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Climate Change Adaptation Strategies of Smallholder Farmers: The Case of Bedele District, Bunno Bedele Zone, Oromia Region, Ethiopia

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Abstract
Understanding of the local dimensions of adaptation is essential to develop appropriate adaptation measures that can minimize the adverse consequences of climate change. The objective of this study was to identify farmers' adaptation strategies and determinants of climate change adaptation strategies in Bedele district, Western Ethiopia. Both primary and secondary data were used for the study and 100 respondents were interviewed. The results shows that the likelihood of households to adopt adverse effects of climate change in the study area used adjust planting date, integration of crops with livestock, irrigation, crop diversification, crop rotation and soil and water conservation practices. Determinants of adaptation choice identified were sex, family size, educational status, farming experience, assess to media, extension contact and access to training and they have significant effect on climate change adaptation strategies which makes difference on adaptive capacity among the smallholder farmers. Access to training increased the probability use of climate change adaptation strategies of crop diversification, improved crop and livestock, soil and water conservation and irrigation practice increased by 2.3%, 10.9%, 4.91 %, and 9% respectively. Also the farmers farming experience increased the probability use of climate change adaptation options of crop diversification, improved crop and livestock, soil and water conservation and irrigation practices by 16%, 18%, 6.4% and 54% respectively. Therefore, researchers forwarded building farmers adaptive capacity by providing access of training and access of credit and awareness creation on climate change through different sources such as mass media and extension service, enhancing farmers on use of crop diversification, irrigation practices and using improved crop varieties, adjust planting date to minimize the effects of climate change in the area.
Key words: Adaptation, Climate change, Determinants of climate change, Smallholder farmers

INTRODUCTION

Climate change is one of the greatest environmental, social and economic threats facing our world today [3]. In the last decade climate change has become increasingly apparent that it is already happening, and will continue to happen, bringing with its local impacts on people's livelihoods [14]. The threat of global climate change has caused concern among scientists as livelihoods, agricultural production and food security of the smallholders could be severely affected by changes in key climate variables (rainfall and temperature). Climate change could have adverse effect on various biophysical and economic activities like agriculture, water resources, forestry, human health, biodiversity and wildlife. The consequences of climate change are severe in third World smallholding peasant agriculture because it is rain-fed and relies on the mercy of nature [18].

Climate change affects agriculture and agriculture also affects climate change. Its impact on agriculture in developing countries has been increasing. Higher temperature and changing precipitation levels caused by climate change depresses crop yields. This is particularly true in low-income countries, where adaptive capacities are perceived to be low. Many African countries which have economies largely based on weather-sensitive agriculture are vulnerable to climate change. However, the rapid pace of climate change, along with increasing socioeconomic pressures, threatens to overwhelm their ability to cope. Ethiopia is especially vulnerable to climate variability and change because large segments of the population are poor and depend on agricultural income, which is highly sensitive to rainfall variability and change in temperature. Most of the farmers have low access to education, information, technology, and basic social and support services, and, as a result, have low adaptive capacity to deal with the consequences of climate variability and change [17; 13].

Ethiopia is challenged by both social and natural problems. The main social problem is poverty. It is estimated that 29% of the total population live under the international poverty line [8]. Poverty in the country is associated with high human population growth, low level of institutional and infrastructural setups, low level of technology employed especially in the agricultural sector which dominates the economy of the country [2]. The main environmental problem of the country is recurrent drought. As the agriculture of the country mainly depends on rainfall, drought highly affects agricultural production and livelihood of the farming population. Droughts in Ethiopia can shrink household farm production by up to 90% of a normal year output and could lead

to the death of livestock and human beings [20].

Flood and hailstorms are the other natural extreme events that affect Ethiopian farmers although not pronounced like the case of drought. Ethiopia was identified among the countries with the major flood events around the world in 2006 [19]. Ethiopia experienced drought early in 2006, but it also suffered severe floods in early August of that year killed more than 200 people in the eastern part of the country. In response to the recurrent droughts and related environmental calamities, farmers in Ethiopia have developed different coping strategies [6].

There was a very high variability of rainfall over the past 50 years in Ethiopia. Rainfall trend during the last half century significantly reduced in the north, west, south and south-east parts of the country while an increasing trend has been observed in the central parts of Ethiopia during the dry season [11]. This has already led to a decline in agricultural production, and cereal production is expected to decline still further under moderate global warming [9]. Moreover, it has led to shortage of food, a decline in biodiversity, and increases in human and livestock health problems, rural-urban migration and dependency on external support. Rainfall in Ethiopia is projected to continue the trend that has been observed. Likewise, both mean maximum and minimum temperature have shown positive trend and on average a 1.3°C increase has observed between 1960 and 2006 [11]. According to [7] temperature projection on the coming decades shows an average increase of 1.1 to 3.1°C by the 2060s, and 1.5 to 5.1°C by the 2090s. This will increase the vulnerability of smallholder farmers to the harmful effects of climate change in the future.

