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*Review paper*

# Review on Trial of women households on Climate Change Adaptation Strategies and It's Impacts on Rural Women Food Security in Ethiopia

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**Climate change and variability leadto the great change in agricultural production of smallholder farmers indeveloping countries. In Ethiopia, almost all farmers are depending on rainfall for their livelihood including women farmers. Even if farmers relied on rainfall, climate change, especially drought highly affects the production and productivity of farmers in the overall country. The main objective of this review is to review climate change adaptation strategies and its impacts on rural women's food security in Ethiopia. For this review, secondary data was collected from published and unpublished documents related to this topic and structured. From the reviewed published and unpublished documents, this review is intended to review smallholder farmers' adaptation strategies to climate change and determinants of women farmers to select adaptation strategies in Ethiopia. This review revealed that crop diversification, mixed farming (crop production and livestock rearing), off farm activities, enset production, soil and water conservation, use of improved seeds, irrigation, and permanent and temporary migrations are the adaptation strategies to climate change practiced by women households in Ethiopia. On the other hand, major determinates of climate change adaptation strategies by women households are, women's education level, sex, age, livestock ownership, family size, farming experience, frequency of extension service, access to market, large farm size, the income of the farmers and access to climate information. Further, climate change adaptation strategies have a positive impact on women's household food security. Therefore the government has to focus on the determinants of adaptation strategies identified above and empowering women households to swift their contribution.**

**Key Words:**Climate change, Adaptation strategies, Ethiopia

## INTRODUCTION

### Background

Climate change is a worldwide concern since it is one of the most serious and widespread threats affecting all regions of the world.IPCC (2007) reported that, increase in average air and ocean temperatures, extensive melting of snow and ice and average sea level is rising and the global average temperature has risen by 0.74°C and the global sea level has risen by 17cm during the 20th century because of melting of snow and ice from the mountains and Polar Regions. The main factors of this global warning was due to anthropogenic emission of greenhouse gases like carbon dioxide, methane, chlorofluorocarbon and nitrous oxide. Electric power station due to burning of fossil fuels, numerous factories spread all over the world, the transport sector and deforestation are the major sources of greenhouse gases(Singh, 2008). Developing countries like Ethiopia is also suspended to increasing temperature. The UNDP climate change country profiles, reported that the average annual temperature of Ethiopia increased by 1.3°C between 1960 and 2006 (McSweeney*et al*., 2010). These trends have thrown a big worsen over developing African countries which have relied on rain-fed agriculture.

Agriculture is the backbone of the economy for most African countries. It is the largest domestic producer sector across the continent and employs about 70% to 90% of the total labor force. Moreover, the agriculture sector supplies up to 50% of household food demand and up to 50% of their income. Besides, most of the income is generated by livestock rearing such as dairy cattle, beef cattle, sheep, goat and chickens with

addition to crop production. But Agricultural production is highly susceptible to climate variability extremes and hence, is the major treat to livelihoods and food insecurity vulnerable parts of the world (Sejian*et al*., 2015).

Climate variability and extreme weather events such as droughts, floods, and storms have an impact on agriculture (crop and livestock production), and from a broader perspective on-farm productivity and results in the risk of food shortage in African countries. For instances, due to increased variability of rainfall and changes in local temperatures, maize yields in Africa have been estimated to may decrease by between 22% and 35% by 2030 and similar predictions have been made for other crops (Bailey, 2011).This variability also has a direct impact on the growth of palatable grass species and the regeneration of fodder species in pasture, and forest fodder is decreasing because of less rainfall that led to a decrease in livestock population which has further affected the production of milk, milk products, and meat. The drought also affected livestock by drying wetlands, pastureland, water resources, streams and decreasing availability of drinking water for livestock and this led to an outbreak of newborn diseases and scarcity of fodder led to change in livestock pattern (Shambel, 2017).

Moreover, changes in frequency and severity of extreme climate events have significant consequences for food production and food security (IPCC, 2007; Ellis, 2010). In the future, at about 1.3 billion poor people, at least 90% of them are located in Asia and sub-Saharan Africa, and climate change will have major impacts on more than 600 million livestock dependent farmers (Thornton *et al*., 2007). According to World Bank (2006)report, one third of Ethiopia's economic growth has been reduced due to extreme climate events such as drought and floods. The impacts are far-reaching on the productivity of rain-fed crops and livestock that causes food insecurity in rural areas of Ethiopia (Deressa, 2006; WFP, 2019).

