International Journal of Advanced Multidisciplinary Research
ISSN: 2393-8870
www.ijarm.com
(A Peer Reviewed, Referred, Indexed and Open Access Journal)
DOI: 10.22192/ijamr Volume 12, Issue 4 -2025

Review Article

DOI: http://dx.doi.org/10.22192/ijamr.2025.12.04.004

Impact of climate change on food security and its adaptation and mitigation mechanisms in Ethiopia-A Review

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Keywords

Adaptation, Climate change, Food security and Mitigation

Abstract

In developing countries including Sub-Saharan Africaagricultural productivity will decrease from 9-21% in 2080 due to climate change. Ethiopia is one of developing country whose food security is highly affected by climate change, this is due to 80% population of the country live in rural areas and their livelihood depends on rain-fed agriculture. Food security situation in the country is linked to recurring food shortage and famine which is resulted from climate change and drought. Climate change negatively affects food security by increasing temperature or global warming, reduce precipitation, shortening crop growth duration, make conducive environments for pest, diseases and insects. In Ethiopia food security is highly affected due to three main reasons these are; about 80% of Ethiopian population highly dependent on rain-fed agriculture, Low income country, varied geographical locations with different magnitude of climate impacts. There was some adaptation and mitigation mechanisms practiced in the country to cope up with food security problems resulted from climate change. However, there were climate change adaptation and mitigation practices in the country it is not sufficient condition to ensure food security of households who faced a problem of food security. Therefore to make improvements to food security in the country the collaboration of households, research institutions, Ethiopian Government, NGOs and policy makers is needed, and they should have play their own role regarding climate change issues and a problem related with changing climate specifically, food security.

1. Introduction

Farmers in underdeveloped countries rely heavily on rain-fed agriculture, hence climate is a key resource for crop and livestock production (Birara *et al*., 2015; Coulibaly, 2015).But its change affects all dimensions of food security (i.e., food availability, food accessibility, food utilization, and food systems stability) (Adugna *et al*., 2016).According to the Intergovernmental Panel on Climate Change (IPCC) Assessment Report (IPCC, 2007), climate change will reduce agricultural productivity in developing countries, including Sub Saharan Africa, by 9-21 percent by 2080, and in some Sub Saharan African countries, the effect will be felt much sooner, even by 2020.Temperature rises and precipitation variability, according to the analysis, are anticipated to limit steady food supply by up to 50%. (Nelson,2009)

Higher temperatures and shifting precipitation levels as a result of climate change are reducing crop yields in poor countries, according to a growing body of scientific evidence (Alemu & Mengistu, 2019).According to the Intergovernmental Panel on Climate Change (IPCC, 2014a), with temperature increases of 1.5-2.5°C, around 20% -30% of plant and animal species will be threatened with extinction (IPCC, 2014a,2014b), posing a serious threat to food security in developing nations (Mekuriaw *et al*., 2014).

Ethiopia is one of the world's most food-insecure and famine-prone nations. Chronic and transient food insecurity has afflicted a huge section of the country's population (African Development Bank, 2014).People who are food insecure on a long-term basis are facing an increasingly serious situation. Ethiopia's food security problem is closely related to the country's chronic food shortages and famine, both of which are tied to the country's ongoing drought. According to (Rowhani, P. *et al*., 2011), more than 41% of Ethiopia's population lives in poverty, with over 31 million people suffering from malnutrition. Using a daily calorie threshold of 2,550 kcal per adult equivalent, 40 percent of Ethiopian households, the majority of whom live in rural areas, were food insecure and undernourished (WFP and CSA, 2014).

In Ethiopia, Africa's second most populous country after Nigeria, food insecurity is a persistent and serious problem. Over 80% of Ethiopia's population lives in rural areas and relies primarily on rain-fed agriculture, making them particularly vulnerable to weather variations (Andersson, C. *et al*., 2011).The current El Niño drought conditions led to a sharp deterioration in food security; the estimated number of food insecure people was 4.5 million due to this vulnerable shock in August, 2015 (Gutu*et al*., 2012) and by the end of the same year this figure had more than doubled. According to a Government-led multi agency assessment, 10.2 million Ethiopians are considered to be food insecure in 2015/16.