Oromia Regional State is the most affected region in Ethiopia due to climate change and variability. The overall natural resources base of the region is highly degraded. This initial potential together with the current global warming aggravates the vulnerability of the people to climate change impacts. Various reports agree that the region has been facing droughts that have occurred in the country indicating susceptibility of the region to climate change. The most significant climate change impact in the region is due to drought and flood [15]. Even a mild water stress during the crop growth period has resulted in complete failure in this region. Thus, people in the region, the study area is not the exception, are facing a variety of shocks and become vulnerable.

Ethiopia which is dependent on rain-fed agriculture together with low level of socioeconomic development is highly affected and vulnerable to climate change [9]. Similar to other farmers in any other part of Ethiopia, the Bedele district farmers are suffering from climate upheavals which have become common natural disasters in the country. Furthermore, the literature on climate change has paid little attention to the analysis of factors influencing adaptation strategies chosen by smallholder households to adapt to climate change. Thus, these are the gaps of knowledge that this study intends to bridge.

This Research confined to only Bedele district, which can somehow represent other districts similar agro-ecological conditions in the region. Limited area coverage in terms of locations selected for the study, because of time and budget constraint to conduct further research in other district, hinder drawing conclusions at macro level due to, varying agro-ecological and socioeconomic diversity in the country. The objective of the study is to assess farmers' adaptation strategies against climate change stresses.

METHODS AND MATERIALS

Description of Study Area

Bedele District is located in Oromia Regional State at 468km away from Addis Ababa, Capital city of Ethiopia. It is bounded by Cora district in South West, by Dabo Hanna in North and by Gachi District in the East. The district accounts total population of 98,034, with the total household of the 10,000. From these, 5800 were males and 4200 were female households [4]. The topographic feature of the district is characterized by different terrain features, such as plateau, gentle slope and valley. The average rainfall of the district was 1361mm, with an average temperature of 27 ^{o}c with minimum and with maximum of 34^{o}c. Weyna Dega and Kola agro-ecology is known climate type in the district according to annual report of Bedele District's Agricultural office reported in 2007.

The most common vegetation in the district is: Bamboo, Gravilia robista, wanza, Bizana, shola, white tree, acacia species, also cereals such as Coffee (Coffee Arabica), maize, sorghum, teff, vegetables (sweet potato, tomatoes, onion, chilies), fruits (avocado, mango, orange, banana, papaya, lemon) (field survey, 2017). The farming system of Bedele district was mixed (crop production and livestock rearing). The major land use categories of district are forest, agriculture and range lands.

Method of Data Collection and Sources

The data collection was done using checklists which was pre-tested prior to the actual field work. Both qualitative and quantitative data were collected through the semi-structured and structured questionnaire from the selected households to identify the climate change adaptation measures that were used by smallholder farmers and the determinants of farmers' choice of adaptation strategies to climate change in the study area. Key informants interview and focus group discussions were used data collection from the individual households.

Both primary and secondary data were used for this study. Primary data was obtained from sample households in the district by preparing and distributing structured and semi-structured questionnaire through interview and focus group discussion. Relevant secondary data also obtained from national meteorological station agency (NMSA), other governmental offices, demographic characteristics and physical characteristic.

Sampling Techniques and Sample size

Bedele district was purposively selected from the districts of Bunno Bedele Zone, based on the use of climate change adaptation strategies and more availability of climate adaptation practices by farmers in the district. From the total of the district three namely Dabena Deru, Qollo Sirri and Carrise kebele were selected randomly for this study.

Respondents for this study were selected purposively by considering availability of climate change adaptation practice by the farmers in the Kebeles and high vulnerability of the farmers by climate change in the area than other districts in the zone.

Thereafter, out of total households of the district (10,000), 100 respondents' were determined following the Yemane (1967) standard formula for sample size determination at precision level of 10% (0.1) margin of error 0.05 and 95% confidence interval.

The standard Yemane formula and it's calculated as:

$$n = \frac{N}{1+N(e^2)}$$

Where;

- n=desired sample size, N= the estimated population size and e = is level of precision

Method of Data Analysis

The data collected from structured interview was systematically coded and analyzed using descriptive statistics by employing Statistical Package for Social Sciences (SPSS version 20); multinomial logit model and results presented using diagrams, pictures, tables and narration.

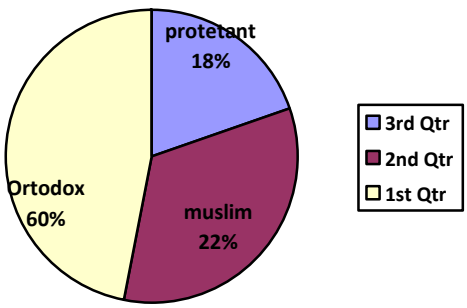
Ethical Consideration

The proposal of this study was approved by Ethical Review Committee of Mettu University, College of Agriculture and Forestry. Verbal consent was obtained from each study participants before interview. Moreover, no personal identifiers were used on data collection questionnaire and the data obtained from the study participants were kept confidentially.