These impacts was highly noted for adaptation strategies that is seen as critical to a great extent to reduce the ultimate effect of climate change on agriculture so as to improve livelihoods and food security of rural households in countries (Vermeulen*et al*., 2012). As defined by FAO (2011) and IPCC (2011), "Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities". There was many potential adaptation options such as SWC have been suggested (Amare and Simane 2017; McCarthy *et al*., 2011)for developing countries like Ethiopia, response to serious problem possessed by climate change.

However, the studies in climate change adaptation options revealed that adoption of those adaptation options was significantly influenced by gender, and due to cultural and social barriers limit women's access to land and climate change information female households was less in taking adaptation options since male households had better opportunities (Deressa*et al*., 2014; Amare and Simane, 2018). Nevertheless, these studies have not indicated the possible gender differentiated adaptation options. Ngigi*et al.* (2017) argued that the adaptation option like SWC is a labor-intensive strategy that may require the use of draft animals which are largely under the control of men. This indicates the needs for women specified data in which alternative adaptation strategies that are more suitable for rural women have identified.

**Statement of the problem**

Ethiopia which is reliant on agriculture is extremely vulnerable to frequent drought and rainfall variability. These shocks are a major cause of transient poverty and households had been unable to secure their food (Abiro*et al*., 2018). Because, climate change is imposing an impact on the food security of millions of people in Ethiopia even though the country is home to Africa's largest crop production and livestock population, and it is the continent's top livestock producer and exporter. Recently, the country has about 57.83 million cattle, 28.89 million sheep, 29.70 million goats, 2.08 million horses, 7 .88 million donkeys, 60.51 million poultry, 5.92 million beehive, 0.41 million mules and about 1.23 million camels (CSA, 2016b). They are an important component of nearly all farming systems in Ethiopia and provide, milk, meat, manure, hides, skins and other products (Funk *et al.,* 2012). About 12,486,270.87 million hectares of land cultivated by grain crops (cereals, pulses and oil seeds) annually in the country (CSA, 2016a).However, the consequence of the climatic variability has increased the frequency of droughts and floods which reduces the production and productivity of these sectors (World Bank, 2010; Alebachew and Woldeamlak, 2011).

Moreover, vulnerability to climate shocks is the main challenge in Ethiopia and creates grater food insecurity problems (WFP, 2019). The country faced increasingly unpredictable rains, and in some years the complete failure of seasonal rains occurrences that are linked to climate change and it differs across regions. The lowlands are vulnerable to increased temperatures and prolonged droughts that may affect livestock rearing. The highlands may suffer from more intense and irregular rainfall, leading to erosion, which together with higher temperatures may result in lower agricultural production. This variability leads to greater food insecurity in Afar, Tigray, Southern Oromia, the central Rift Valley, and the eastern. According to the assessment of the Intergovernmental Panel on Climate Change (IPCC), climate change is expected to affect all aspects of food security in general. Particularly, the tropical region, the already most vulnerable to food insecurity, will be the most adversely affected where 73 percent, or 360 million, undernourished women and

children live. About 30 million people still do not have access to adequate food throughout the year and about 32 million people are undernourished (WFP, 2019).
Furthermore, many rural women in Ethiopia who are living in low socioeconomic classes are experiencing disastrous effects of climate change due to existing gender disparities, including access to resources and education, paid employment and health care. Eyoband Victoria (2016) states that,if these disparities remain unaddressed, poor women will be more likely affected by these inequalities compared to men and will have more household responsibilities, including the collection of water for drinking, cooking and washing, the collection of fuel wood, and the small-scale cultivation of subsistence crops. The indirect effect of climate change is that rural women are more vulnerable to sexual abuse since they have to travel to more remote sources of water.

Despite the multidimensional impact of climate change on their live including food security, the abilities of rural women to cope with climate change impacts are lower than men's because of their reduced access to information, perception, markets, mobility, alternative income sources, and decision-making mechanisms as stated in Climate change profile of Ethiopia stated by Ministry of foreign affairs of the Netherlands, April 2018 (WCDI, 2018).

