

## Review Article

# Review on Climate Change Adaptation Strategies in Ethiopia

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**Abstract:** Almost all farmers in Ethiopia were depending on rainfall for their agricultural activities. Even if farmers depend on rainfall, climate change, especially drought highly affect the productivity of farmers in the country in general. The main objective of this review is to review household perception on climate change, adaptation strategies and determinants of choice of climate change adaptation strategies in Ethiopia. For this review secondary data was collected from published and unpublished documents related to this topic and organized. From the reviewed published and unpublished documents, smallholder farmers perceive climate change through local knowledge and their past experience rather than scientifically identified perception using GIS and remote sensing technology, farmers employed different climate change adaptation strategies such as cultivating different crops, planting different crop varieties, changing planting dates, use of soil and water conservation techniques, conservation agriculture practices and engaging in non-farm income activities. From the review result access to information, farming experience, number of households in one village, distance to main market, and income of household, and agro-ecological settings influenced farmers' adaptation choices to climate change.

**Keywords:** Adaptation, Choice, Ethiopia, and Review

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## 1. Introduction

### 1.1. Background of the Review

Agricultural production in Ethiopia highly affected by climate change since almost all rain fed agriculture is practiced in the country. Drought and rainfall variability reduce agricultural production and result in food insecurity in the country. El Niño occurred in 2015 reduce crop and livestock production especially in drought prone areas of Ethiopian country [6]. The production system of the study area mostly depends on rain fed which is highly sensitive to climate change impact. To adapt the adverse impact of climate change, smallholder farmers of the study area were used different climate change adaptation strategies traditionally but, there was little empirical studies conducted on factors that influence the choice of farmers of climate change adaptation strategies scientifically. Smallholder farmers adaptation to climate change were using improved varieties of crop, adjust planting date, crop diversification, and soil conservation practice were

the major adaptation strategies of smallholder farmers while experience of household head, family size, frequency of extension contact, distance from market, livestock ownership, access to credit, landholding size and lack of affordable technology affects the household decision to adopt climate change adaptation strategies [4].

To adapt climate change through different climate change adaptation strategies, smallholder farmers have to perceive causes and consequences of climate change on their livelihoods. All most all farmers perceive climate change in different ways; increases in temperature and decrease in precipitation over the years [11]. Therefore, the perception of farmers for climate change helps them to prepare themselves for using different climate change adaptation strategies. Even though farmers know different climate change adaptation strategies they were limited to different factors affecting their decision to use those strategies.

When the adverse impact of climate change is not minimized by using different climate change adaptation strategies, agricultural production both crop and livestock

production declined and results in food insecurity and vicious circle poverty. Knowing factors affecting the farmer's decision to adopt climate change adaptation strategies were the key issues have to be considered to recommend the farmers which adaptation strategies they should adopt to solve the problems [3]. Therefore, the aim of this review is that to assess smallholder farmer's perception of climate change, to review climate change adaptation strategies used by smallholder farmers of the country, review factors influencing the decision to adopt different climate change adaptation strategies in Ethiopian.

### 1.2. Objectives of the Review

The objective of this review are the following:

1. To review smallholder farmers perceptions on climate change in Ethiopia.
2. To review climate change adaptation strategies in Ethiopia.
3. To review factors affecting adoption of climate change adaptation strategies in Ethiopia.

## 2. Discussion

### 2.1. Definitions and Basic Concepts of Climate Change Climate

Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, rainfall, and wind [14]. Climate change: Climate change refers to a variation in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity [14]. Climate change may be due to natural internal processes or external forcing such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use [14].

Climate change refers to ongoing changes in the global climatic system resulting primarily from anthropogenic global warming as a consequence of the increased and continuing emissions of greenhouse gases, and the loss of vegetation cover and other carbon sinks [9]. It can also be defined as gradual changes in climate norms, notably temperature and changes in the frequency, extent and severity of climate and weather extremes, explained as a persistent change in the mean and variability of climate variables such as temperature, rainfall, humidity and soil moisture [17].

Perception: It is the process by which people receive information or stimuli from our environment and transform it into psychological awareness [18]. People infer about a

certain situation or phenomenon differently using the same or different sets of information. The knowledge, interest, culture and many other social processes shape the behavior of an actor who uses the information and tries to influence a particular situation or phenomenon [25]. Adaptation: Adaptation is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities [14]. In human systems, adaptation seeks to moderate or avoid harm or 6 exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects [14].