RESULTS AND DISCUSSION

Genera information about respondents

The presence of religious leaders and followers in that area also has its own role to minimize the negative impact of climate change by planting different trees in order to make attractive their church garden and also by giving awareness on different case to response any negative effects related to climate change in the area. Also, religious leaders played important role in climate change adaptation strategies by teaching their fellows during they come the church by planting multipurpose plants (personal communication from church leader).



Researchers' data 25May, 2017

Figures1: Represents religions affiliation of farmers in the study district.

We classified the farmers of the area in to three category based on their monthly income (in Birr) as: less than five hundred birr as poor, from five hundreds to two thousands as medium and those their monthly income

are more than two thousands Birr were classified as rich respectively. Based on this we got the following results: The majority of the respondents about 40% were poor and the rest 31.7% and 28.3% were medium and rich respectively (table 1). This indicated that the farmers in the study area have less adaptive capacity towards the impacts of climate change which makes them to more vulnerable to affected by climate change.

Table1: Monthly income status of respondents in frequency and (%)

NO	wealth status	No of respondents	percents
1	*Rich*	28	28.3%
2	*Medium*	32	31.7%
3	*Poor*	40	40%

As stated in the below table 2, the majority of respondents were illiterate 56% and 44% were educated. This shows that the farmers in the study area have less adaptive capacity towards impacts of climate change. The result clearly shows that this were because of most of local communities lack of formal education, thus result indicated that they have low participation in the climate change adaptation strategies and climate change issue. The number of female in the study area was decreased as level of education levels increased, this is due to less gender equality among male and female in the society to sending their children to school. As a result female in the study area become very vulnerable due to lack of climate change information which implies that females have less adaptive capacity than male.

Table 2: Educational levels of respondents on climate change.

Educational level	Response	Sex		Total	Percentage
		Male	Female		
	Illiterate	18	38	56	56%
	Grade 1-8	22	11	33	33%
	High school	2	3	5	5%
	Diploma	4	0	4	4%
	BSC holders	0	2	2	2%
	Total	45	55	100	100%

Socioeconomic Characteristics of Household Heads

The livelihoods of the farmers in the study area were mostly dependent on agriculture, i.e. rearing of animals and crop cultivation. About 67% of farmers were engaged in mixed agricultural activities, while 33% of the farmers were engaged in crop production activities.

The farming experience of the household heads was 41 years with maximum and the minimum experience of 10 years. Farmers in the study area were engaged in mixed farming activities, including staple food crops production (such as Sorghum, Maize and Teff) and rearing of domestic animals such as cows, oxen, goats, sheep's and donkey.

Major sources of income in the study area are on-farm activities mainly from sale of crops, sales of livestock and livestock products (milk and butter). Trading, daily labor and hand craft are also other sources of income for some of the sample households.

The survey data indicated that the family size of the sampled households varies from 1 to 12 with an average household size of 7, which is higher than the national average family size of 5 [4]. The land holding of sampled households ranges from 0.3 to 6 hectares with an average size of 3.1 hectares.

The survey results show that 13.3% of the respondents reported that they were trained on issues related to climate change and its impact, whereas 86.7% reported the opposite. The distance from the nearest market of the sample households at the time of survey was 6 kilometers, respectively. The survey result also shows that the frequency of extension contact with the farmer ranges from 1 to 10 times contact per year. The survey results show that 30% of the respondents had access to media (radio and TV) on the issue of climate change and its impact, whereas 70% reported the opposite. Out of the total sample households surveyed, 71.7% reported that they have access to farmer to farmer extension to share important information and agricultural inputs with each other, whereas 28.3% reported the opposite (Table 3). This shows that the majority of the farmers' share information on climate related issues and important agricultural inputs with each other in the study area.

Table 3: Summary of socio-economic characteristics of farmers

Questions	Response	Sex		Total	Percentage	Total
		male	Female			
Do you access to media?	Yes	32	38	70	70%	100%
	No	13	17	30	30%	
Farmer to farmer extension?	Yes	35	37	72	71.7%	100%
	No	10	18	28	28.3%	
Farmer extension?	Yes	17	23	40	40%	100%
	No	28	32	60	60%	
Training?	Yes	13	21	33	33.3%	100%
	No	32	35	67	66.7%	
Land holding?	Yes	33	42	75	75%	100%
	No	12	13	25	25%	

As stated in the above table3, the majority of farmers were reported no farmers' extension contact in the study area, this shows that farmers are far from information about climate change and its effects. So, as a result they were vulnerable to climate change and have less adaptive capacity due to lack of awareness and information from different sources like media, farmer extension as well as training on issues of climate change.

