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Abstract

Climate change is a global problem that our world communities are facing at this moment. While climate change resilience is the response given to the climate change by all stakeholders the problem is touched. In this aspect smallholder farmers' climate change resilience is the coping or responding mechanisms that the small farmers are gave for the occurrence of climate change. Within this mind the review of this paper was conducted with objectives of the mechanisms that Ethiopian farmers used in respond to climate change and on the factors affecting smallholder farmers coping of climate change. According to recent articles written/published on the climate change the problem comes from the angle of climate change impaired all living things found in the world equally. But In responding to climate change problem the capacity and capability of world country is different from place to place. Ethiopia is one of the world countries damaged and damaging by this problem. The small holder farmers of Ethiopia used and using different coping mechanism of climate change. The mechanisms used by small farmers of Ethiopia in coping with climate change are: cultivating diversified crops, mixing crops with pastoralism, tree planting, off-farm activities, selling the assets, cultivating drought resistant crops like enset, using irrigation and migration are some of coping/responding mechanisms of climate change used by Ethiopian smallholder Farmers. There are also some factors that affect small holder farmers in responding to climate change. Those are: lack of information, agro ecological zone, livestock and land holding ownership, frequency of extension contact, on and off farm income, distance from market to home and age, sex, education level, family size of House hold head. So according to recent reviews the above mentioned factors are positively and negatively affect farmers' climate change coping mechanisms.

Key words; climate change, climate change resilience, factors, mechanisms

Abbreviation and Acronyms

CCAFS	Climate Change Adaptation and Food Security
CO2	carbon dioxide
CIA	Central Intelligence Agency
CRGE	climate resilience Green Economy
DA	Development Agent
FDRE	Federal Democratic Republic of Ethiopia
GDP	Growth domestic product
Ha	Hectar
IPCC	Intergovernmental Panel on Climate Change
MoFED	Ministry of Finance and Economic Development
Mt	Mega tone
NAPA	*National adaptation programme of action*
NGO	Non-governmental organization
NMA	National Meat Association
SNNP	South nation nationalities and people
SWC	Soil and water conservation
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United state

1. Introduction

Climate change is a change of climate which is attributed directly or indirectly to human activity. It alters the composition of the global and/or regional atmosphere and natural climate variability

observed over comparable time periods. Climatic variability's are the types of changes (temperature, rainfall, occurrence of extremes); magnitude and rate of the climate change that causes the impacts on the area of public health, agriculture, food security, forest hydrology and water resources, coastal area, biodiversity, human settlement, energy, industry, and financial services (UNFCCC, 2007).

Currently the issue of climate change is one of the key global agenda. This is because climate is a major environmental variable that affects nearly all human activities MoFED (2010). For instance, unpredictable weather condition experienced from climate change with its potential negative impacts on socioeconomic activity of Ethiopia particularly on agriculture, is considered as one of the major challenges to implementation of the country's growth and transformation plan (Aschalew Shiferaw 2014)

Ethiopia is among the least developed and the most vulnerable countries to climate change (NMA 2007; World Bank 2010) due to its geographical location, low adaptive capacity and weather sensitive economy (NMA 2007). Rainfall is highly erratic and there is a high degree of variability in both time and space (NMA 2007; EPCC 2015). Since agriculture (which employs around 85% of the labor force, contributes more than 50% of the GDP and supplies 90% of export values) is climate sensitive, it is likely to remain the main engine of growth in the country, and climate-induced shocks will continue to be a threat to macroeconomic stability and could cause a remarkable loss in the total production unless strong remedial actions are put into action (MoFED 2010; EPCC 2015).

The government has recently launched a vision to build a climate resilient green economy (CRGE) by 2025 (FDRE 2011). This is an economy that would be middle-income, resilient to the negative impacts of climate change and would be achieved with no net increase in greenhouse gas emissions relative today. One of the pillars for the CRGE strategy in the agricultural sector is the adoption and diffusion of various climate smart strategies for improving crop and livestock production for higher food security and farmer income while reducing emissions (FDRE 2011). However, there is a paucity of information on the conditions under which multiple climate-smart practices are adopted and on the synergies among such practices in increasing household resilience by improving agricultural income.

this program focused mainly on increasing the productivity of the agricultural sector so as to minimize the adverse impacts of climate change through strengthening the human resource capacity, using modern inputs, integrating watershed management, intensifying small-scale irrigation, diversify income-generating activities, expanding infrastructure, feed conservation and forage development, research on drought resistant and early maturing crops, disease and pest control mechanism, providing early warning and proper utilization of meteorological information which are basic for the sector. Though such policies and strategies are designed and implemented, their effectiveness so far is not satisfactory (EPCC 2015) and more research, devotion and commitment is needed.(A. Asfaw et al.2018)