Ethiopia is particularly vulnerable to weather-related shocks because 80 percent of its people relies on rain-fed agriculture. Precipitation differs by region and is unpredictable (World Bank and United Nations, 2010). Although the Intergovernmental Panel on Climate Change (IPCC) predicts only a modest change in Ethiopia's rainfall patterns in future (Christensen, J.H. *et al.,* 2007)and (Regassa *et al*., 2010)findings argue that this can still adversely affect very poor small farmers especially if such decreases are concentrated in the growing season.

According to Irenso *et al.* (2020), the 2015 El Nio drought was one of the worst in Ethiopian history, with more than 27 million people becoming food insecure and a total population of 18.1 million requiring food aid in 2016.Furthermore, evidence exists that the climate is already changing, resulting in severe drought. In Ethiopia, the drought pattern has ten years, but the cycle period is getting shorter and shorter, resulting in major food security issues every three years. Households with insufficient food access frequently face other issues related to food insecurity, such as poor health and decreased productivity. These difficulties can often lead to anevil cycle in which households are unable to produce enough food,

even in good years, due to chronic health problems that prevent them from working to their full ability. Given limited resources and expanding populations in many developing countries, the seriousness of food insecurity and its numerous effects has prompted much of the development agenda to look for particular areas for assistance (IFPRI, 2009).

Ethiopia's government announced the 2015 Humanitarian Requirement Document on March 5, 2015. (HRD).Following a multi-sectoral ground assessment done at the end of 2014, the publication identifies humanitarian food and non-food requirements for vulnerable groups in the country (UNICEF, 2015). According to HRD, 2.9 million people seek emergency food assistance in 2015, up from 2.7 million during the same period in 2014.All of the foregoing facts suggest that Ethiopia's food security status has long been a source of concern for the government, donors, and other foreign organizations.

Regardless of the uncertainties around climate consequences, it is evident that the magnitude and rate of expected changes will necessitate adaptation. Climate change's increased consequences force agriculturally dependent communities to employ a variety of adaptation and coping measures (Akinnagbe and Irohibe, 2014).This primarily refers to indigenous knowledge and skills acquired outside of formal schooling in rural areas over a lengthy period of time (Mongi*et al*., 2010).Investments in technology innovation and agricultural intensification connected to higher input efficiency, as well as the implementation of incentives and monitoring mechanisms that include smallholder farmers, will be required to maximize agriculture's mitigation potential. Various review papers, articles, and published journals were examined in this seminar with the following objectives in mind.

1.1 Objectives

1.1.1 General objective

✓ To review the impact of climate change on food security and its adaptation and mitigation mechanisms in Ethiopia.

1.1.2 Specific objectives

✓ To enhance further understanding on impacts of climate change on food security in Ethiopia.

✓ To assess adaptation and mitigation options practiced to cope up the impact of climate change on food security in Ethiopia.

2. Literature Review

2.1 Definition of basic terms

2.1.1 Food security

Food security is defined in different ways by different organizations, scholars and researchers.(FAO, 2019)Define food security broadly as achieving food security " at the individual, household, national, regional and global levels when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life".

2.1.2 Food availability

Defined as "The amount of food that is present in a country or area through all forms of domestic production, imports, food stocks and food aid" (WFP, 2009).

2.1.3 Food access

Household food access is the ability to obtain sufficient food of guaranteed quality and quantity to meet nutritional requirements of all household members. Here the food should be at right place at the right time and people should have economic freedom or purchasing power to buy adequate and nutritious food (Jrad*etal*., 2012). On the other hand, Kuwornu*et al*. (2011) explained that food access is determined by physical and financial resources as well as by social and political factors.