### 2.2. Climate Change in Ethiopia

Climate change is a key concern to Ethiopia and need to be tackled in a state of emergency. It has brought an escalating burden to already existing environmental concerns of the country including deforestation, serious soil erosion and loss of top soil and land degradation which in turn have adversely impacted agricultural productivity [7]. The economy of Ethiopia is mainly based on rain-fed agriculture which is the source of livelihood for the majority of its population [14]. Ethiopia exhibits different agro ecological zones attributed to varied microclimates. There are different ways of classifying the climatic systems of Ethiopia, including the traditional and the agro-climatic zone in classification systems [15].

Among the different ways of classifying the climatic systems of the country, the traditional and agro-ecological classifications are the most common ones [24]. Climate is the main determinant of Ethiopian economic growth. This due to the fact that Agriculture sector is continued to be the engine of the country's economic growth. Agriculture includes crop production, livestock husbandry, forestry, fishery and others. Out of 39% of Contribution of agriculture to the country's GDP, crop production is estimated to contribute to the agriculture sector on average about 70.2%, livestock sub-sector accounts around 20.3% and forestry and other subsectors around 9.5% of the total agricultural value in the country at the end of 2014/15 [19].

The problems cause by climate change on agriculture and for which MoA is responsible to take actions against are land degradation, biodiversity loss, animal diseases, crop diseases and pests, factors that reduce agricultural production, shortage of food and feed, intensified disasters and increased environmental refugees [7]. Climate is often described by the statistical interpretation of rainfall and temperature data recorded over a long period of time for a given region or location. The mean annual distribution in Ethiopia is characterized by large spatial variation which ranges from about 2000 mm over some pocket areas in the southwest to less than 250 mm over in Afar and Ogaden lowlands [21].

The heavy dependence of Ethiopia's economy on rain-fed agriculture exacerbated its vulnerability to climate change impact. In addition, its geographical location and topography in combination with low adaptive capacity entail a high vulnerability to the impacts of climate change. Historically, the country has been prone to extreme weather variability.

Rainfall is highly erratic, most rainfalls with high intensity, and there is a high degree of variability in both time and space. Since the early 1980s, the country has suffered 11 major drought years (Masih *et al.*, 2014).

Even in recent years, Ethiopian farmers and systems experienced one of the worst droughts in 50 years which was comparable to the 1983-5 drought in large part due to El Niño. In 2015, Ethiopia faced one of the most severe droughts in half a century due to the effects of El Niño. Significant rainfall deficits severely impacted the lives and livelihoods of farmers and herders throughout the country. Following two consecutive poor rainy seasons; belg and kiremt, harvests were well below average, with some areas experiencing between 50 and 90 percent crop loss. The livestock sector has seen extreme mortality and morbidity rates and abnormal migration in search of pasture and water. Many families dependent on agriculture have become indebted and dependent on humanitarian assistance. At the start of 2016, more than 10.2 million people were in need of emergency food aid, 1.7 million households were seed insecure and 2.4 million households in need of livestock support [9].

Rain failure, floods, drought and other changes in the country's natural and environmental system due to climate change threaten the performance of the economy as a whole and cause severe malnutrition and loss of livelihoods for households mainly in marginal and less productive lands in the country [20]. This effect is attributed to the fact that those changes can seriously depress agricultural production in the country. This clearly demonstrates that, economic growth in general and households' welfare in particular are significantly influenced by changes in rainfall and other climate variables [12]. This shows that the impact of climate change in the country can be felt not only on agricultural output but also on other sectors of the economy. Many studies have concluded that the agriculture sector of the country is the most affected sector by climate change.

The trends in the contribution of agriculture to the country's total GDP clearly explain the relationship between the performance of agriculture, climate and the total economy. Future climate change of Ethiopia predicted and put conclusion that temperature will increase for the coming ten years. However, there is contradicting results concerning the predicted level of rainfall [23]. There are constant, decreasing and increasing levels of projected rainfall levels which were generated using different models. According to [18], the frequency and severity of natural shocks in Ethiopia is increasing because of severe and repeated rainfall failures which strengthens the scenario that rainfall is decreasing time to time. The country will experience an increasing level of temperature and rainfall in the coming ten years. However, it stated that a small increase in rainfall can be expected. Studies also indicated that Ethiopia in the coming years will face a decrease in agricultural production due to the adverse impact of climate change and variability's (Tadele *et al.*, 2013).

## 2.3. Perception and Adaptation to Climate Change

### 2.3.1. Climate Change Perception

In developing countries, the relationship between agriculture and climate is highly complex than others, and smallholder farmers are able to identify specific pattern of weather. Smallholder farmers decide what to produce based on their experiences in the past years. Local knowledge forecasts provide more than just information about the forecast. They provide a set of behavioral rules that households and communities follow when certain indicators are or are not observed. Predicting climate is an important cultural component for farmers [19].