Smallholder farmers represent 75% of the world's farms (Lowder, Sinoet, & Raney, 2016), comprise 60% of the agricultural workforce worldwide (Fyfe, 2002) and provide over 80% of the food consumed in the developing world (UNEP, 2013). Even though there are no widely-accepted definition of smallholder farmers (Morton, 2007), most of them depend on their production for both food security and income, cultivate small areas (less than 10 ha) and often use family labour (Cornish, 1998; Nagayets, 2005). Despite the importance of smallholder farmers to the agricultural sector, they often have limited resources to maintain or increase agricultural productivity, live in environmentally fragile and remote locations, and are often marginalized from social and development assistance programmes (Harvey et al., 2014; Vorley, del Pozo-Vergnes, & Barnett, 2012). Many smallholder farmers are also affected by ongoing stressors such as the fragmentation of landholdings (Vorley et al., 2012), the unpredictability in the prices of many agricultural commodities and the existence of regionalized and globalized markets, which brings smallholder farmers into direct competition with industrial-scale farming (Morton, 2007).

They are considered one of the most vulnerable groups to climate change (Morton, 2007) due to: (i) their high reliance on ecosystem goods and services that are under increasing pressure (Fischlin et al., 2007; Millennium Ecosystem Assessment, 2005) as a result of climate change, (ii) their low capacity to adapt to changes (Adger, Huq, Brown, Conway, & Hulme, 2003), (iii) their dependence on rainfed crops (Eakin, 2005; Lobell et al., 2008) and (iv) their location in marginal landscapes (such as hillsides, deserts and floodplains), where their farms are exposed to a variety of climatic hazards (Morton, 2007; UNEP, 2013). Smallholder farmers are also considered vulnerable to climate change due to the direct and negative impacts of climate change on the suitability (Hannah, Ikegami, Hole, Butchart, & Peterson, 2013) and productivity (Lobell et al., 2008) of crops they rely on for both subsistence and income.

Besides the impacts on the national economy, climate change impacts have been affecting health and livelihood status of smallholder farmers in Ethiopia. Some of these impacts include climate-related epidemics, crop failure, flooding, livestock mortality, shortage of water and pasture, migration, and food aid dependency. Unsustainable adaptation strategies of the farmers, such as selling assets and charcoal production, have resulted in the degradation of assets, environment degradation, and biodiversity losses. Climate change-induced food and water shortages affect the health, educational, and economic status of the households. For instance, during drought events, children are forced to drop out of the school to participate in such household activities as collecting water and fuel-wood from long distances. Malaria affects labor availability at the household level and increases the health expenses of the family.

2. SMALLHOLDER FARMERS RESILIENCE TO CLIMATE CHANGE

Climate change is a change of climate which is attributed directly or indirectly to human activity. It alters the composition of the global and/or regional atmosphere and natural climate variability observed over comparable time periods. Climatic variability's are the types of

changes (temperature, rainfall, occurrence of extremes); magnitude and rate of the climate change that causes the impacts on the area of public health, agriculture, food security, forest hydrology and water resources, coastal area, biodiversity, human settlement, energy, industry, and financial services (UNFCCC, 2007). In Ethiopia, climate variability and change is mainly manifested through the variability and decreasing trend in rainfall and increasing trend in temperature. Besides, rainfall and temperature patterns show large regional differences (Zerga & Gebeyehu, 2016). Climate change is a key concern to Ethiopia in our time 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 (Ayana et al., 2011) and agriculture sector (UNDP Ethiopia

Resilience refers to the ability of a system to deal with stresses and disturbances, while retaining the same basic structure and ways of functioning, capacity for self-organisation, and capacity to learn and adapt to change. Resilience is therefore about managing changes and adaptations should contribute to climate-resilient development, i. e. adaptations that can stand the test of current and future climate risks. A resilient adaptation is thus one that contributes to the various features of resilience in the short and long-term. Resilient adaptation complements the concept of the "precautionary principle" in Article 15 of the Rio Declaration of 1992 (Glantz 2008). The concept of resilient adaptation can serve as a guiding principle for planning adaptations which account for uncertainties in future climate change. Considering this uncertainty and the dynamic nature of climate change, mal-adaptations, i. e. adaptations that may appear appropriate and beneficial in the short-term but increase vulnerability with time are non-resilient.

2.1.Mechanisms used by the smallholder farmers in responding to climate threat

In developing countries like Ethiopia, the common approach to studying the perception of farmers to climate change is based on comparing farm survey or farm group discussion results with data records from meteorological stations. Although informative in terms of understanding the level of awareness of farmers and the possibility of validating farmers' claims of perceptions of change against meteorological data, these approaches do not explicitly identify factors influencing awareness of climate change (Deressa et al., 2011).