The studies in climate change adaptation strategies, and its impacts on agriculture, particularly on food security in Ethiopia are suggested the importance of gender differentiated adaptation strategies to be targeted by policy to better adoption of adaptation options (Asfaw*et al*., 2018; Amare and Simane, 2018). The extent, in which these studies are insights the impacts of adoption of adaptation strategies on household food security are in appreciation. For instances, Amare and Simane (2018),using soil and water conservation, water harvesting, and small-scale irrigation as adaptation options and assessed by nearest neighbor matching, radius matching, and kernelbased matching algorithms, revealed that adoption of adaptation options was significantly influence household food security in Muger sub-basin of the upper Blue-Nile basin of Ethiopia. The other study byAli and Erenstein (2017) showed that the farmers who have been adopted more adaptation strategies had higher food security levels than the farmers who did not. However, this review is going to exploregender specific data whichhas paramount importance in designing women specific interventions which help women to better adaptation.

## LITERATURE REVIEW

### Overview of the definition and concepts

### Climate change adaptation strategies

While the term adaptation is widely circulated, it has no single definition of universal application. Different climate change literature defines adaptation differently. The following are some of the examples found: 1) adaptation to climate is the process through which people reduce the adverse effects of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides (Burton, 1992); 2) adaptation involves adjustments to enhance the viability of social and economic activities and to reduce their vulnerability to climate, including its current variability and extreme events as well as longer-term climate change (Smit, 1993); 3) the term adaptation means any adjustment, whether passive, reactive or anticipatory, that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change (Stakhiv, 1993); 4) adaptation to climate change includes all adjustments in behavior or economic structure that reduce the vulnerability of society to changes in the climate system (Smith *et al*. 1996). Recently, IPCC defines adaptation as 'adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities'(IPCC, 2014).

### Food security:

exists when all people at all times have physical or economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for active and healthy life (FAO, 1996). It is influenced by four key dimensions: availability of sufficient food; economic, physical and social access to the resources needed to acquire food; stability of this availability and access; and utilization, including nutrition, food safety, and quality.

### Climate change perception

Studies in Africa as well in Ethiopia showed that Perception about climate change and its effects influence whether actors decide to adapt. That study revealed that farmers have clear ideas about changing trends in climate change and variability in their local climate (Alebachew 2011; Mersha and Frank, 2016). The risk perceptions and socio-cognitive processes of decision makers are important for motivating adaptation decisions (Frank and Badre, 2011). According to (Adger*et al*., 2009), farmers' behavior is shaped more by their perceptions of climate change and climate risk, rather than by the actual climate patterns as measured by scientific methods. The study conducted in East Hararghe Ethiopia showed that households who perceive effects of climate change such as disease incidence and crop failure are more food secure than those who do not perceive. On the other hand, farmers who perceive change in temperature and rainfall

(precipitation) patterns are less food secure than those who perceive (Lemma and Wondimagegn, 2014).

There are gendered risk perceptions regarding climate change that in turn influence actors' adaptive behavior. Men and women perceive and experience risks differently, which limits their adaptation, on the hands, gender-specific roles, responsibilities and social norms are linked to differences in risk perceptions, access to resources, and participation in social groups influences coping strategies and adaptive behavior, and ultimately the wellbeing outcome in a gender-differentiated way (Ngigi*et al*., 2017). In the study by Mersha and Frank (2016), households perceived as drought which is a decline in and inconsistence of rainfall and mentioned the effects of drought such as food shortage, death of livestock, over-reliance on government food aid and out-migration of young people while Women particularly mentioned the erosion of social values and relations. The other study conducted in Kenya revealed that households without access to extension services are less familiar with the general discourse in the country that temperatures are increasing and female-headed households were more inclined to perceive an increase in rainfall than male-headed households (Bryan *et al*., 2013).

**Factors affecting the choice of adaptation strategies**

It has been highly noted that adoption of climate change adaptation options does generate substantial benefit in terms of achieving household food security for the reason that adaptation options increase food availability because they boost crop productivity and promote food stability by reducing the risk of crop failure, making the household less vulnerable to negative shocks, and improving the resilience capacity (Amare and Simane, 2018). However, the response given by the farmers would have been affected by different constraints. Especially, rural women in developing countries have seen more vulnerable to these constraints while, reason have reported as they generally have fewer assets and rights on their properties than do men (Julia *et al*., 2014).

