



Review Article

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Smallholder Farmers Perceptions and Adaptation Strategies to Climate Change in Ethiopia Review



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Abstract

The objective of this review on Smallholder farmers perceptions and adaptation strategies in case Ethiopia. Smallholder households obtain livelihoods through the rural labour market, self-employment in rural non-farm economy, migration and rain-fed agriculture. Agriculture is the major source of rural livelihoods. Climate refers to the average weather and represents the state of the climate system over a given time period. Due to natural variability and human interventions, there is increase in the emission of the greenhouse gases reflecting variation of the mean state of weather variables including temperature, precipitation and wind. Greenhouse gases (GHGs) are more important for their ability to trap heat from the sun and create atmosphere that supports the life on Earth. However increasing levels of these gases is the cause of global temperatures, resulting in the most severe ecological crisis that earth has witnessed in the whole of human history. Adaptation is adjustment in ecological, social or economic systems in response to actual or expected climatic stimuli and the effects or impacts. This term refers to change in processes, practices or structures to moderate or offset potential damage or to take advantages of opportunities associated with changes in climate. It involves adjustment to reduce the vulnerability of community's regions or activities to climate change and variability. Adaptation is important to climate change issue in two ways- one relating to assessment of impacts and vulnerabilities, the other of the development and evaluation of response options. In Ethiopian diverse type of climate adaptation strategies considered crop variety; improve crop and livestock, soil and water conservation practices and irrigation. The main factor influence to farmers' adaptation strategy climate changes such as group of age, family number or size, farm profits, farm dimension, distance to the farm, distance to the market, access to credit, livestock holding, farm to farm extension and access to climate information is basic one. The crucial barrier to type of weather transform altered copy on the farmers' side are lack of knowledge, lack of capital, lack of sufficient land and lack of information. Therefore, future policy should focus on awareness creation on climate change to adaptation through different ways such as mass media and extensions, encouraging informal social net-works, improving the availability of credit and enhancing research on use of new crop varieties are more suited in different agro ecological zones.

Keywords: Climate change, Adaptation

Introduction

Agriculture is the dominant sector of the economy in most of least developing countries. Ethiopia is one of the developing countries in which agriculture is the main source of the Economy. It contributed 41.6 percent to GDP, 60 percent for employment and 80 percent for export earnings. This sector is expected to have a base and primary determinant for GTP. In line with this environmental conservation it plays a great role in sustainable economic growth and development. The issue of climate change stands at the heart of this transformation agenda. Currently the issue of climate is one of the key agenda worldwide. Ethiopia is highly vulnerable to climate change and low capacity to adopt

and perceived. Climate change is a natural phenomenon which influences agricultural production and negative effect on the social and economic activities and lead to food insecurity in particular [1]. According to IPCC [2] Africa is one of the regions that will be hard hit by the impact of climate change like increasing in temperature and reduction in rainfall. Agricultural production and food security in many African countries could be affected by climate change and variability. By 2020 some countries rain-fed agriculture could be reduced by up to 50 percent, with smallholders being the most affected. The impact of climate change could be reducing the economic growing in some parts of Africa and these effects are expected to get worse. This implies that

reduction in agriculture production of the smallholder farmers and would be further adversely affected food security. To sustain current levels of food production and to meet future challenges smallholder farmers` may have to respond to the impact of climate change using an adaptation strategy. Climate change affects all aspect of economic growth especially in least developing countries. To reduce the impact of climate change and enhance food security, adaptation measures are urgently required. The process of adaptation options is needed to be location, integrated and flexible. This climate change affects to all agricultural sector

in a multitude way. For example, changing weather pattern such as heavy flood and storms makes the agricultural production low and leading to extreme events of poverty and slow down economic development. In general, there is a relationship between climate vulnerability, poverty and food insecurity [3].