The study of Paulos Asrat and Belay Simane (2017) and Deressa et al. (2011) revealed that farmers living in the dry lowland area perceived more change in climate than farmers in the wet lowland. This could either be associated with the repeated drought events occurring in the area in recent years or could be linked to various environmental changes that cause reduced water availability and agricultural yield in the dry lowland areas. With regard to adaptation, better awareness and use of adaptation measures is revealed in the wet lowland condition as compared to the dry lowland. This difference between the two locations may call for further heightening of intervention to facilitate the scene for enhanced climate change perception and adaptation. According to Deressa et al. (2011), the age of the head of the household represents experience in farming and studies have indicated that experienced farmers are more likely to perceive

climate change. The degree of education of the head of household is also hypothesized to be positively related to awareness of climate change. Access to information on climate change through extension agents or other sources creates awareness and favorable condition for adoption of farming practices that are suitable under climate change. Higher income positively affects public perception of climate change. Similarly, it is hypothesized that higher farm and nonfarm incomes positively influence farmers' perception of climate change. The following mentioned points are the mechanisms smallholder farmers of Ethiopia used to cope from climate change.

2.1.1. Crop diversification and mixing crop production with pastoralism

This strategy seeks to avoid risks of total crop failure rather than maximizing yields of one particular crop. According to the study conducted by (Kristiansen, 2011) in Ethiopia, crop diversification is widespread. Crop diversification is the most commonly used method to overcome climate changes in Ethiopia. Greater use of different crop varieties in the same season could be associated with lower expenses and ease of access by farmers. Legesse B. et al. (2013) also noted that crop diversification together with soil and water conservation and water harvesting practices were commonly used climate change adaptation strategies in eastern Ethiopia.

More recent studies conducted show that smallholder farmers use of different crops or crop varieties, planting trees, soil conservation, changing planting dates, and irrigation as the most common adaptation strategies in the country. However, despite having perceived changes in temperature and rainfall, a large percentage of farmers did not make any adjustments to their farming practices. According to Asrat and Simane (2018), studies revealed that the use of improved crop varieties, agro forestry practices, soil conservation practices, irrigation practices, and adjusting planting dates are the most important resilience strategies by smallholder farmers. However, adaptation decision is location-specific and influenced by key drivers such as socioeconomic, environmental, and institutional factors.

(NAPA, 2007) states that mixed species herds, widespread and seasonally available pastures, splitting animals into discrete herds, and mobility in response to seasonal variation in pasture productivity are key strategies in Ethiopia. Selling of livestock was a common coping strategy during drought periods amongst farmers in the Upper Awash Basin in Ethiopia.

2.1.2. Tree planting

According to Kristiansen (2011), tree planting to be one of the major methods used by farmers to adapt to climate changes in the Nile Basin of Ethiopia. Vegetation like trees, plants, and grass are valuable because the roots protect the soil from erosion. Trees are valuable during floods and droughts, and many trees together might give lower temperatures in the near area, a more fresh air, and also shadow.

In addition to above mentioned result the study of (Deressa et al. 2011; Deressa et al. 2009) shows the majority of farmers (49.6 percent) adopted tree planting with at least one additional measure while 39.5 percent took tree planting as a sole response to climate change. For instance A survey in the Nile Basin of Ethiopia also found planting trees as the most common adaptation strategy. Planting trees has diverse ecological and economic benefits, which bring about adaptation to climate change. However, the responses of farmers to climate change can also be driven by their understanding of the causes of climate change. The majority (96 percent) of the households in the survey of (Tessema et al. Agricultural and Food Economics 2013) the main cause for climate change is deforestation. Therefore, planting trees may also be taken by the farmers partly as a mitigation strategy in addition to adaptation.

2.1.3. Off-farm activities

According to the study of Cooper et al. (2008), farmer's vulnerability to climate changes can be mitigated if the farmers have off-farm work on the side. Sale of labor was a successful coping strategy among farmers in the Upper Awash Basin of Ethiopia during drought periods. Traditional and contemporary coping mechanisms in Ethiopia also include increased petty commodity production. Off-farm activities can for instance be selling of honey, clothes, or home made products like mattresses, hot food, beverages, whips, and ropes.

2.1.4. Soil and water conservation (SWC)

(Kristiansen, 2011) In his study indicates that in Ethiopia, they have often used different kinds of soil and water conservation strategies since around 1990, and soil and water conservation strategies have probably developed much since that time. Soil and water conservation strategies are mainly used because of soil degradation and soil erosion, and because farmers due to this, want to rehabilitate their fields. These activities are increasingly important today because climate changes to some extents are accelerating these processes.