According to Maddison (2007), perceiving change and then deciding whether or not to adopt a particular climate change adaptation strategy. Whenever they have the opportunity, farmers tend to adopt new variety of measures or technologies in response to the perceived changes of weather conditions. The supports from development Agent's, information gained and technologies available to them will highly influence their adaptation and response capacity. For instance, farmers use drought resistances varieties of crop whenever the rainfall patterns are changed and amounts of rain are reduced. They tend to plant different crop varieties and use short term crops with adjustment of planting dates. These adjustments are done when they perceive reduction in rainfall and changes in the onset and offset of rainy seasons. For poor farmers, adaptation strategies to climate change are vital because failure to take adaptation measures could lead to social problems and displacement [13].

To approach the issues of climate change appropriately, the local communities or farmers understanding and level of awareness about climate change is determinant factor. Farmers perceive climate change as having a strong spiritual, emotional, and physical dimension [11]. The study by Benedicta *et al.* (2010) showed that farmers are well aware of climate change, but few seem to actively take steps toward adjusting their farming activities.

According to [24], majority of farmers were able to recognize that temperatures have increased and there has been a reduction in the volume of rainfall, still few farmers lack the perception of change in climatic condition of their area to take steps to adjust their farming activities. The degree of farmers perception on climate change also depends on its impact on farmers livelihood, their social, institutional and economic background. It is different and depends mainly on level of education, livelihood activity, location and age.

### 2.3.2. The Basics of Adaptation and Adaptation Strategies to Climate Change

There are many different strategies that the farmers can implement to reduce the risk of climate change impacts. Farmers use different adaptation strategies that fit with the types of the problems caused by climate change they faced. This is due to the fact that impact of the climate change is unevenly distributed over different geographic areas and hence the adaptation mechanisms also vary with types and level of the impact of climate change (IPCC, 2007).

A number of adaptation strategies that the farmers used to reduce the impact of climate change are mentioned in different literatures. This includes; changing crop variety, changing planting dates, mix crop and livestock production, decrease livestock, moving animals or temporary migration, change livestock feeds, soil and water management, planting trees, 10 change from livestock to crop production, change animal breeds, seek off-farm employment, planting short season crop, and irrigation or water harvesting are among some of the several strategies available to enhance social resilience in the face of climate change (Bradshaw *et al.*, 2004; Nhemachena and Hassan, 2007).

Studies carried out independently by [24], the World Bank (2010), and Mengistu (2011) also showed that using different crop varieties, changing planting dates, planting trees, adoption of drought tolerant and early maturing crop varieties, increased use of soil and water conservation techniques or soil erosion prevention programs, diversification, water harvesting techniques, increased use of irrigation and or use of irrigation techniques, changing fertilizer application, changing cropping densities, pesticide application, the pastoral system or the herd composition, applying different feed techniques, improvement or rehabilitation of terraces, home-garden agriculture are among the common adaptation strategies farmers carry out in response to climate change. Despite the wide range of adaptation options, there is no guarantee that a particular farmer will undertake adaptive action. The extent to which adaptation strategies are implemented varies among individual farmers depending on their capacity and willingness to adopt [17].

A study has been conducted by Nega *et al.* (2015) on perception of climate change and its impact by smallholders in pastoral/agro pastoral systems of Borana, South Ethiopia. The results suggested that most participants perceived climatic change and its negative impact on agriculture and considered climate change as a salient risk to their future livelihoods and economic development. Different levels of perception were expressed in terms of climate change and the impact on traditional rain-fed agriculture. Age, education level, livestock holding, access to climate information and extension services significantly affected perception levels.

Solomon *et al.* (2016) undertook a research on perception and adaptation models of climate change by the rural people of Lake Tana Sub-basin, Ethiopia by employing Heckman probit and MNL models. The farmers perceptions to climate change found to be statistically and significantly related to factors such as marital status, farm size, climate change information access and the level of income generations. [2] Examined farmers vulnerability, perception and adaptation to climate change in Kwara State using descriptive statistics and MNL model. The study revealed that majority (84%) of the farmers believed that temperature had increased while about 65.8% noticed that rainfall had declined.

Wondimagegn and Lemma (2016) conducted a study on climate change perception and choice of adaptation strategies base on empirical evidence from smallholder farmers in eastern Ethiopia. According to this study, majority of farmers in the study area are aware of climate change

patterns and their adverse effect on income, food security, diversity, forest 12 resources, food prices and crop and livestock diseases. Results showed that, from the sample households, more than 95% perceived the rise in average temperature and about 86% perceived the decrease in precipitation over the years. Abrham *et al.* (2017) also investigated smallholder farmers adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia using a descriptive statistics and MNL model. The result showed that 90% of farmers have already perceived climate change and 85% made attempted to adapt.