2.1.4 Food utilization

The World Food Summit's definition of utilization (the third element of food security) is "safe and nutritious food which meets their dietary needs". The availability of and access to food on their own are not enough, people have to be assured of "safe and nutritious food". The food consumed has to provide sufficient energy to enable the consumer to carry out routine physical activities. Utilization also covers factors such as safe drinking water and adequate sanitary facilities to avoid the spread of disease as well as awareness of food preparation and storage procedures. According to Jrad*et al*. (2010) food utilization refers to proper biological use of food requiring a diet that contains sufficient energy and essential nutrients as well as knowledge of food storage, processing, basic nutrition, and childcare and illness management.

2.1.5 Food stability

Refers to continuous supply of adequate food all year round without shortages (Jrad*et al*., 2010). To be food secure a population, household, or individual must have access to adequate food at all times. They should not be at risk of losing access to food as a consequence of a shock. The concept of stability can therefore refer to both the availability and access dimensions of food security. To say there is food security in a given country, region or community all the above elements of food security (access, availability, stability and utilization) should be fulfilled. If one or more elements of food security missed it is impossible to say there is food security in a given group of community.

2.2 Food security in Ethiopia

Ethiopia is the second most populous country in Africa with an estimated population of 94.3 million people in 2013 (CSA, 2013).As indicated by Africa Food Security and Hunger/ Undernourishment Multiple Indicator Scorecard, Ethiopia ranked as first in having the highest number of people in state of undernourishment/ hunger which is 32.1 million people. In Africa the country scoring (37.1%) of the population being undernourished/ in hunger (African Development Bank, 2014). The livelihoods of rural Ethiopian people are highly sensitive to climate. Food insecurity patterns are seasonal and linked to rainfall patterns, with hunger trends declining significantly after the rainy seasons. Climate related shocks affect productivity, hamper economic progress and exacerbate existing social and economic problems (Anderson, S.*et al*., 2015).

Food insecurity situation in Ethiopia is highly linked up to severe, recurring food shortage and famine, which are associated to recurrent drought. Currently there is a growing consensus that food insecurity and poverty problems are closely related in the Ethiopian context. Droughts and other related disasters (such as crop failure, water shortage, and livestock disease, land degradation, limited household assets, low income) are significant triggers, more important factors which increase vulnerability to food security and undermined livelihoods (MoARD, 2009).

2.3 Impact of climate change on food security

2.3.1 Impact of climate change on food accessibility

Access to food refers to the ability of individuals, communities and countries to purchase food in sufficient quantities and quality (Ludi, E., 2009). Households in Sub-Saharan Africa are unable to obtain food for a several of reasons, including high food prices, market access, poverty, employment status, educational status, and property rights (Chijioke, O.B. *et al*., 2011). This will affect Sub Saharan Africa population that relies primarily upon subsistence agriculture, markets has long been important as a secondary source of food. In general, in Sub-Saharan African countries there has often been a seasonal food shortage from June to August, when crop yields do not meet of population, and food must largely be bought from markets (Brown, M.E. *et al*., 2009). Over the last 30 years, falling real food

prices and growing real incomes have resulted in significant gains in food access in many developing nations. Climate change-related rises in food prices and lower rates of income growth could reverse this trend (Ludi, E., 2009).

2.3.2 Impact of climate change on food availability

Food availability refers to the existence of sufficient quantities of suitable food, whether produced domestically or imported. Food availability is likely the most often used indicator of food security, and it has a link to climate change, which has a direct impact on food security (Thompson, H.E. *et al*., 2010). The major direct impact of climate change is expected to have on food security is through food availability component due to effects in agricultural productivity (Wlokas, H.L. *et al*., 2008).Many components of climate change, such as temperature rises, changes in rainfall amounts and patterns, rising CO2 levels in the atmosphere, climatic variability and extreme events, and sea level rise, have a direct impact on food supply in Sub-Saharan Africa (Chijioke, O.B. *et al*., 2011).Based on evidence from Sub-Saharan Africa, there appears to be a disagreement about the consequences of climate change on food security (Badolo, F. *et al*., 2012).