2.1.5. Selling of assets

Temesgen Desalegn et al. (2006) conducted that, sale of agricultural tools and other assets are identified as a coping mechanism to climate variability and extremes in Ethiopia. Farmers may sell some of their resources in market, and this can be an important extra income, and can also function as a safety net and a coping mechanism. Material assets within the household can be seen as a buffer against difficult periods, in the same way as for example livestock. Similarly the study of Amsalu and Adem (2009) indicates , about 78% of the households in Borena, 40% in Guji, and 33% in South Omo Ethiopia reported an increasing trend of livestock selling.

2.1.6. Enset

As the study of (Nater, 2010) shows, enset, or false banana, is a relatively drought resistant plant and it is a highly valuable plant in many Ethiopian communities, especially in the south. Enset is a suitable plant in some parts of Ethiopia and therefore more or less an example of the former section. It is however so important that it is decided to be taken as an individual section. Enset provides more amount of foodstuff per unit area than most cereals in Ethiopia .As the study of (Nate 2010) indicates 40–60 plants occupying 250–375 square meters can provide enough food for a family of five to six people.

2.1.7. Food aid

As the study conducted by (NAPA, 2007) Food appeal and food aid have been identified as a coping mechanism to climate variability and extremes in Ethiopia. During critical times of drought, government, NGOs, relatives, and others can help farmers financially. Costs associated with droughts in Ethiopia in 1999 are estimated to have coasted 5.3 million US $. The World Bank is one of a number of development partners supporting the government's Productive Safety Net Program (PSNP), which has played a major role in reducing the number of people affected by the drought, and saving the livelihoods of millions of Ethiopians

2.1.8. Irrigation and diverting of water

As study identified by (GoE, 2010) small-scale irrigation is an important component of adaptation. Similarly the research carried out by (Kaur et al, 2010) assessed the effectiveness of small-scale irrigation as a climate adaptation intervention in Ethiopia. The study found that small-scale irrigation is a potentially valuable component of adaptation strategies as it increases agricultural productivity and households' ability to cope with climate variability. However, accompanying measures are required to ensure that (a) water sources themselves are resilient to a variable climate and (b) the design is proofed against extreme events.

The study conducted by (Calow and McDonald, 2009) broadly speaking that, boreholes and deep wells are likely to be less vulnerable to the effects of climate variability and change than surface water sources or shallow wells. However, drilling costs in Ethiopia are high due to the low level of infrastructure development, high failure rates and bureaucratic procedures for private sector involvement, and most irrigation is currently supplied by surface water. There is a low level of knowledge about the groundwater resource and little monitoring of groundwater levels, making it difficult to assess the sustainability of abstraction. It is also critical to develop mechanisms for fair distribution of water, both within communities and between upstream and downstream users. In some study sites water users had developed an informal payment system between communities for use of water; lessons could be learned from such benefit-sharing arrangements, but the potential costs need to be borne in mind.

The research assessed by (Deressa, Hassan, Ringler, Alemu, & Yesuf, 2009) indicates that in Ethiopia, only 2,900 km^2 (2003 estimation), or 1% of cultivated land, is irrigated. Use of irrigation is one of the least practiced adaptation strategies among the major adaptation methods identified in Ethiopia.

2.1.9. Migration climate

(Dadi, 2007) in his research entitled some people in Ethiopia live a semiomadic lifestyle. They migrates a couple of times during a year in search for pastures for their livestock. For instance, they have a permanent farm one place, but parts of the year they move the family and their livestock to other areas and come back several months later. By other hand finding of (NAPA, 2007) indicates Traditional and contemporary coping mechanisms to climate variability and extremes in Ethiopia include permanent and temporary migration in search of employment.

2.2.Factors determine the climate change resilience of smallholder farmers

Different studies revealed that greater proportion of smallholder farmers even in developing countries do perceive a changing climate (Komba and Muchapondwa 2012; Uddin et al. 2014; Hameso 2017). But the proportion of farmers who have had undertaken measures in response to the changing climate is low (Komba and Muchapondwa 2012; Abid et al. 2015; Deressa et al. 2014). The perception implementation gap emphasizes the importance of identifying factors which hinder smallholder farmers to adapt. Different studies have been conducted (Deressa et al. 2009; Tazeze et al. 2012; Tesso et al. 2012b; Debalke 2014; Balew et al. 2014) to point out the factors which regulate adaptation to climate change based on agro ecology. Moreover, results are not conclusive and there is no consistency in the outcomes of studies conducted so far in Ethiopia regarding the determinant factors, which suggests that a factor in a certain locality at a time might not be true in another locality.