The report by World Bank (2008) indicated that the factors like gender inequity and the persistent biases in the access of women and other marginalized stakeholders to production resources, occupational education and training, information, and extension services are constraining adaptation strategies. The study conducted by Asfaw*et al*. (2018) in most vulnerable area of Ethiopia showed that the farmers hindered to respond to adaptation strategies mainly due to financial constraint, lack of knowledge and limited early warning information and scarcity of water in the area. According to Amare and Simane (2018), climate change adaptation decisions are significantly affected by various socio-economic, institutional, environmental, and demographic factors and particularly, gender, family size, land ownership, access to extension service, livestock ownership, and frequency of droughts and floods that have happened in the past 25 years are the important factors influencing farmer's decision to adopt adaptation options.

According to a study conducted in Vietnam on determinants of farmers' adaptation to climate change in agricultural production, Using binary logit model and multivariate probit model, training attendance, farm size, educational level, farming experience, access to credit, and gender were the factors that influenced significantly the probability that farmers would adapt to climate change (Thoai et al, 2018)., and also Otitoju (2013) was conducts a study aimed at the effects of climate change adaptation strategieson food crop production efficiency in SouthwesternNigeria.The result of the multinomial logit (MNL) model indicated that household size, age of the household head, years of education of household head, sex of the household head, and years of climate change awareness, farmsize and average distance, extension contact, and access to credit were affect the farmers' choice of the main farm-level climate change adaptation strategies in food crop production in study area.

According to a study conducted by Tsegamariam (2018),to examine climate variability and determinants of itsadaptation strategies; the case of coffee producer farmers at AbeshegeWoreda in Ethiopia using logit regression model, the result shows that perception, education level, farm size, access to credit service and total family size are among the factors which are positively and significantly affecting the farmers' adaptation decision. Also, Amogne et al., (2018) conducted a study on analyzing the determinants in the adoption of climate changeadaptation strategies of smallholder farmers in north central Ethiopia using MNL model to investigate the factors guiding household choices of climate change adaptation methods. The MNL regression model outcome reveals that age and education level of the head, family size, herd size, having a training, access to information, microfinance as well as extension services, agro-ecology, having a family member who needs daily care, perceiving that climate change can be adapted and experienced crop failure were found to be the determinants factors.

***Age of the Women*:**

The study by Onwuchekwa and Winner (2016) indicated thatage has significant effect on adoption of climate change mitigation measures. The adoption of climate change mitigation strategies declines as the farmer gets older because, the older one becomes the more risk averse he/she is. Thus, there would be negative relationship between adoption of new innovations and age, and/or as agriculture is labor intensive hence it requires health individuals since most of rural residents are involved in agricultural activities (Ihek*et al.*, 2014; Micah and Absalom, 2014). Hence, older women will be expected to be less active in

adoption of climate change adaptation strategies, and on the other hands, younger women will be expected to be more likely active in adoption of climate change adaptation strategies.

***Educational level*:**

Education equips individuals with the necessary knowledge of how to make living. Educated farmers are able to acquire and process information easily which may lead to more adoption of adaptation strategies. The study by Asfaw*et al.* (2018) revealed that livelihood diversification is positively and significantly influenced by education. The study was implied that the educated farmers tend to earn their source of livelihood from different sources so as to share risks without exception of men or women.

***Family size*:**

Economically dependent family member has negative effect and have seen at 1% level of significant in livelihood diversification strategies (Asfaw*et al.,* 2018). The other finding showed that the probability of food security decreases with an increase in household size (Abayineh and Belay, 2017). On the other ways, family size determines the availability of family labor, hence it contribute in diversification of adaptation strategies.

***Land ownership*:**

This variable is a basic asset for majority of the rural livelihoods. The farmers with larger landholdings seem to highly use adaptation options and the probability of using adaptation options increases as the proportion of farm size increases (Amare and Simane, 2018).