According to a 2020 assessment of the impact of climate change on food production, about two-thirds of Africa's arable land is expected to be lost by 2025 due to decreased rainfall and lower yields, with estimates of up to 50% in some Sub-Saharan countries including Ethiopia where rain-fed agriculture accounts for 96 percent of the cultivated land (FAO, 2007).Climate change has the greatest impact on food production in tropical regions between 30° North and 60° South of the equator,where less water is available and temperatures are rising, and in temperate zones between 300° North and 600° South, where precipitation is changing (Endalew, B. *et al*., 2015). The International Food Policy Research Institute (IFPRI) tries to compare calorie availability in 2050 with and without climate change and predicted it will decline resulting in an additional 24 million undernourished children (0-5 years), 21% more relative to a world with no climate change, almost half of which would be living in sub-Saharan African countries (FAO and WFP, 2010). The following table shows Sectoral impact of climate change in Ethiopia.

Table 1: Sectoral impacts of climate change in Ethiopia

Sector	Potential impacts
Agriculture	Shortening of maturity period, crop failure and expanding crop diseases
Livestock	Change in livestock feed availability and quality Effect on animal health, growth and reproduction Impact on forage crops quality and quantity
Forests	Expansion of tropical dry forests, desertification loss of indigenous species/expansion of toxic weeds
Water resources	Decrease in river run-off and energy production Flood and drought impacts
Health	Expansion of malaria to highland areas Threat from expanding endemic diseases and newly emerging varieties of human, plant and livestock diseases
Wildlife	Shift in species distribution Out migration, of endemic and threatened species
Environment	Reduced productive capacity from degradation of forests, range and water recourses

Adapted from Mengistu and Mekuriaw (2014)

2.3.3 Impact of climate change on food utilization

Food utilization refers to the individual or household capacity to consume and benefit from the food (Ruane, J. and Sonnino, A.*et al.,* 2011)although food availability and access are necessary conditions for food utilization, they are not sufficient conditions to reduce malnutrition. A household with both physical and financial access to food may be food insecure if it is unable to obtain a balanced and healthy diet (Negin, J. *et al*., 2009). The most significant component of food security in a changing climate, but least studied, is food utilization. Even if availability and accessibility are not harmed, if food sources are unable to contribute to a balanced, nutritious diet, the consequences for population health and productivity could be severe (Pinstrup-Andersen, P., 2009).The utilization component of food security is generally related to nutritional aspects of food consumption. Climate change could directly affect micronutrient consumption of developing countries like Ethiopia in three ways: by changing the yields of significant micronutrient crop sources, by affecting the nutritional content of a specific crop, or by influencing decisions to produce crops of differing nutritional value (Badolo, F. *et al*., 2012).

Climate change affects food consumption capacity through many pathways, according to a World Bank poverty net report (Hallegatte, S., 2016). Climate change has an impact on the rate and pattern of food production, which might have an impact on the population's nutritional needs.Climate change may have an impact on a family's ability to acquire a diverse range of foods in order to maintain a healthy diet (Hallegatte, S., 2016). According to a study conducted in Sub-Saharan Africa, food prices have risen by about 50% between June 2010 and February 2011.As a result, one of the main causes of the recent high and unpredictable food costs is climate change (severe weather occurrences).

According to recent estimates from the United Nations' Food and Agriculture Organization (FAO), one in every four Africans does not have enough food to live an active and healthy life (Bremner, 2012; and FAO, 2015).Because of their geographical location and climatic conditions, high dependence on agriculture, natural resource-driven activities, and weak adaptive capacity to climate change, developing countries, particularly those in Sub-Saharan Africa, are more vulnerable to the effects of climate change (Akinnagbe and Irohibe, 2014).