Based on the concept of 'one size does not fit all' in climate change adaptation discourse, the implication is, therefore, the need for conducting micro level assessments. Furthermore, identifying the prominent factors which determine adaptations is the starting point in designing intervention measures to improve farmers' adaptive capacities. Since little has been studied regarding the responses to climate change and factors regulating the decision to adopt; and subsequently the study area is among the drought-prone areas of the country which is expected to be affected severely by the changing climate; pinpointing the determinant factors is timely and decisive so as to formulate policies which would enhance adaptive capacity. (A. Asfaw et al.2018)

Deressa et al (2009) in their investigation to study the determinants of farmers' choice of adaptation strategie, perception and adaptation by farmers in the Nile Basin of Ethiopia for mixed crop and livestock farmers during the 2004/5 production year reveals that most farmers

perceived that temperatures had increased and that precipitation had decreased. Findings reveal that education, age, non farm income, livestock ownership, access to extension services, access to climate information, access to credit, and number of relatives in the community positively influenced the farmer to adapt. Contrary to Deressa et al (2010), household size was found to be insignificant in influencing the farmer's decision to adapt to climate change.

Accoding to the study done by Yohannes L. (2010) in Adama Woreda on the factors that influence the farmers' decision to take adaptation strategies, the average annual rainfall, average annual temperature, agro-ecological setting, information on climate change have a significant impact on all adaptation options. The distance from the market and the size of the land has a positive and significant influence on soil conservation. In addition the size of the land has a significant influence on planting trees as adaptation. However, farmers' characteristics (such as gender, sex and education), social factors (number of relatives) and institutional factors (extension visits) although these had been found by other studies as a determinants to the adaptation options, in her study they are not significantly different from zero.

According to (Smit & Wandel, 2006) Vulnerability to climate change in Ethiopia is highly related to poverty (loss of copying or adaptive capacity) in most of the regions. Adaptive capacity is the ability or potential of a system to respond successfully to climate variability and change, in order to reduce adverse impacts and take advantage of new opportunities. Those societies that can respond to change quickly and successfully have a high adaptive capacity. Ethiopia is vulnerable to climatic variability due to its low adaptive capacity accountable to low level of socioeconomic development, high population growth, and inadequate infrastructure, lack of institutional capacity and high dependence on climate sensitive natural resource-based activities.

According to the study of Negussie Zeray and Ashebir Demie (2016) and Aschalew Shiferaw 2014 South Nations Nationalities and people (SNNP), and Benishangul-Gumuz region were relatively not vulnerable, whereas Afar, Amhara, Oromia, and Somali regions were vulnerable. The lesser vulnerability of SNNP was associated with its relatively higher access to technology and food market, its highest irrigation potential and its literacy rate. Afar, Somali, Oromia, and Tigray regions were among the highly vulnerable regions. The vulnerability of Afar and Somali was mainly associated with lower levels of regional development. Despite the fact that these regions were less populated than the other regions, the% age of people with access to institutions and infrastructure remains very low due to the lowest level of regional development. The following are some of the factors that affect smallholder farmers in responding to climate change in Ethiopia.

2.2.1. Lack of information

The work of (Deressa et al. 2009) revealed that the most important factor mentioned as barrier to adaptation by the surveyed farmers is lack of information (which accounts 22.5%) about climate

change and adaptation strategies. This is attributed to various factors including lack of institutional support mechanisms and failure to mainstream the issue of climate change in the public extension system of the country. Lack of information was also identified as the main barrier to adaptation by a survey in the Nile Basin of Ethiopia. Lack of farm inputs including seed (20.7 percent), chemical fertilizer (3.6 percent) and oxen (8.1%) are as the second most important impediments. Out of the three farm inputs mentioned by the farmers, the problem emerging from lack of seed (20.7 percent) outweighs the other two while the problem from lack of drought oxen rests as the second most important barrier.

As expected there is significant and positive association between education level of the household head and adoption of modern crop seeds when combined with inorganic fertilizers or water management practices. The result of (Teklewold,et al 2013) reveals a significant wealth or liquidity constraint effect for the adoption of the combination of climate smart practices. This indicates modern seeds and inorganic fertilizer, an externally purchased inputs, is not adopted by resource poor farmers. Similarly, adoption of only fertilizer or only agricultural water management practice is less likely for credit constrained farm households. The results also reveal that households with confidence in the skills of extension agents are more likely to adopt improved variety or fertilizer. It is also found that access to climate information is important for farmers to use water management practices). With regards to the importance of rainfall and plot level shocks in determining the adoption of combination of adaptation practices, the result indicates that in areas/years where rainfall is worst in terms of timing, amount and distribution, it is more likely that household shifts in to a combination of practices that are more climate smart. This finding suggests that smallholder farmers who realized rainfall variability are using water management practices in combination with modern seeds and inorganic fertilizer as adaptation strategies to mitigate the risk of climate variability.