Moreover, adaptation is critical and necessary in developing countries, especially in Ethiopia where the fact that vulnerability is high. Most people of livelihoods and living standard are affected by the impact of climate change. Farmers with better knowledge and information on climate change and agronomic practices enable to use adaptation methods to cope up with change in climate and other socioeconomic conditions [4]. A better understanding of the local dimensions of climatic change is also essential to develop appropriate adaptation measures that can mitigate the adverse impact of climate change. Therefore, awareness of the potential benefits from adaptation is an important issue. According to Deressa et al. [5] increasing temperature and rainfall variability in different part of Ethiopia were adversely affect the agricultural production of the rural household farmers. To minimize the impact of climate change on stallholder farmers', adaptation strategy is vital instrument. The main critical points such as social, economic, technology and environmental trends are able smallholder farmers to perceive and adapt to climate change. In addition, knowledge by itself on the adaptation method and factor affecting farmer's choice of the adaptation strategies are enhancing efforts directly towards tackling to the impact of climate change. (ibid)

By understanding all of these facts, effort should focus on finding mechanisms in which smallholder farmers can reduce these problems and improve effort to strength smallholder farmers' adaptation to climate change. Generally, it is believed that the adaptation strategy of smallholder on agriculture to climate change is imperative to enhance the resilience of agricultural sectors. Agriculture is the major driver of economic growth especially in developing countries. Ethiopia is one of the least developing countries in which majority of its population depend on agriculture sector. Raising the agricultural production at the national level leads to improve overall economic growth and development. However, currently climate change has become a serious threat to sustainable economic growth [6]. The impacts of climate change have been adversely affecting the economic growth. These impacts affect all economic sensitive sectors especially agriculture sector. Ethiopia is a poor country and its

economy is highly depending on agriculture which had failed to meet the growing food demand. This is due to the fact that the negative effect of climate changes on agricultural production [7]. Moreover, According to Deressa [8] Ethiopian agriculture sector is negatively affected by climatic related disasters with drought and flood being the major one. Adaptation is an essential strategy to enable farmers to cope with the adverse effect of climate change and variability which in turn increase the agricultural production of the poor farm households [9]. Similarly, knowledge of the adaptation methods on the side of smallholder farmers may make it better to tackle the challenge of climate change [10].

Climate change is unexpected impact because it is a natural phenomenon that varies with location, socio economic and environmental conditions. The capacity to adapt to climate change is unequal across and within societies. This fact implies that the adaptation measures at micro level farm household are important to get truth and appropriate policies. According to Maddison [10] there is a difference in the propensity of farmers living in different locations to adapt. Farmers in different area or agricultural zone have unequal propensity and capacity to climate change impact and adaptation. According to Admassie et al. [11] in-depth study on vulnerability and adaptation should continue. To address this studying one specific site area is appropriate.

Theoretical Literature Review

Overview of Climate Change

Climate is a thin sense more often than not distinct as the standard weather or more rigorously, as the arithmetical explanation in provisions of the indicate and unpredictability of appropriate quantity over a stage of time from months to thousands or millions of years. Climate change refers any change in climate over time through natural variability or as a result of human activities [2, 12]. Climate change refers a change of climate which is attributed directly or indirectly to human being activities that alter the composition of the global atmosphere and which are in addition to natural climate variability observed over comparable time period. Africa is highly stressed, low adaptive capacity and easy vulnerable to climate change. The main penalty of this negative impact of weather change or present climatic hazards are poverty, unequal access to resources, food insecurity, globalization trends, social and political conflicts and incidences of diseases such as malaria, tuberculosis and HIV/AIDS. This impact of climate change presents a substantial challenge to regional agricultural development. The sub Saharan Africa country are low adaptation mechanism and vulnerable to the widespread effect of climate change. According to IPCC [2] increase in global average temperature above the range of 1.5-2.50 which is negatively influences species distribution and survival. In most of developing country where the majority of the population has the dependence on natural resources-based livelihoods, this can an crash on socio economic and difficulty to the overall threats to sustainable development.