According to Mohamed (2017), cited in (Endalew*et al*., 2015), immediate causes of food insecurity in Ethiopia include recurrent droughts and erratic rainfall patterns which are resulted from climate change), ecosystem degradation, rapid population growth, low levels of technology employed in agriculture and the sector's resulting low productivity, poor rural infrastructure, and existing policy constraints. In many parts of the country, a combination of natural and man-made factors has resulted in a serious and growing food insecurity problem.Ethiopia's economy is dominated by the subsistence agriculture sector, which accounts for around 42 percent of the country's gross domestic product and plays a key role in the country's economic development (CSA, 2018).

Climate change has a significant impact on the Ethiopia for three key reasons: (i) about 80% of the population is largely depend on rain fed agriculture (ii) low income country (iii) varied geographical locations with different magnitude of climate impacts. Climate change induced El-Nino increase the average temperature and affect rainfall pattern in time and space leading to a recurrent drought which results in food insecurity particularly in dry and semi dry areas of the country. Since the 1980s, the country has undergone 16 major national droughts, as well as dozens of local droughts. As a result of the drought caused by climate change-induced EL-Nino, 10 million people were food insecure in 2015/15, and 5 million people are food insecure in 2017.

Climate change is already occurring in Ethiopia, therefore historical and current changes can help to predict future changes. Ethiopia's temperature has risen at a rate of roughly 0.2–0.37 °C every decade over the last few decades. Minimum temperatures are rising at a faster rate of about 0.4°C every decade.Many distinct environmental systems are threatened with even relatively low levels of warming of 1-2 °C, and food productivity, human health, and water resources could be significantly impacted in some locations. ‘‘Worst-case" forecasts (5th percentile) show maize, sorghum, millet, and groundnut losses of 27-32 percent by mid-century, assuming a warming ofaround 2 ºC, over pre-industrial levels (Schlenker and Lobell, 2010). According to the IPCC, large-scale warming of 4°C or more will raise the possibility of severe, pervasive, and permanent consequences to which adaptation will be challenging.

2.3.4 Impact of climate change on food stability

Climate change will increase the frequency and severity of climate-related catastrophes such as floods and droughts. These pose serious concerns to food stability, particularly for households with limited food consumption capacity (Reilly and Willenbockel, 2010); Parker, L. *et al*. (2019). It also adds to the loss of farmland and grazing pastures, as well as the worsening of water scarcity, all of which have a detrimental impact on livelihood, household income, food shortages, malnutrition, and disease (Jibrillah, A.M. *et al*., 2018).If this situation continues, further extreme climate-related events would exacerbate local and global food price volatility, threatening the overall stability of food systems (Wheeler & von Braun, 2013).

2.4 Adaptation and Mitigation practices

2.4.1 Adaptation Mechanism to impact of climate change on food security in Ethiopia

Various researchers define coping strategies in different settings. The most commonly accepted definition is that a coping strategy is a technique through which members of a household or community meet their relief and recovery requirements and adjust to future disaster-related risks and shocks without relying on outside assistance (Sewnet, 2015).Many research findings in Ethiopia show that when individuals or families are faced with extreme hunger and starvation for a long length of time, they may adopt negative food insecurity coping methods such as limiting food frequency and going without food for two to three days.There was also need to use improved seed which is more drought and pest resistant, and for seeds which mature faster as the rains have become more unpredictable and shorter in some place.

Pastoral and agro-pastoral areas of the country are more vulnerable to drought, weather-related shocks, livestock and human diseases than other parts of the country; as a result, they move from one place to another, especially during dry seasons, in order to find water and pasture for their livestock, which causes them to clash with other border communities at the same time.Ahmed (2015) conducted research on agro-pastoralists in the Babile district of Somali regional state and discovered that they use alternative coping mechanisms such as moving from one location to another during the dry season, selling more livestock than usual, borrowing food, reducing the number of meals, reducing the size of meals, selling firewood and charcoal, seasonal migration, and seeking alternative sources of income.