2.2.2. Agro ecological zone

Agro- ecology is one of the main factors that determine adopting strategies to climate change. The finding of (Gebre*et al.* (2015) revealed that agro-ecology was negatively and significantly affects smallholder farmers' decision to use small-scale irrigation as coping option. Farmers in woinadega agro- ecological zone were less likely than farmers who were living in kola in using small scale irrigation as option to cope up with climate change this might be relate to differences in natural of resources, evapo transpiration and soil type. Farmers in kola agro ecological setting are expected to invest more on small scaled irrigation in order to minimize the moisture stress and shortage of rainfall. In line with this finding, reported that as compared to Kola, farming communities in "Woinadega" deceases to use irrigation, and soil and water conservation, but increase in using different crop type s and/or varieties in Tigray, Northern Ethiopia.

2.2.3. Sex of the household head

The investigation of (Ajibefun and Fatuase (2010), and Temesgen et al (2010) the sex of the household head is significantly and positively affects adaptation of agro- forestry, soil and water conservation and small scale irrigation. Male headed sample households are more likely to use more strategies as compared to female headed households. This might be due to the fact that women may have limited access to information, land, and other resources due to traditional social barriers or due to the large involvement of the female in housing activities.

Furthermore, Belainehet *al*. (2013) indicates that male headed sample households are more likely to select and use diversified crop and soil and water conservation as adaptation strategy to lessen the holistic effect of climate change as compared to female headed households in the face of an ever increasing pressure on grazing resources and prevalence of severe shortage of animal feed.

2.2.4. Educational level of the household head

In the study of (Aschalew 2014),Gebreet *al*. (2015), and Dirriba and Jema(2015) this variable significantly and directly affected use of soil and water conservation practices. Thus, education increases the use of soil and water conservation practices as adaptation mechanism to the change in climate. This might be education distinct individual's with the necessary knowledge on how to access information in climate change Because higher level of education is directly related with access to information on improved technologies and higher productivity.

Aschalew (2014),Gebreet *al*. (2015), and Dirriba and Jema(2015) result explained that farmers with higher level of education were more likely to adapt with different adaptation options to the change in climate. Similarly the study of Seidet *al*. (2016) suggested that literacy status of farm households' increases awareness about the consequences of climate change on productivity and benefit of crop production and soil and water conservation practices to reduce impacted of climate change.

2.2.5. Livestock ownership size

Livestock are a significant contributor to the GDP of Ethiopia and are the main source of income for a large part of the society. Simultaneously, a large share of GHG emissions originates in the Livestock sector, and the sector is expected to expand even faster than population growth. According to (FDRE 2011) report to prevent the projected doubling of livestock-related emissions to 124 Mt CO2e by 2030, the Livestock STC identified five main levers that offer an abatement potential of 45 Mt CO2e to which climate finance projects could make a major contribution. These abatement levers are: enhancing and intensifying animal mix diversification (e.g., poultry, sheep, goats, fish, etc), improving value-chain efficiency for livestock belonging to farmers and pastoralists through regionally appropriate techniques, and increasing the use of mechanization (small-scale and tractors) through techniques tailored to each type of terrain. A sixth, non-costed lever, rangeland management, provides an additional abatement potential of 3 Mt CO2e, resulting in a total abatement potential of 48 Mt CO2e in the Livestock sector.

The (Seid*et al.*, 2016) work indicated that the size of livestock holding is affect positively and significantly the use of soil and water conservation practice, adjusting planting date and improved varieties. Farmers with large herd size have better chances to invest on tools required for conservation practice. This result is also similar with Temesgen(2010),Belaineh*et al* (2013), Aschalew (2014) and Kide (2014). But livestock size has a negative and significant impact on use of temporary migration as adaptation strategy. This might be due to that livestock size play a great role in increasing food security by serving as source of food, income and traction andas assetsin order to stay stabled the households in their local area. In addition to above ideas Wassie and Fekadu (2015) also explained that household's mobility from one location to other location is significantly determined by livestock ownership as option choice in pastoralists of southern part of Ethiopia.