***Distance to market*:**

It will assumed that access to market will make better opportunity for women to sell their production and purchase inputs to diversify livelihood strategies. Women nearer to market have better chance to increase diversification and in turn will improve food security. According to Adugna*et al.* (2015) distance to markets positively affected the use of irrigation and negatively and significantly affected soil and water conservation and crop variety selection. More, proximity to market has reported as an important determinant of adaptation strategies because the market serves as a means of information exchange on the other hands.

***Livestock ownership*:**

Livestock are important in farmer livelihood through; use for draft power, manure, income from sale of milk/butter, and sale of live in times of risk to buy necessities. The household having larger size of livestock can have better chance to have better income from livestock. Hence, the more livestock owned by the household will be the less possibility of the women to participate in other adaptation options rather they focus on livestock management (Amare and Simane, 2018; Asfaw*et al*., 2018). On the other hands, poor women who owe no or less livestock are likely to relay on other adaptation options.

***Climate information:***

Its importance was highly noted in adaptation to climate change, and better access to early warning information about drought and flood before it happened has reported as it has a significant and positive impact on the likelihood of using different adaptation strategies (Bushesha and Mvena, 2015).

***Agro-ecology*:**

It is a dummy variable that takes 1 if a women being in dega, 2 if in woinadega and 0, otherwise. Agro-ecology determines soil type and rainfall level which limits what is economically possible in adaptation strategies. Hence, it makes distinct even between adopters of adaptation options (Amare and Simane, 2018).

***Training on Climate change*:**
The study by Asfaw*et al*. (2018) revealed that providing of short-term training and access to information play important role in enhancing the adaptive capacity of smallholder farmers, and this also has been confirmed by Amare and Simane (2018) even they suggested that increasing the awareness of climate change adaptation options should be focused in policy.

***On-farm income*:**

It will expect that increase in on-farm income will increase the possibility of the women adopting climate change adaptation strategies while, most of rural women involved in farm activities. The extra farm income will be used to acquire inputs that needed in farm activities. The finding by Seid*et al*. (2016) showed that farmers with higher on-farm income may have the ability to invest on agriculture inputs.

***Off-farm activity*:**

Farmers participating in off-farm income activities might be focus on non-farm activities rather than more engagement in on on-farm adaptation strategies. Aschalew (2014) find that the farmers' non-farm income increased they devote less and less time for farming activities.

***Women headship*:**

It is expected that a women who is household head has an opportunity to be access to training and other social

services that will influence them to be aware and engage in adaptation strategies better than the women who is not household head. The evidence that show the difference between women headed and not headed was lack even, most studies neglected the women's role in adaptation measures as they are poor access to different assets in Africa particularly, in Ethiopia. But, the analysis between men headed and women headed was showed that male-headed households had better opportunities to practice adaptation strategies than the female-headed households (Belay, 2017). However, the finding by Hassan and Nhemachena (2008) in southern Africa showed that, female-headed households are more likely to take up climate change adaptation methods than men.

***Access to extension service*:**

It might be play important role for rural farmers particularly for women in improving production and productivity of agriculture and interns to adaptation strategies. Nhemachena*et al*. (2014) reported that farmers who have higher extension contacts have better chances to be aware of change in climatic conditions and also have various management practices that they can use to adapt to climatic conditions.

***Access to credit*:**

It is a dummy variable that takes 1 if a women has access to credit and 0, otherwise. Institutional loan plays an important role in adaptation strategies. Women who have access to credit from the formal sources are able to use more purchased inputs for subsistence crop production. However, Amare and Simane (2018) reported that access to credit was not significantly influenced the farmers' decision to adopt adaptation options in Muger sub-basin of the upper Blue-Nile basin of Ethiopia.

***Membership to cooperatives***:

It is a dummy variable of which the value is 1 if the women is member and 0, otherwise. Cooperative serve people through different ways. People who engaged have different information access, discuss with; this make them self-confident and there will be equal share of resources and power. CCA (2004) reported that, the co-operatives have the capacity to reduce social conflict by providing a means to equitably distribute resources, decision-making power and economic benefits.

***Participation in social groups*:**

The study by Muntaha (2014) revealed that Participation in social groups by both men and women is an important factor associated with adaptation strategies, and participation by women is particularly important in enhancing their perceptions of climate change.