Rural agricultural and Climate change

The agricultural sector remains at the centre of developing countries' economies. It plays significant role in food safety for all human being. In spite of their developmental significance, the rural communities are also characterized by poverty and marginalization, which aggravate and are aggravated by the effects of climatic variations, seasonal changes and uncertainty caused by climate change. According to FAO [3], farmers in some regions may benefit temporarily from the effects of CO₂ emissions in the form of higher yields, the general consequences of climate change are expected to be adverse, particularly for the poor and marginalized who in turn, constitute the main inhabitants of rural agricultural communities. The main reason is that, the rural agricultural communities are dependent on the fragile agricultural activities for their means of livelihoods and they are located in areas of high environmental risk and climatic exposure and easily affected.

Moreover, the subsistence of these communities is largely resource-based. More intense and uncertain weather patterns and extreme events such as floods and droughts contribute to deforestation, desertification, land degradation, depletion of water sources, infrastructural and social damage, among others. This erodes not only local income but ultimately the ability of rural agricultural communities to respond to the challenges posed by a changing climate. This makes rural agricultural communities a priority in the design of innovative climate change responses. In addition, climate-smart agriculture, contributes to the achievement of sustainable development goals. It integrates the sustainable development of economic, social and environmental by jointly addressing food security and climate challenges.

It is composed of three main pillars:

- a. Sustainably increasing agricultural productivity and incomes;
- b. Adapting and building resilience to climate change;
- c. Reducing and/or removing greenhouse gases emissions, where possible.

Climate-smart agriculture is an approach to developing the technical, policy and investment conditions to achieve sustainable agricultural development for food security under climate change. The effects of climate change on agricultural systems create a compelling need to ensure comprehensive integration of these effects into national agricultural planning, investments and programs. The Climate-smart agriculture approach is designed to identify and operational sustainable agricultural development within the explicit parameters of climate change FAO [13].

Climate change and agriculture sector in Ethiopia

There are different ways of classifying the climatic systems of Ethiopia, including the traditional and the agro-climatic zone in classification systems [14]. The most commonly used classification systems are the traditional and the agro climatic zones. According

to the traditional classification system, which mainly relies on altitude and temperature for classification, Ethiopia has five climatic zones. The agro-ecological classification method is based on combining growing periods with temperature and moisture regimes. According to the agro-ecological zone classification system, Ethiopia has 18 major agro ecological zones, which are further subdivided into 49 sub agro-ecological zones. These agro-ecologies are also grouped under six major categories [15], which include the following:

- a. Arid zone: This zone is less productive and pastoral, occupying 53.5 million hectares (31.5 percent of the country).
- b. Semi-arid: This area is less harsh and occupies 4 million hectares (3.5 percent of the country). Sub moist: This zone occupies 22.2 million hectares (19.7 percent of the country), highly threatened by erosion.
- c. Moist: This agro ecology covers 28 million hectares (25 percent of the country) of the most important agricultural land of the country, and cereals are the dominant crops.
- d. Sub humid and humid: These zones cover 17.5 million hectares (15.5 percent of the country) and 4.4 million hectares (4 percent of the country), respectively; they provide the most stable and ideal conditions for annual and perennial crops and are home to the remaining forest and wildlife, having the most biological diversity.
- e. Per-humid: This zone covers about 1 million hectares (close to 1 percent of the country) and is suited for perennial crops and forests. Over these diverse agro ecological settings, mean annual rainfall and temperature vary widely.

Agriculture is the backbone of the Ethiopian economy. In line with this climate is the key determinant factor for economic growth and development. This is due to the fact that most of population in Ethiopia is the dependence of rain fed agriculture sector. This sector is an important for the communities and also use as an engine for the country's economic growth.