Farmers' Perception on Climate Change

In order to get essential information and insight into farmers' adaptation to climate change, looking at their perception on each parameter/indicators are quite important. Hence, knowledge about farmers' perception on climate change attributes in the study area is an appropriate issue to be discussed. For this purpose, two known climate attributes: temperature and precipitation have been used. Parameters such as annual temperature increased, annual temperature decreased, annual rain fall increased and annual rainfall decreased were used to describe farmers' perception on climate change.

Perception on temperature changes

Most of the farmers interviewed perceived occurrence of long-term changes in temperature. About 70 percent of the respondents perceived that the temperature in the area was increased. 15 percent of the farmers noticed a decreased in temperature and 15% of the farmers didn't know whether there is a change in the temperature or not (Table5). The trend analysis between average annual temperature and time indicated that average temperature in the study area was increased by 0.096^{o}C each year (Figure2). The trend analysis between mean maximum annual temperature and time also indicated that maximum annual temperature in the study area increased by about 0.12^{o}C each year (Figure3). Moreover, the trend analysis between mean minimum annual temperature and time also shows an increased in one-year time results in an increase in the minimum temperature of the area by 0.059^{o}C (Figure 4). Thus, farmers' perceptions appeared to be in accordance with the statistical record of the area.

Table4: perception of sample households on average annual temperature.

Perceived change	**Sex**		**Total**	**Percentage**
	Male	Female		
In creased	28	42	70	70%
Decreased	7	8	15	15%
No change	10	5	15	15%

As illustrated on the above table (Table4), 70% of respondents were reported that the temperature in the study area was increased; this shows that, there is climate change and variability in the study area. The remaining 15% of respondents indicated that the temperature in the study area is decreased and 15% of the respondents didn't know whether temperature is changed or not within indicated time.

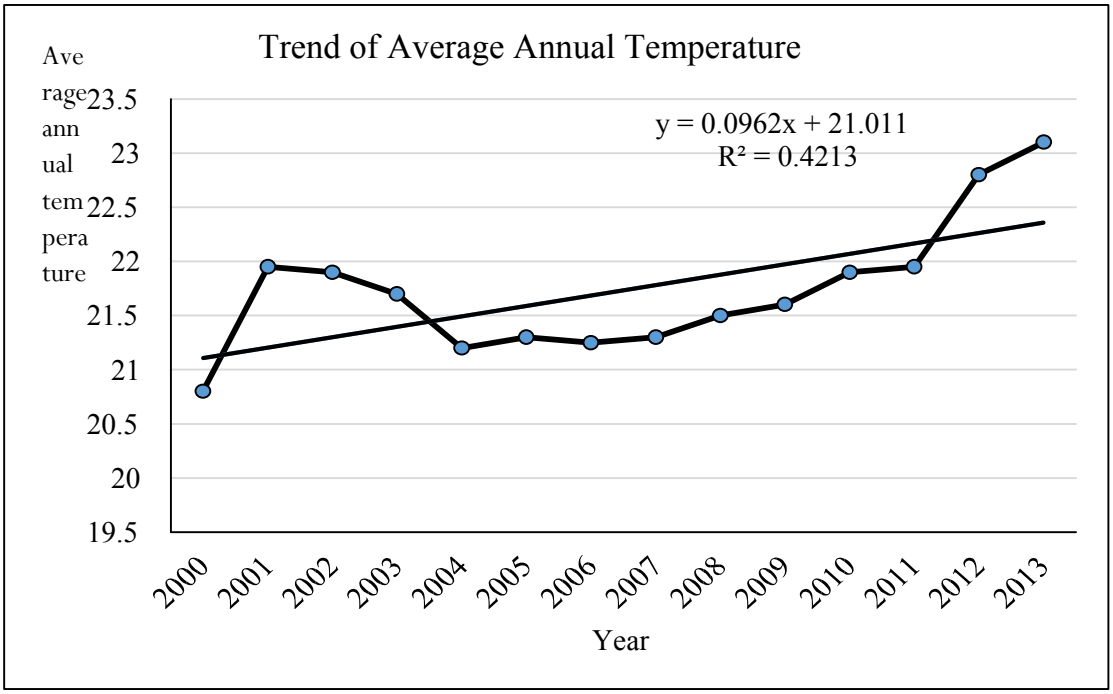


Figure 2: Trend of average annual temperature in Bedele area from 2000-2013
Source: (NMA, Bedele, 2000-2013)