**Adaptation strategies to climate change**

Crop diversification, changing input use intensity, change planting date, tree planting, integrating crop with livestock, soil and water conservation are among climate change adaptation strategies that are important for smallholder households (Abrham, 2017). According to Mohammed *et al*. (2014), adaptation strategies are identified as: increased use of irrigation, practicing crop diversification, integrated farming system, use of drought-tolerant varieties, use of salinity tolerant varieties, practicing crop rotation, cultivating short duration crops, practicing intercropping, find off-farm job, moved to non-farm activities, agroforestry, soil conservations techniques, zero tillage and crop insurance.

The recent study conducted in one of critically affected regions by climate variability and extreme events showed that, the farmers in the area were employed land augmentation activities, land management practices, irrigation and water harvesting, agronomic practices like changing planting calendar and planting early maturing crop varieties and engaging in beyond farm activities as climate adaptation strategies, and training on climate change adaptation options, targeting female-headed and poor farmers have been suggested as it has a positive impact for increasing the implementation of these adaptation strategies (Asfaw*et al*., 2018).

**Impacts of climate change on food security**

Various plants in the world, endemic to certain countries with different attributes, need special conditions and external additions to grow properly. Crops need specific conditions to thrive, including optimal temperature and water. Up to a certain point, warmer temperatures may benefit the growth of certain crops in some parts of the world. However, if temperatures exceed a crop's optimal level, or if sufficient water and nutrients are not available, yields are likely to fall. An increased frequency of extreme events, especially floods and droughts, also harms crops and reduces yields (FAO, 2016).More extreme temperatures, combined with decreasing rainfall, can prevent crops from growing at all.

Hatfield and Prueger (2015), using perennial fruits such as apples and cherries as examples, precise that climatic variations will have different impacts on plant development depending on the growth stage. Hatfield and Prueger (2015) also underline that a rise of 1°C to 4°C above the optimal temperature of certain plants has the potential to decrease productivity between 2.5% and 10%. A rise in temperature above the common optimum level of 22°C for perennial fruits would disturb the pollination phase, causing a reduction in glucose,

which would negatively affect the overall plant growth.Campbell *et al.* (2016) state that a one-degree increase in temperature is estimated to decrease variety of crops, including rice and maize, by 3 to 10 percent production.

World Bank (2008) estimated that food production will need to increase by 50 percent by 2030 just to keep up with the demands of a growing global population. Similarly, climate change is estimated to cause decreases in global cereal production of 1-7 percent by 2060. This problem will be greatest in developing countries, and particularly in South Asia and sub-Saharan Africa. Reduced production leads to higher food prices and increasing food insecurity, particularly for rural families in developing countries with less production and lower purchasing power (parry *et al*., 2009). The following figure 1 shows the streaming impacts of climate change on food security and nutrition.