Coping mechanisms used by rural farm households in Ethiopia includes livestock sales, agricultural employment, certain types of off-farm employment and migration to other areas, requesting grain loans, small scale trading, selling cow dung and crop residues, reduction of food consumption, consumption of meat from their livestock, consumption of wild plants, reliance on relief assistance, relying on remittances from relatives, selling of clothes, and dismantling of parts of their houses for sale (Lewis, 2017). Some of the coping strategies are likely to be implemented only after the possibilities of certain other options have been pursued.

2.4.2 Mitigation mechanism of climate change impact on food security in Ethiopia

Ethiopia's contribution to world anthropogenic GHG emissions is negligible (approximately 0.3 percent of total) (USAID, 2015). According to Ethiopia's GHG profile, agriculture contributes the most (61 percent), followed by land use change (18 percent), energy (17 percent), waste (3 percent), and industrial processes and product use (1 percent) (USAID, 2015). (Fig. 1).Ethiopia wants to reduce its GHG emissions by 64% (225 MtCO2e) in 2030from expected business-as-usual levels under its climate resilient green economy (CRGE). Forestry contributes 130 MtCO2e, agriculture contributes 90 MtCO2e, while industry, transportation, and buildings provide 20, 10, and 5 MtCO2e, respectively in reduction of GHG emission (USAID, 2015). Ethiopia has the ability to reduce carbon emissions by 2.76 billion tons by protecting and managing its forest resources (Moges*et al*., 2010).

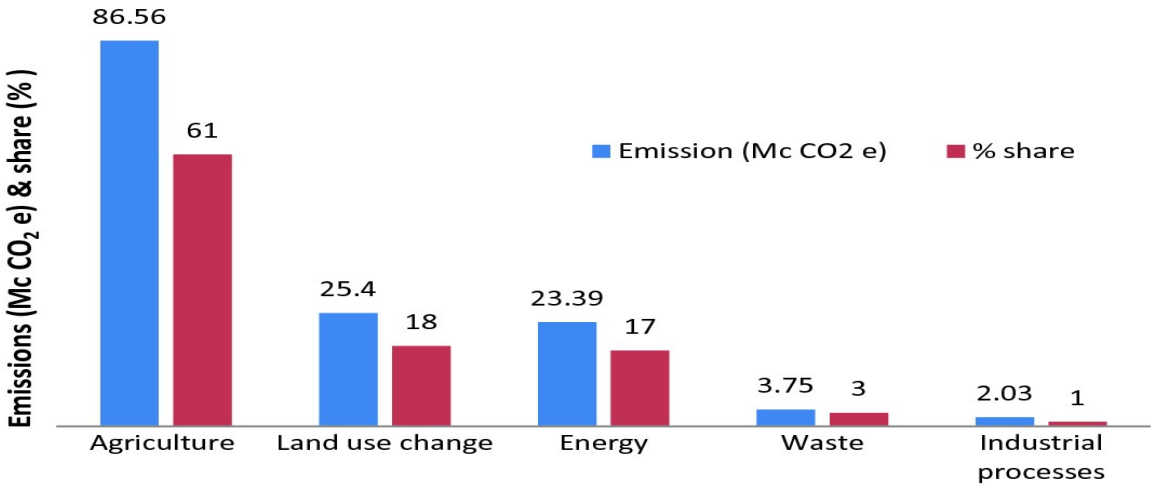

Figure 1: Greenhouse gas emission in Ethiopia by sector Adapted from (USAID, 2015).