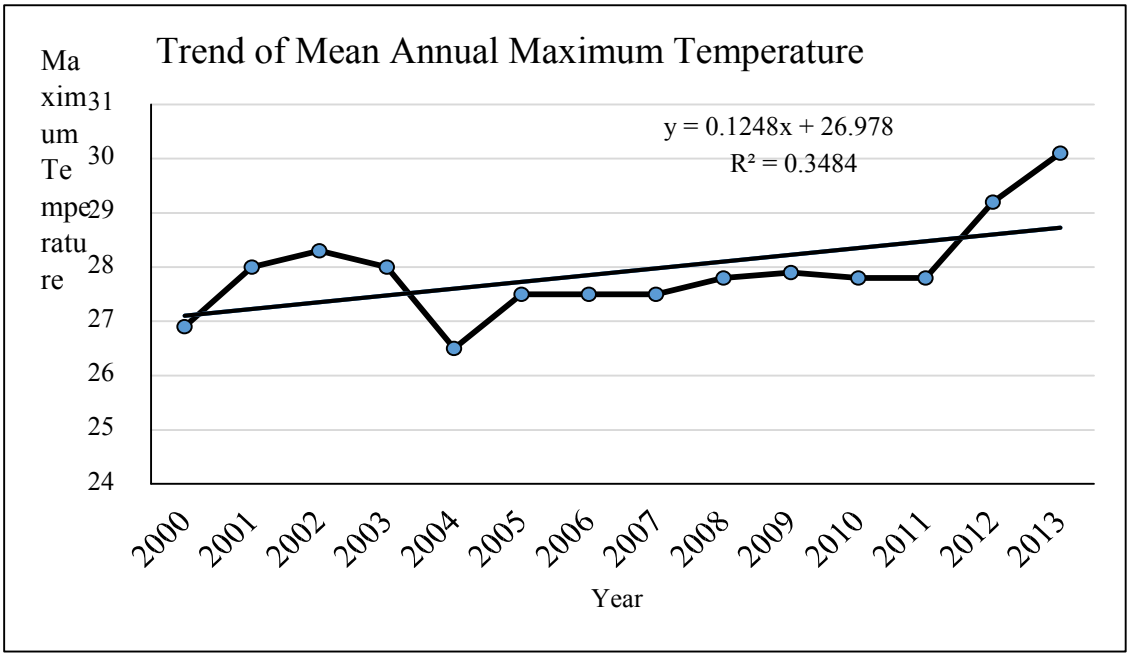


Figure 3: Trend of mean annual maximum temperature in Bedele area from 2000-2013
Source: (NMA, Bedele, 2000-2013)

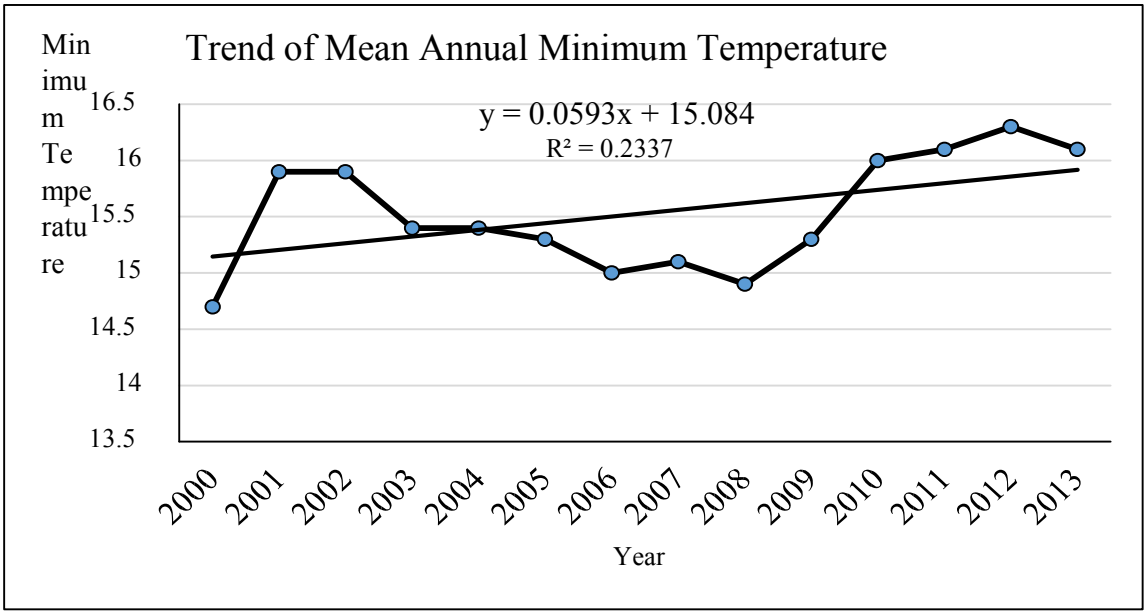


Figure 4: Trend of mean annual minimum temperature in Bedele area from 2000-2013
Source: (NMA, Bedele, 2000-2013)

Perception on precipitation changes

Most of the interviewed respondents perceived occurrence of long term change in rain fall in the area. About 66.67% of interviewed respondents perceived amount of rainfall decreased in the study area as highlighted on the table 5 below. About 20% of the respondents noticed an increased in the total amount of rainfall and 13.33% the respondents noticed no change in the amount of rainfall as their perception on the precipitation.