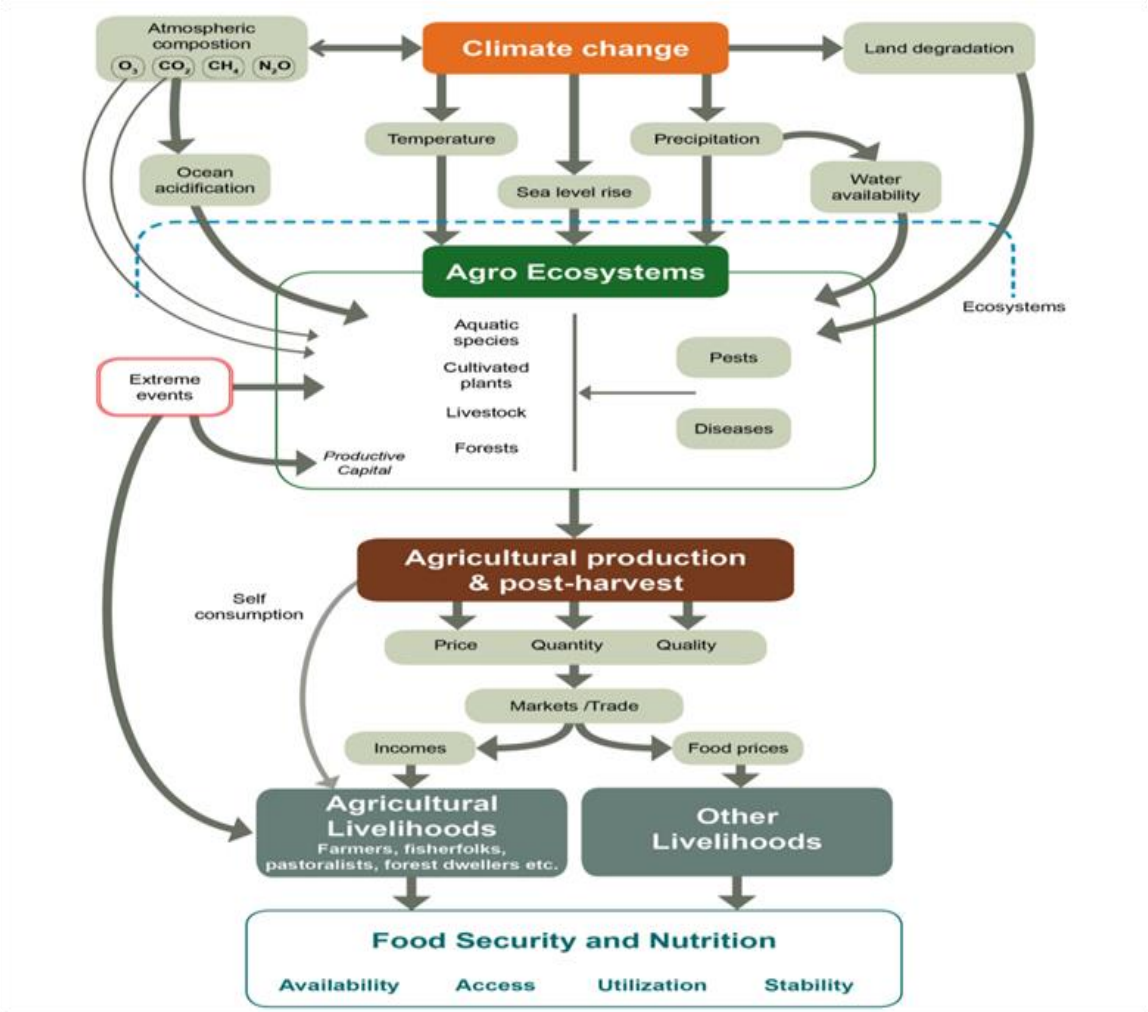


**Figure 1:** The cascading effects of climate change impacts on food security and nutrition.Source: adapted from (FAO, 2016).

A study by the WFP found that without significant reductions in greenhouse gas emissions, climate change 'will greatly increase hunger, especially in the poorest parts of the world (Ibid). Based on trends in population growth and inequitable distribution of wealth, WFP estimate that globally, 10-20 percent more people will be at risk of hunger by 2050. Almost all of these will be in developing countries, with 65 percent expected to be in Africa. This has severe implications for nutrition. The risk of hunger resulting from climate change is the result of both direct impacts on food systems, and of indirect impacts that affect the different dimensions of food security (WFP, 2009).

**Adaptation to climate change and food insecurity**

The ability to maintain food security in the face of climate change depends on their adaptive capacity. This capacity is influenced by access to and control over resources, such as information and knowledge on climate change, natural resources such as land and water for agriculture, and opportunities for earning a

sustainable income,inequitable policies, power relationships, and cultural norms (FAO & WFP, 2009). Thus, socially excluded groups, including female-headed households, orphans, persons living with HIV/AIDS, and landless people, are highly vulnerable to the impacts of climate change and other stressors that lead to food insecurity.Due to gender inequality, women may face higher risks of food insecurity. Even though women play a critical role in agriculture and in managing household food supplies, they lack access to services and control over important resources and decisions affecting food security. Therefore, they may become trapped in a vicious cycle, with food insecurity and malnutrition making them more vulnerable to climate change, and climate change exacerbating the risk of food insecurity.