2.2.6. Family size

According to the finding of Temesgen*et al*. (2008) Family size has positive and significant impact on the likelihood of using soil and water conservation practice as an adaptation strategy. The reason might be that families with higher number of members may have the probability of work division between them in order to handle soil and water conservation as an adaptation mechanism. Furthermore, Seid*et al*. (2016) stated that large family size is normally associated with a higher labor endowment, which would enable a household to accomplish various agricultural tasks which are labor intensive such as diversifying farm products, using irrigation agriculture and using new varieties of different crops which require new farm operations. Similarly, family size has shown positive and significant association with temporary migration as coping option. This means that unit increase in family size will aggravate the migration to urban and Arab countries. The reason might be households with higher family size are forced to migrate to fulfill the household basic necessities as compared to families with lower household size.

2.2.7. Land holding size

According to the work of (Lemmi, 2013; Aschalew, 2014) Land holding size is significantly and positively affected use of agro forestry as an adaptation strategy. Farm size is always associated with greater wealth, more capital and resources and those families with such large land holding have an opportunity to formal and non-formal credit service accesses, and the ability to take risk regarding to climate change decisions. However, land holding size has shown negatively and significantly association with soil and water conservation practice. The reason might to due to fact that farmers with more land holding can benefit from the economics of scale of it as compared to those who had small land holding size.

2.2.8. Frequency of extension contact

Temesgen*et al*. (2010) revealed that number of extension contact was significantly and positively affected use of small scale irrigation practice and improved crop and livestock varieties as coping

chanism. The reason might be that farmers with higher extension contact have more information on climate change in order to take mechanisms by using improved crop and livestock varieties (early mature, drought tolerant, and pests and diseases tolerant) and irrigation to supplement the low precipitation. Moreover, Aymone (2009) had indicated that access to extension service increases the probability of perceiving the climate change and increase the likelihood of uptake of adaptation techniques. Similarly 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. On the other hand extension contact was inversely and significantly related with adjusting planting date and temporary migration. Farmers with higher extension services are lesser likely to migrate from their homeland to other areas. This might be helped them to participated in other adapting strategies such as non-farm and off-farm activities, small scale irrigation (to reduce moisture stress effect) and soil and water conserving practice to enhance their farm productivity. Similarly, those households with better extension service have less probability to adopt adjusting planting/sowing date in the study.

Frequency of extension contact is positive and significant association with soil and water conservation, adjusting planting/sowing date and improved varieties as coping options. This might be due to the fact that access to extension contacts, access to media, networks and climate change forums. Madison (2006) had indicated that access to climate information increases the probability adjusting planting date and harvesting time, decision on choice of variety and time of fertilizer application, practicing soil and water conservation and planting more trees at plot level. Madison also expressed that access to climate information on climate change through extension agents or other sources creates awareness and favorable condition for adoption of farming practices that are suitable under climate change also it is an important precondition for farmers to take up adaptation measures. Further, access to climate change information has inversely and significantly influence on temporary migration. The possible reason might be during amusing future climatic condition, farmers with more access to climate information of their local area are less likely to migrate temporarily to other locations.

2.2.9. Age of household head

As the finding of Mulwa*et al*. (2015) indicates age matters in any occupation and rural households mostly devote their live time or base their livelihoods on agriculture and it is believed that the older the household head, the more experience he has in farming and climate change forecasting. Opposite to the expectation, the study showed that age is negatively and significantly associated with agro forestry at p<5% probability level. Moreover, this variable inversely and significantly related to soil and water conservation activity to reduce the adverse effects of climate change in the study area. The possible reason might be, farmers are expected to make stone bunds, ridging, mulching, conservation agriculture and manure application as soil and water conserving mechanisms which are labor intensive. Therefore, aged farmers may lack

perform such activities due to being aged. Similarly CCAFS (2015) also reported that developing countries such as Ethiopia are highly vulnerable to climate change impacts due to underdevelopment and widespread poverty, thus limiting their capacity to adapt: elder, women, and disable communities in arid and semi-arid areas lack to adapt different strategies to lessen the negative effects of climate change.

2.2.10. On and Non/off -farm income

The study conducted by Kide (2014), Seid et al. (2016) and Gebre*et al.* (2015) revealed that on-farm income had positive and significant impact on use of agro forestry, soil and water conservation, small- scale irrigation and improved varieties (crop and livestock) as adapting strategies. This has shown that farmers with higher on-farm income are more likely to adapt agro-forestry, soil and water conservation practice, small scale irrigation and improved varieties in study area. The reason might be due that farmers with higher on-farm income may have the ability to invest on agriculture inputs (irrigation materials, improved seeds) and human power (employing daily laborer in conserving soil and water, and irrigation actives).