Table 5: Perceptions of respondents on rainfall pattern

Perceived change	**Sex**		**Total**	**Percentage**
	Male	Female		
Increased	10	10	20	20%
Decreased	30	37	67	66.67%
No change	5	8	13	13.33%

As stated in the above table (5), the majority (66.67%) of the respondents replied that the annual rain fall was decreased. This shows that there is variation of rain fall which indicate the climate change and variability observed. The remaining 20% were reported that the rain fall increased and 13.33% of farmers were reported as no annual rain fall variation occurred.

The trend analysis between annual rainfall and time using data obtained from meteorology agency indicated that annual rainfall in the study area decreased by 46.75 mm each year as indicated on the (figure 5) below.

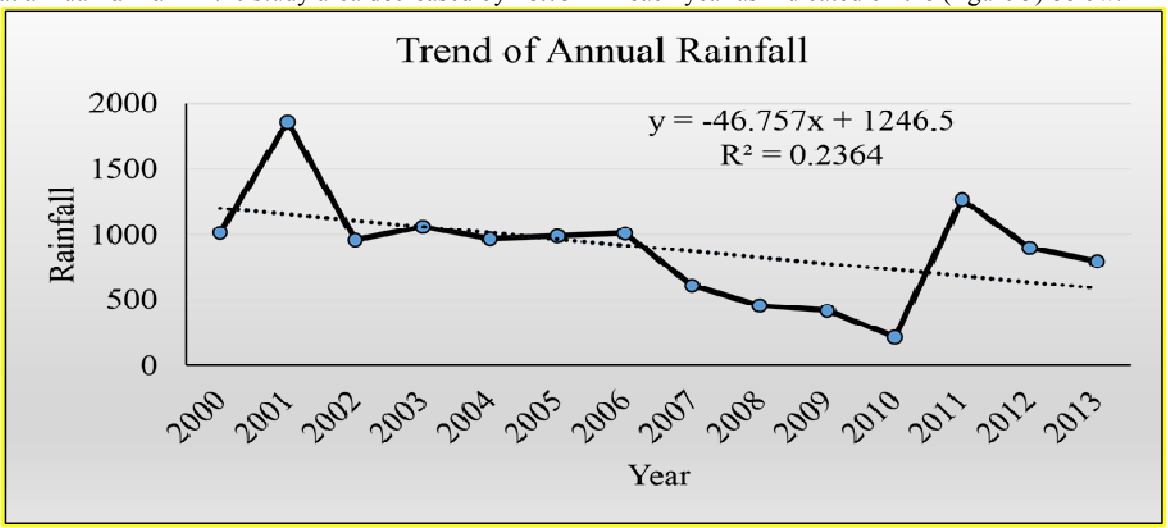


Figure 5: Trend of annual rainfall in Bedele area from 2000-2013
Source: (NMA, Bedele, 2000-2013)

Climate Change Adaptation Strategies

In the study area, farmers have adopted different strategies to reduce the consequences of climate change thus far and to manage future patterns in climate change. The sampled households were subsequently asked if they have responded through adaptation to reduce the impact of climate change in their surrounding environment. Accordingly, they reported their opinions that they are using different adaptation options to minimize the negative impact of climate change. These include, use of improved crop varieties, use of irrigation, soil and water conservation techniques, crop diversification (agroforestry practices) and adjusting planting dates.

Irrigation agriculture has become widely used substitute for inadequate or unreliable precipitation in the study area since recent years. This can provide a large comparative advantage to farmers of the study area. However, availability, accessibility, and scarcity of irrigation culture in the study area by farmers were a great problem as reported by farmers during the interviewed schedule. About 36.7% of respondents have experienced by using soil and water conservation techniques as adaptation strategy to reduce the adverse effect of climate change (table 6). This were done to minimize run off or soil erosion to care of soil fertility loss in the farm land and our respondents perceived this was done as soil fertility improved from time to time it will maximize their yield per unit area according to their perception.

When we quantify this in to percentage out of our respondents in the study area, 8.3, 6.7, 5, 3.3 of farmers were used irrigation, improved crop varieties, adjusting planting dates, and crop diversification respectively according to (table6) below. The joint probability of using all adaptation strategies was 21.7% and the joint probability of failure to adopt all the adaptation strategies was 18.3%.

Table6: Adaptation strategies used by farmers

Adaptation strategies	Sex			
	Male	Female	Total	Percentage
Use of irrigation	5	8	13	8.3%
Soil and water conservation practices	10	17	27	36.7%
Use of improved crop varieties	8	4	12	6.7%
Adjusting planting date	2	3	5	5%
Crop diversification	-	3	3	3.3
Use above all	10	12	22	21.7%
No options	8	10	18	18.3%

Determinants of Farmers' Choice of Adaptation Strategies

Sex: Sex has no significant effect on adaptation strategies of climate change as indicated in the table below (Table7). The result of study shows that there was no significant difference observed between women and men perform for the well-being of their family members for climate change adaptation strategies, which simultaneously can be regarded as well-designed adaptation practices if they invited with the same condition or equally treated. Also, the previous findings confirm this finding, which say that, females have less adaptive capacity unless there is equal treatment with men [1].