The agriculture sector they expressed in the form of crop production, livestock production, forestry, fishery etc. Each of them contributed to agriculture sector, for instance crop production is estimated to contribute about 60 percent, livestock 27 percent, forest and other sub sector around 13 percent of the total agricultural value in the country [16]. According to [8], Ethiopia as one of the country's the most vulnerable to climate change with the least capacity to respond. Indeed, Ethiopia has experienced at least five major national droughts since 1980, along with literally dozens of local droughts. Cycles of drought create poverty traps for many households, constantly thwarting efforts to build up assets and increase income. Food shortage and famine associated with rainfall variability cause a situation of high dependency on international food aid. And Ethiopia is one of the biggest food aid receipt countries in Africa that accounts to 20-30% of all food aid to sub-Saharan Africa [17]. This is due to the

fact that agricultural production in Ethiopia is adversely affected by climate change and weather variability's, which is decreasing crop yield, decrease in livestock feed availability, affecting animal health, expansion of tropical dry and expansion of desertification. Moreover, agriculture sector is the Key determinant to the life of human being. However, it is affected by drought, floods, storms and rainfall failures. This effect is attributed to the fact that those factors that affect by climate change can be seriously depressing agricultural production in the country. As a result the country leads to shock the economy as a whole and loss malnutrition of livelihood for the households in particular [18].

The effects of climate change on agricultural production of Ethiopia is manifested through shortening of maturity period and then decreasing crop yield, changing livestock feed availability, affecting animal health, growth and reproduction, depressing the quality and quantity of forage crops, changing distribution of diseases, changing decomposition rate, contracting pastoral zones, expansion of tropical dry forests and expansion of desertification, etc. Rainfall is highly erratic, most rain falls with high intensity, and there is a high degree of variability in both time and space.

According to IPCC [2], the successes and failures of crops have always been subject to prevailing environmental factors. Crop production is increasingly vulnerable to risks associated with new and evolving climatic changes. These are variations in environmental conditions that pose significant challenges to smallholder farmers. The planet is facing more extreme weather events, such as heavy precipitation, higher coastal waters, geographic shifts in storm and drought patterns and warmer temperatures. Besides, Climate change is regularly listed as a major contributor to the food insecure state of Ethiopia and drought remains the top priority by the government [19]. Farmers also reflect this in their claims that the weather is indeed different to what it was a few decades ago [20]. However, evidence does not bear out any significant change in rainfall; although it has some changes in the pattern of rainfall have been observed.

According to NMA [21], there has been a warming trend in the annual minimum temperature over the past 55 years. It has been increasing by about 0.370C every ten years. The country has also experienced both dry and wet years over the same period. The trend analysis of annual rainfall shows that rainfall remained more or less constant when average over the whole county. Ethiopia is the vulnerable country to climate variability and change due to lower adaptive capacity, low level of socio-economic development, high population growth, inadequate infrastructure and lack of institutional capacity and heavy reliance on natural resource-based socio-economic activities which are highly climate sensitive. The country will experience an increasing level of temperature and precipitation in the coming decadence.

The heavy rainfall and temperature patterns in the different regions in Ethiopia and the differences in the level of socio-

economic development implies that the regions differ in their vulnerability and adaptive capacity to changing climate related hazards. According to Deressa T, Hassan M, Ringler C [22] found that Afar, Somali, Tigray and Oromiya regions more vulnerable to climate change than other region of the country. The study revealed that Afar and Somali is attributed to their low level of rural service provision and infrastructure development and that of Tigray and Oromiya to the higher frequency of drought and flood, lower access to technology, fewer institutions and lack of institutions. This increasing frequency of droughts and floods have negatively affected agricultural production, demonstrating agriculture's sensitive to climate change.

According to World Bank [7] in Ethiopian context agriculture is the dominant sector of the economy. It contributes near half of the GDP and for the vast of majority of the employment, for generating income, foreign currency and also supplying basic needs of food security. Even though, Ethiopia is highly vulnerable to climate variability and change. Due to the fact that highly depend on rain fed and traditional practices in major part of the area.

Planned climate change in Ethiopia

Over the upcoming year all models agree that temperature will be enlarge in Ethiopia, model predict precipitation give contentious grades of both rising and decreasing Precipitation. Similarly, According to the World Bank [7] Climate change is projected to reduce yields of the wheat staple crop by 33% in Ethiopia. This amounts to a serious threat to food security and to the achievement of major developmental goals.