A research was conducted by [14] on climate variability and determinants of its Adaptation Strategies of Producer Farmers at Abeshege Woreda, Ethiopia using logit regression model to identify the determinants of farm-level adaptation strategies. The results confirmed that education level, access to credit, farm size and total family size are some of the important determinants of farm-level adaptation. [16] Identified the major climate change adaptation strategies used by farmers in the Southern and Central Tigray of Ethiopia, the factors that affected their choice of adaptation strategies and the barriers to adaptation by employing multivariate probit model. Based on their findings, access to information, farming experience, number of households in one village, distance to main market, income of household, and agro-ecological settings influenced farmers' adaptation choices to climate change.

A research conducted by [16] on farmer's perceptions and adaptation strategies to climate change, its determinants and impacts in Ethiopia which examined farmers to assess the causes, indicators and determinants of climate change based on smallholder farmers' perception, the extent of adaptation, barriers to adaptation, and the factors influencing adaptation and adaptation choices in Ethiopia by employing a multivariate probit model.

The research found that lack of information, poverty, low level of technology; shortage of input labor, poor soils, lack of adequate water and shortage of land for cultivation significantly affect farmers decision to adopt climate change adaptation strategies. A study has been conducted by Belay *et al.* (2017) on Smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia using Multinomial logit model to analyze adaptation to climate change. Perception to climate change found to be the prime determinant for adaptation. Farmers found to follow different coping mechanisms where some of them negatively affected the future development of the community and immediate recovery from climate change impacts. The result concluded that awareness creation on climate change, facilitation of credit availability, investment on non-farm engagement, improve good mix of livestock holding, encourage adult education, dissemination of indigenous early warning information, diversifying crops to perennial trees, and improved frequencies of agricultural extension contact enabled farmers well perceived climate change and then adapted to the changes. [22] undertook a research on

perception and adaptation models of climate change by the rural people of Lake Tana Sub-basin, Ethiopia by employing Heckman probit and MNL models. The MNL model results revealed that age, educational level, wealth status, agricultural extension services, and distance to the nearest health center are found to be significant for determining climate change adaptation. [26] Conducted a study on climate change perception and choice of adaptation strategies base on empirical evidence from smallholder farmers in east Ethiopia. The study found that the major adaptation strategies used by farmers in response to adverse effects of climate change include cultivating different crops, planting different crop varieties, changing planting dates, use of soil and water conservation techniques, conservation agriculture practices and engaging in non-farm income activities. The MVP model result revealed that the choice of adaptation strategies are influenced by gender of household head, household size, farm size, distance from market and number of farm plots. [1] Investigated smallholder farmers adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia using a descriptive statistics and MNL model. It is found that farmers made attempted to adapt using practices like crop diversification, planting date adjustment, soil and water conservation and management, increasing the intensity of input use, integrating crop with livestock, and tree planting. The econometric model result indicated that education, family size, gender, age, livestock ownership, farming experience, frequency of contact with extension agents, farm size, access to market, access to climate information and income were the key factors determining farmers choice of adaptation practice.

### 3. Conclusion and Recommendation

#### 3.1. Conclusion

Climate change adaptation strategies in Ethiopia vary from region to region in the country. The study conducted at different part of the country on climate change adaptation strategies and factors affecting the choice of climate change adaptation strategies were reviewed. From the review result climate change adaptation strategies used by farmers of the country were using different crop varieties, changing planting dates, planting trees, adoption of drought tolerant and early maturing crop varieties, increased use of soil and water conservation techniques or soil erosion prevention programs, diversification, water harvesting techniques, increased use of irrigation and or use of irrigation techniques, changing fertilizer application, changing cropping densities, pesticide application, the pastoral system or the herd composition, applying different feed techniques, improvement or rehabilitation of terraces, home-garden agriculture. Factors affecting the choice of climate change adaptation strategies from the result of the reviewed journals include education level of the households, family size, gender, age, livestock ownership, farming experience, frequency of contact with

extension agents, farm size, access to market, and access to climate information and income of the farmers.

#### 3.2. Recommendation

This review paper indicated that, there are several climate change adaptation strategies in different parts of Ethiopia, especially those who live in drought prone areas and others too. But there are also several factors which hinder the choice of climate change adaptation strategies which reduce agricultural productivity of the farmers and the economy of the nation as a whole. Therefore, the following important points should be taken under consideration by the responsible bodies of the country at each level.

1. Awareness creation on climate change adaptation strategies should be provided.
2. Drought tolerant crop varieties should be distributed for all farmers of the country.
3. Information facilities like telephone, radio, Television should be reached the farmers.
4. Small scale irrigation should be expanded in the whole part of the country.
5. Different infrastructures such as road access, electricity, water, etc should be facilitated for all actors.

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