Age: Result shows that, age has significant and does affect the use of soil and water conservation for adaptation options to climate change in the areas as highlighted in the table below (Table 7). This show that, age have impact on the farmers to bring adaptive capacities difference to response climate change in the area indicated in the table below (Table7). As age increased by one unit the use of soil and water conservation increased by 23%, whereas crop diversification, improved crop and livestock and irrigation does not affected by age. The previous finding on the ground also reported that, age, were the key factors determining farmers' choice of adaptation practice [1].

Family size (F. Size): the result clearly shows that, family size was insignificant and has no effect on climate change adaptation strategies by the farmers in the area. Family size has no significant difference on the determinants of climate change adaptation strategies such as, crop diversification, improved crop and livestock, soil and water conservation and irrigation practices by the farmers (Table7).

Access to credit: Access to credit has significance and positive effect on adaptation strategies to climate change. As one unit increased access to credit, the probability of farmers use crop diversification and irrigation adaptation methods increased by 6.7% and 2.8% respectively (Table7). This finding have similarity with findings of [16] which says that access to credit is the major factor to make farmers ability to use an adaptation strategies such as irrigation and crop diversification at their local area to practice.

Total Land holding (TLH): Total land size has insignificant and has no effect on the use of climate change adaptation strategies. Total land size has negative effect on the use of improved crop and livestock, soil and water conservation and irrigation practices by the farmers because farmers limited to use adaptation option due to land shortage to minimize the effects of climate change. The possible reason could be if the farmers have more land holding they can benefit from the economic scale of it as compared with those who have small land holding. However, the farmers in the study area were reported as insufficient of land.

On-Farm income: The farm income of the households surveyed has a positive and significant effect on use of crop diversification and improved crop and livestock as an adaptation strategy (table7). This result of study indicated that the farmers in the study area have low income so, they have less adaptive capacity and vulnerable to climate change impacts. As one unit increased on-farm income, the probability of farmers' use of crop diversification and improved crop and livestock adaptation methods increased by 15.3% and 48.4% respectively (Table7). This finding have similarity with findings of [10]which says that income from farm is the major factor to make farmers ability to use an adaptation strategies using crop diversification and improved crop and livestock.

Off-farm income: Off-farm income has insignificant and has no effect on the use of climate change adaptation strategies. Off-farm income has negative effect on the use of crop diversification and livestock, soil and water conservation and irrigation practices by the farmers. The result of research indicates that the farmers in the study area lack of off/non-farm income to increases uptake of crop diversification and livestock, soil and water conservation and irrigation as adaptation strategies to climate change. So, as result this constraints on the farmers to use different adaptation strategies to responses climate change effects. Majority of income sources in the study area were only based from agricultural production.

Home distance from farm: Distance from home to farm is insignificant and has no effect on the use of crop diversification and soil and water conservation but, it has significant effect on the use of improved and livestock and irrigation practice to adaptation of climate change in the area. Distance to home from the farm has negatively the adaptation strategies with crop diversification improved crop and livestock and soil and water conservation. As the distance from home to farm is increased by one unit, the use of improved and livestock and irrigation practice decreased by 26.4% and 22% respectively (Table7).

Extension contact: The Extension contact has a positive and significant effect on use of improved crop and livestock, soil and water conservation and irrigation practice as an adaptation strategy (table7). As extension contact increased by one unit, the use of improved crop and livestock, soil and water conservation and irrigation increased by 6.8%, 5.5% and 14.2% respectively (table7). The result indicates that the farmers in the study area were reported as no extension contact as majority of respondents reported during interviewed. So, as result the farmers in the study area were most vulnerable to climate change and its effects due to lack of training.

Distance from the market center: Distance from the market centre is significant and negatively affect the use of crop diversification and soil and water conservation, but distances to market centre is significant and positive effect on the use of irrigation practice to adaptation of climate change in the area. As the distance from the market centre is increased by one unit, the use of crop diversification, soil and water conservation and irrigation practice decreased by 20.43%, 23% and 22% respectively (Table7). This was due to lack of infrastructure and poor facilities such as transportation, road and climate change information in the rural areas. Proximity to market is an important determinant of climate change adaptation strategy, presumably because the market serves as a means of exchanging information with other farmers and to get agricultural input supply. Distance from the market centre is significant and negatively affect the use of climate change adaptation strategies such as, crop diversification, soil and water conservation and irrigation practice to adaptation to climate change in the area [10].

Access to media: the results shows that access to media has significance and positive effect on adaptation strategies to climate change. As one unit increases access to credit, the probability of farmers use crop diversification, improved crop and livestock and irrigation practice for climate change adaptation methods increased by 2.8%, 20% and 18.4% respectively (Table7).