Climate change and food security should focus on empowering poor women and girls to realize food and nutrition security. Addressing all four dimensions of food security, including protecting and promoting resilient livelihoods to ensure adequate food availability and access; improving utilization with a focus on nutritional status; and enhancing stability through vulnerability and risk reduction and management is critical issue. Gender inequality, poor governance, and climate change are recognized as drivers of food insecurity and malnutrition (CARE International, 2010). Therefore, strategies that will contribute to the mutually supportive objectives of climate change adaptation and food security is developed:

- Increasing agricultural productivity, climate resilience, and sustainability, particularly for smallholder farmers (for example, by promoting conservation agriculture practices, restoration of degraded soils, and agricultural biodiversity)
- Promoting the rights of vulnerable people, particularly women, to critical livelihood resources such as land and water
- Integrated water resource management
- Sustainable land use management and ecosystem services
- Technology transfer (irrigation, conservation, and sustainable agriculture, biogas technology, etc.)
- Disaster risk reduction strategies
- Enhancing government capacity to implement social protection schemes
- Linking emergency food assistance to longer-term food security responses
- Promotion of savings and insurance schemes
- Assessing vulnerability to and impact of climate change on the different dimensions of food security
- Improvement of food security monitoring to incorporate indicators related to gender equality, nutrition, and climate variability and change
- Partnerships with other humanitarian, development and environmental organizations, research institutions, governments and the private sector to identify practical and effective responses to climate change and food insecurity
- Knowledge management and sharing across sectors, communications and awareness-raising

**Food security: measurement and indicators**

There is no single indicator for measuring food security. The decision to rely on a particular method usually depends on resources and time constraints, the objective of the study, available data, type of users and degree of accuracy required (Debebe, 1995a). Different indicators are needed to capture the various dimensions at the country, household, and individual levels. At the national or regional level, food security can be measured in terms of food demand (requirement) and supply indicators.

Food security at the household level can also be measured by households' food or calorie acquisition/consumption per adult per day. The calorie consumed by the household is compared with the minimum recommended calorie of 2200 kcal per adult per day. If the consumption/acquisition is less than the recommended amount then, the household is categorized as food insecure and if greater than, as food secure (Hoddinott, 1999).

## CONCLUSION

In Ethiopia, climate change adaptation strategies vary from place to place in the country. The study showed at different part of the country on climate change adaptation strategies and determinantsof climate change adaptation strategies choice were reviewed. From the review result climate change adaptation strategies used by farmers of the country were using different crop varieties, planting trees,changing planting dates, planting of drought tolerant and early maturing crop varieties, increased use of soil and water conservation techniques or soil erosion prevention programs, water harvesting techniques, diversification, increased use of irrigation and or use of irrigation techniques, application, changing cropping densities, changing fertilizer, the pastoral system or the herd composition, and home-garden agriculture. Major determinates of climate change adaptation strategies from the result of the reviewed journals include education level of the households, gender, age, livestock ownership, family size, farming experience, frequency of contact with extension worker, access to market, large farm size, income of the farmers andaccess to climate information.

## RECOMMENDATION

Based on the review the following necessary recommendations are forwarded.

- Agricultural extension service should be farther expanded and encouraged, and in addition, development agent should be provide their responsibility in teach and change the attitude of farmers by giving updated knowledge, innovations and information related to climate change and variability and motivate farmers to adopt adaptation strategies.
- Weather institute, broadcasting agency, research institute and universities should coordinately create more awareness to coffee farmers in disseminate weather information, conduct different climate change forums and workshops at household level how farmers respond to the adverse effects of climate change on coffee production.
- The agenda of planting trees and environmental management that have started by the government at national level should be encouraged and continued until coffee farmers and all households in a country accept as his/her responsibility and participate in planting trees in a year.
- Government should help and motivate the coffee farmers particularly aged and female headed households in providing agricultural inputs and give knowledge, skill and attitude training in coordinated with NGO's and foreign donors and investors.
- Financial institution should be affordable for smallholder coffee farmers in making suitable policy and strategies of credit service accesses.
- Households should be participate in different nonfarm activities, expand their farming activities in contract land and share cropping, and develop their knowledge through adult education and information, and experience exchange through farmer to farmer extension.
- In overall, the study provided some necessary information about climate change and its effect on coffee production in the study area. But it didn't include wide area that includes all districts in the zone. Therefore it is good if farther study will be conducted with support of technology which can determine the sustainability of coffee production in the area.

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