Many developing countries, including Ethiopia, appear to have already started implementing Climate Resilient Green Economy initiatives (CRGE). The goal of a climate-resilient green economy is to achieve low-carbon development (LCD). Ethiopia can serve as an example in this regard, having attempted to develop a new national strategic framework for a smooth transition to a climate resilient green economy by 2030. Ethiopia's long-term goal is to develop a climate-resilient green economy.The mission statement created to aid the development of Ethiopia's CRGE strategy lays out a five-step plan for achieving a climate-resilient, low-carbon economy.Ethiopia's climate change institutions, monitoring and funding mechanisms, and sectorial and regional action plans all need to be improved, according to the roadmap. When all of the pieces come together, the EPACC should be able to draft a CRGE Strategy that lays out a clear path to achieving the goal of a climate-resilient green economy by 2030. (Adem and Bewket, 2011). Building resilience entails lowering the likelihood of being food insecure while also boosting the adaptive capacity to deal with threats and adjust to climate change (Gitz and Meybeck,2012).

Climate smart agriculture (CSA) was another mitigating strategy used in Ethiopia Climate-smart agriculture (CSA) is a strategy for guiding measures to restructure and realign the agricultural sector to successfully support development and secure food security in the face of climate change. CSA attempts to achieve three major goals: (1) increasing agricultural output and economic sustainability, (2) adapting to climate change and creating resilience, and (3) reducing and/or eliminating greenhouse gas emissions, where possible (IPCC, 2013). CSA methods that encourage the efficient use of land, water, soil, and other natural resources.

In general, Ethiopian communities have significant indigenous knowledge, skills, and technologies that are critical for dealing with dangerous environmental situations, including as climatic variability and change. To cope with and overcome the impacts of climatic variability and change, they use a variety of short- and long-term climate change mitigation and adaptation techniques (Zegeye, H., 2018) (Table 2).

As a result, using indigenous knowledge and local coping techniques as a starting point for planning climate change mitigation and adaptation should be promoted (Chidumayo*et al*., 2011; Zegeye, 2012). However, a variety of factors/barriers limit communities' ability to adapt to the effects of climatic fluctuation and change (Table 3).

Thus, biophysical, human, financial, technical, technological, institutional, infrastructural, informational, and political obstacles to climate change adaptation exist. As a result, communities must be assisted in strengthening their resilience to current and future climate stresses by utilizing indigenous knowledge and local coping/adaptation strategies, as well as the adoption of appropriate technologies that are in line with government plans and research directions (Asfaw, 2010).It is recommended that exposure and sensitivity be reduced, as well as adaptable ability and adaptation processes be strengthened by building on existing adaption methods (Alemayehu and Bewket, 2016).

Table 2 : The most notable traditional climate change mitigation and adaptation strategies in Ethiopia

Traditional climate change mitigation and adaptation strategies
Soil and water conservation (terracing, crop rotation, intercropping, mulching, crop residue retention, use of animal dung, composting, use of synthetic fertilizers, etc.)
Tree planting (home gardening, traditional agroforestry)
Crop diversification (growing different crops and varieties)
Livestock diversification and use of cross-breeds
Small-scale irrigation (by households and community groups)
Changing crop sowing dates
Grain storage and reduction of postharvest loss
Collection of wild foods (edible fruits and vegetables, fish)
Traditional water harvesting and storage (use of water wells, rainwater harvesting)
Rangeland management
Management of wildfires
Indigenous forecasting and early warning systems
Growing fruit plants (e.g. apple in the highlands)
Sale of grains and livestock and their by-products
Livelihood diversification and adjustment (off-farm income, seasonal migration, change in consumption pattern, taking credit, borrowing grain and/or money from relatives, land renting and remittance, seeking food aids during periods of droughts and crop failures)

Mobility, that is, livestock and/or people (pastoral and agro pastoral communities)
Involvement of traditional institutions (Edir, Equb, religious institutions) and social networks
Looking for assistance from the government and international agencies (e.g. food aid)

Adapted from (Zegeye, H., 2018)

Table 3: Factors/barriers limiting the ability of communities to adapt to the impacts of climate in Ethiopia