According to study stated by Aschalew (2014) stated off farm income variable negatively and significantly impacted the soil and water conservation, and small- scale irrigation as adaptation strategies. Farmers with lower non/off-farm income have higher probability to adapt soil and water conservation practice, and small- scale irrigation. The possible clarification could be farmers with less non/off- farm activities may have higher possibility to invest more time on agricultural activities in order to reduce the impact of the change and variability in climate. In line with this result, that the farmers' income from non-farm activities increased they devote less and less time for farming activities hence it could negatively affect the farmers' climate change adaptation decision. However, on/off-farm income has shown positively and consistently relationship with agro forestry as an adaptation strategy. The reason might be farmers with higher off/nonfarm income may have additional financial power in order invest on planting trees to maintain and enhance their farm productivity. In line with result of Aymone (2009) and Seid et *al.* (2016) availability of off /nonfarm income improves farmers' financial position, which, in turn, enables them to purchase farm inputs such as, seed and fertilizer.

2.2.11. Distance of market from home stead

Temesgen (2010) and Aschalew (2014 revealed that Distance of market from home significantly and negatively affected use of improved varieties (crop and livestock) and temporary migration as opting mechanism. The possible reason is households nearer to the market use improved varieties as opting strategy because they may access information on improved varieties to use it as adaptation strategy against climate change stresses. Moreover, Seid*et al.* (2016) explained that when farmers are far from market center, the transaction cost for acquiring input and output will be high and this will, interns, reduces the relative advantage of adopting new technologies

3. Conclusion and policy Implication

Climate change is a common enemy that our world society is facing in the twenty first century. This change of climate is more affects developed and underdeveloped society than developed world. From the developing world Ethiopia is one of the country that faced and facing or by this problem. In Ethiopia also there are different diversified livelihoods societies exist. From those the society which is more vulnerable to climate problem is our rural people. In Ethiopia rural area the farmers use different mechanisms to response the climate change occur in their environment.

Climate change resilience is the option used in responding to climate change. As shallowly tried to mentioned above Ethiopian smallholder farmers used/using different mechanisms to cope the climate change. Those are they plant more trees to resist drought and famine from their farm land and also they use diversified crops on their farm land including the crops that resistant to drought like Enset. Besides producing of different diversified crops they also produce livestock means they goes agrarian activities with pastoralist one. They also use those livestock and crops as selling asset including their land. They can sell them if the climate change is occurred. Few Ethiopian smallholder farmers used irrigation in the summer either by diverting/accumulating the winter rainy water by creating small lake or directly use from river to cope climate change. Not only this, if is the problem beyond their capabilities they may go to support for food aid. So these are the mechanisms used by smallholder farmers of Ethiopia to respond to climate change occurring and occurred in the Ethiopia.

Even though they use different mechanisms there are a lot of obstacles face Ethiopians smallholder farmers to cope from climate change. From that access of information play significant role negatively or positively. If the information that disseminate through media or extension agents or DA is not reaches to the farmers on climate change they may easily affected by climate change. Agro ecology is also the main factor that affects small holder farmers on responding to climate change. In this aspect smallholder farmer who lives in kola and weyna dega cannot have equal opportunity even to take coping strategy. For instance the smallholder farmer who lives in kola can have less opportunity for irrigation than that of wayna dega. In addition to sex, educational level, livestock ownership, family size and land holding are the factors that affects small holder of farmers negatively or positively. The distance between the small holder farmers and market is also other factor that affects our farmers. If the market they use usually is far from the place where they live they may not get access of the material they need.

Based on the findings from the literatures reviewed, the following points are suggested as options to resilient climate change problem in Ethiopia:

- In order to cope with climate change Ethiopian small farmers should have to start responding to climate change by cultivating different types of crops, conserving natural recourse by planting trees and so on. On the other hand smallholder farmers should expand the habit of irrigation to produce additional production in winter time even by accumulating summer water.
- The crop that Ethiopian smallholder farmers produce also should be drought resistance crops like Enset
- In cultivating crops only producing diversified crops cannot be solution for climate change so mixing with livestock production (pastoralism) is preferable.
- In addition to participating in farm activities participating in off-farm activities is also other solution in coping with climate change
- Having a lot of land, livestock and other asset is important in respond to climate change if small holder farmers have enough assets that can be sold in the time of the occurrence climate change they can sell it and find other solution.
- If the climate change problem is beyond the capability of our farmers they should have to migrate to other place in that time if any thing needed by them they should have to ask or seek support from government or NGOs, like food and the like.
- Information plays a great role in responding to climate change so our smallholder farmers should have to access of information this include the GO, NGO and Das, they should have to properly reach the information to the farmers.
- The farmers should have to learn formal education as much as possible
- The income of small holder farm should not have depend on on-farm activities participating on both income generating activities is preferable.

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