*Pennistumpurpureum*) and locally named Kanda (*Commelinabeghalensis*) forage as an important adaptation strategy to climate variability to overcome animal feed shortage. On the other hand, at the time of drought, farmers usually feed their animals using crop residue and collect acacia pods as one type of adaptation strategy to climate change in the study area (figure 5 a to d)

(a)Elephant grass (*Pennistumpurpureumscumach.)*

(b)Hairy commelina (*Commelinabeghalensis*)

(c) Crop residue

(d)Acacia pods

CONCLUSIONS AND RECOMMENDATIONS

The findings on farmers' perception of climate change shows that most of the respondents perceived an increase in erratic rain fall and crop damage by pests, whereas, the majority of them perceived an increase in a lack of feed for cattle due to drought, higher temperature, an incidence of drought or scarcity of water and shortening of the rainy season. It is important to note that farmers of the study area perceived climate change through temperature, rainfall and climatic disaster symptoms.

The findings on the identification of adaptation options shows that most of the respondents adapt to climate change by using improved fodder crops and crop residue for livestock feed and using soil and water conservations,specially, stone terracing. On other hand, most of the respondents do not engage in off-farm jobs and the majority of respondents adapt to climate change by use agroforestry measures, adjusting planting dates, use of drought tolerant crops such as BH140 maize, humera-1 sesame, however over half of the respondents do not use small scale irrigation techniques. This indicates that these adaptation options are used in a complementary way and provide a venue to reduce sensitivity and increase the adaptive capacity of smallholder farmers that latter improve their livelihoods and ensure food security.

Based on the findings of this study, meteorological and agricultural organizations at different levels need to prioritize dissemination of timely weather information and agricultural extension information through communication channels such asradio, posters, phone, farm and home visits. Also government shouldneed to strengthen the farmer's training centers(FTC) to train and educate farmers and should make tours and field days to visit the best farmers and villages.

Interventions of national or regional government and non-government institutions need for the construction of dams that help to small scale irrigation, need the provision of microcredit facilities to address farm inputs and financial constraints, and also need for optimizing the capacity of research institutions and agricultural staff to develop and promote improved farming practices, drought-resistant and early maturing crop varieties and supply inputs that increase crop yield and productivity.

Furthermore, policies and programs need to focus on the diversification of enterprises that are less sensitive to climate change to enhance farmer's income, provide irrigation facilities based on both ground and surface water. Encouraging farmers' membership to many social groups can promote group discussions and better information flows and enhance adaptation to climate change, and should give better attention to efforts on opening up the options towards improve farmers' knowledge about theproper use of weather information in carrying out agricultural activities to avoid risk and adverse effect of climate variability hence strengthen climate change education scheme with ICT innovations such as cell phone applications and up to date early warning system by integrating information from both.

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