Limiting factors
• Human population growth (large family size)
• Inappropriate land use and forest policies, strategies and programs
• Low institutional capacity of local bodies
• Marginalization of local communities in decision-making concerning their natural resources conservation and utilization
• Deforestation, overgrazing, soil erosion and decline in soil fertility
• Limited access to land (the average landholding size per household is generally less than 1 ha)
• Poor access to planting materials (improved crop seeds, tree seeds and seedlings)
• Lack of data and information on climate change and its impacts
• Outbreak of (crop, livestock, human) pests and diseases
• Limited access to extension services
• Limited water supply
• Limited access to health services
• Limited access to education and training
• Limited infrastructure (schools, roads, electricity, telephone, potable water reservoirs, irrigation dams)
• Limited access to new skills and technologies
• Conflicts over scarce resources (grazing lands, water points)
• Poor access to markets and financial resources and services (funding, credits)
• Inappropriate development interventions (e.g. villagization/resettlement)
• Disruption of traditional social networks and transformation to new social relationships

Adapted from (Zegeye, H., 2018)

3. Conclusion and Recommendation

3.1 Conclusion

Climate is an important resource both for livestock and agricultural production if it is at optimum level which makes favorable condition for the livestock and crop production, but due to climate change which is happening rapidly now a days the issue of food security fall under question. The result of almost all papers reviewed shows that the net effect of climate change has negative impacts on food security in Sub-Saharan Africa especially in developing countries, this is because of the livelihood of developing countries mostly agriculture dependent. Ethiopia is one of developing country whose food security is highly affected by changing climate. Climate change negatively affects all elements of food security (availability, accessibility, utilization and stability). Climate change negatively affect food security by increasing temperature or global warming, decreasing precipitation, shortening growth period of crop production and create

conducive environment for pests, diseases and insects which causes decline in agricultural production.

Food security in Ethiopia is highly affected by climate change due to three main reasons, these reasons include; About 80% of Ethiopian population highly dependent on rain-fed agriculture, Low income country, Varied geographical locations with different magnitude of climate impacts. To minimize the adverse effect of climate change on food security there was some adaptation and mitigation mechanisms undertaken in the country. Those households who faced a problem of food security used different coping mechanisms like reducing food consumption, reduce number of meal, sale livestock, migrate from place to place in drought season for search of water and pasture for their livestock. These households also sale small ruminants, rely on off-farm activities, engage on labor wage as coping mechanism, use improved seed which resist drought, pest and diseasesand also mature in short period. There was also some mitigation mechanisms used in Ethiopia to minimize the effect of climate change on food security. Climate smart agriculture (CSA) and climate resilient green economy (CRGE) were the two climate mitigation mechanisms practiced in Ethiopia.

3.2 Recommendation

Although, there was some adaptation and mitigation practices undertaken in in Ethiopia to cope up with the impact of climate change on food security it is not sufficient to improve the food security of households in sustainable way. So that to make improvements on food security the following measures should be undertaken by households, Ethiopian Governments, NGOs, policy makers and Research institutions. Research institutions should find the gap and put clear solution for the problems related with climate change. Governments, policy makers and NGOs should support in solving the problems identified by different scholars and researchers specifically issues related with natural resources management, conservation and utilization. Since climate smart agriculture is at its beginning it is expected to be supported by government and policy makers to create awareness for the farmers to apply this new technology to improve food security in Ethiopia. Households should use technologies that has been identified and recommended by researchers, experts and other development agents. In another ways households should diversify their livelihood and participate on different income generating activities rather depending only on agricultural activities.

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Quick Response Code	Subject: Environmental Science
DOI:10.22192/ijamr.2025.12.04.004	

How to cite this article:
Dubiso Gacheno. (2025). Impact of climate change on food security and its adaptation and mitigation mechanisms in Ethiopia-A Review. Int. J. Adv. Multidiscip. Res. 12(4): 29-43.
DOI: http://dx.doi.org/10.22192/ijamr.2025.12.04.004