Access to training: Access to training on climate change adaptation strategies was found to be significant and has positive with crop diversification, improved crop and livestock, soil and water conservation and irrigation as an adaptation strategy to reduce the negative effect of climate change. As access to training in climate change increased by one unit, the use of crop diversification, improved crop and livestock, soil and water conservation and irrigation practice increased by 2.3%, 10.9%, 4.91% and 9.0% respectively.

Farming experience: Farming experience has significance and positive effect on adaptation strategies to climate change. As one unit increases farmers farming experience, the probability of farmers use crop diversification, improved crop and livestock, soil and water conservation (SWC) and irrigation adaptation methods increased by 16%, 18%, 6.4% and 5.4% respectively (Table7). This experience affects the use of adaptation strategy to climate change positively and significantly to reduce the impact of climate change. Also findings of [1] highlighted that, the best determinants of smaller holder farmers' adaptation to climate change is farming experience in their area.

Table7: Marginal Effects of Multinomial Logit Model for Climate Change Adaptation Strategies

Explanatory Variables	*Crop diversification*		*Improved crop and livestock*		*SWC*		*Irrigation*	
	Mfx	**P-Values**	**Mfx**	**P-Values**	**Mfx**	**P-Values**	**Mfx**	**P-Values**
sex	0.0097	0.618	0.4269	0.782	0.086	0.95	-0.47	0.74
Age	-0.027	0.39	-0.082	0.87	0.023	0.065*	-0.34	0.42
F. size	0.098	0.194	0.46	0.151	0.44	0.15	0.54	0.11
Credit	0.067	0.011*	0.165	0.42	0.024	0.90	0.028	0.020*
TLH	0.54	0.55	-0.77	0.101	-0.12	0.92	-0.714	0.5
On-farm income	0.153	0.04*	0.484	0.065*	-0.56	0.156	-0.56	0.175
Off- farm income	0.06	0.84	0.076	0.68	-0.0198	0.911	0.22	0.23
Home Distance from farm	-0.204	0.558	0.264	0.020*	-0.023	0.441	0.22	0.08*
Extension contact	-0.26	0.566	0.068	0.085*	0.055	0.06*	0.142	0.04*
Distance to market Centre	-0.2043	0.054*	-0.26	0.45	-0.23	0.021*	0.22	0.085*
Access to media	0.028	0.0348*	0.20	0.082*	-0.98	0.120	0.184	0.018*
Access to training	0.023	0.060*	0.109	0.079*	0.0491	0.0049**	0.090	0.091*
Farming experience	0.16	0.043*	0.18	0.04*	0.064	0.001**	0.54	0.005**
Constant	-0.299	0.335	-0.33	0.302	-1.512	0.815	-11.96	0.098*

*=significantly different at 95% confidence interval
**=highly significance difference at 99% of confidence interval

CONCLUSION

The results show that the majority of the farmers have perceived changes in rainfall and experienced the effects of a changing climate over a period of two decades. That is, extended dry periods and declining precipitation are more frequent across the agro-ecologies in the district. As a result, smallholder farmers have already been adversely affected. The farmers are trying to adapt through the use of improved agricultural practices like increasing on-farm tree planting, soil and water conservation, adjustment of planting dates, crop diversification, improved crop and livestock integration, use of agricultural inputs like fertilizers and pesticides. Farmers' capacity to choose effective adaptation options is influenced by household demography, as well as positively by access to credit, income, and access to markets, access to climate information and extension, and livestock production. This implies the need to support the indigenous adaptation strategies of the smallholder farmers with a wide range of crop diversification, crop livestock integration, training, soil and water conservation and technology support, some of it targeted on smaller, poorer or female-headed households. As the rainy seasons are recently becoming more and more unpredictable and uncertain, depending on rainfed agriculture in the area is less unlikely and hence policy driven actions to provide irrigation facilities based on both ground and surface water are vital. Moreover, creating opportunities for non-farm income sources is important as this helps them to engage in those activities that are less sensitive to climate change. Furthermore, providing climate change information, extension services, and creating access to markets are crucial. Therefore, including these activities in the existing formal extension channels of the Ministry of Agriculture and other line ministries will be useful to farmers.

RECOMMENDATION

- The ever-increasing climate variability and change effects would require strong institutional involvement.
- Empowering local community with climate change information and education: creating and expanding awareness about climate change, its consequences by providing reliable and up-to-date information to take appropriate adaptive measures.
- In the future, similar studies should be conducted which adequately address the issue of vulnerability to climate change, adaptation and the relative merit of each adaptation option to better guide policy option for adaptation to climate change and variability to ensure food security.

- Both governmental and nongovernmental organization should give emphasis to the awareness of the climate change in the area.
- Crop diversification, using improved crop and livestock integration and adjusting planting date is also an imperative option to minimize the adverse effects of climate change in the area and holds true for similar agro-ecologies with the study district.

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