Hence, there is a strong observable link between climate change variations and overall economic performance. The models predicting future climate change scenario in Ethiopia put conclusion that temperature will increase in the coming decades. However, there is conflicting results concerning the predicted level of precipitation [23]. There is constant, decreasing and increasing level of projected precipitation level are generated using different models. According to NMA [21] indicate that temperature will increase in the range of 1.7- 2.1C⁰ by the year 2050 and 2.7-3.4C⁰ by the year 2080 over Ethiopia. The country will experience an increasing level of temperature and precipitation in the coming decades. However, it stated that a small increase in rainfall can be expected. Studies indicate that Ethiopia in the coming year will face a decrease in agricultural production due to the adverse impact of climate change and variability's [23].

This suggests that agricultural production as an engine of growth and development and vulnerable to climate change and climate variability. While the more pronounced effects on crops and livestock are likely to materialize in later decades, efforts to enhance the resilience to climate shocks of crop yields and livestock production should be improve, this mechanism become increment in agricultural output and lead to achieve the overall objective of Ethiopian growth and transformation plan.

Idea of adaptation and climate change

There are diverse definition of adaptation to climate change. These definitions are given as follows. Adaptation - Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploit beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation [24].

Adaptation - Practical steps to protect countries and communities from the likely disruption and damage that will result from effects of climate change. For example, flood walls should be built and in numerous cases it is probably advisable to move human settlements out of flood plains and other low-lying areas..." (Website of the UNFCCC Secretariat). Adaptation - Is a process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, and implemented (UNDP, 2005). All these three definitions differ from one another in several ways. First, all are used different words to describe the definition of adaptation. The first key words in the definition that express adaptation as 'adjustment', 'practical steps' and 'process' can be interpreted differently by various stakeholders. 'Process' seems to be a very broad and open-ended term that does not include any particular time or subject references and can easily incorporate

'steps' and 'adjustments'. 'Adjustment' seems to imply a process that leads toward some standard or goal. These seemingly small differences might create different expectations from different stakeholders, depending on the meaning of the term that they decide to use.

The IPCC provides a broad definition by distinguishing various types of adaptation (e.g., anticipatory, reactive, public, planned adaptation, etc.) and focuses not only on technical adaptation measures but also on institutional responses. The IPCC definition also includes adaptation of natural systems not just human. One can already see that some stakeholders (e.g., community-based adaptation practitioners) use a more technical interpretation of the term (the one closer to the definition from the UNFCCC Secretariat website), while others (e.g., adaptation policymakers) use a broader definition and emphasize the institutional/policy side of adaptation. These varied interpretations could have serious financial implications. Adaptation and mitigation are two split policy responses to climate change. Both are; however, basically linked. Mitigation is needed to reduce the impacts and allow for adaptation to takes place, for ecosystems these boundaries are generally narrower than for human systems. Because mitigation measures will not be able to immediately avoid global warming [25], adaptive measurements will be needed to avert the negative consequences of climate change at the short term. On the longer-term mitigation measures will be able to avoid further warming or even reduce the effect.

There are many different strategies that the farmers can implement to reduce the risk of climate change impacts. Farmers use different adaptation strategies that fit with the types of the problems caused by climate change they faced. This is due to the fact that impact of the climate change is unevenly distributed over different geographic areas and hence the adaptation mechanisms also vary with types and level of the impact of climate change. Therefore, adaptation strategies that the farmers used to reduce the impact of climate change in different way: for instance changing crop variety, changing planting dates, mix crop and livestock production, decrease livestock, moving animals/temporary migration, change livestock feeds, soil and water management, planting trees, change from livestock to crop production, change animal breeds, seek off-farm employment, planting short season crop, and irrigation/water harvesting are among some of the several strategies available to enhance social resilience in the face of climate change [7,26].

Adaptation strategies are differing among individual farmers depending on their capacity and willingness to adopt. There are factors that are restricting adaptive capacity and willingness to adopt as a potential source of limits and barriers to adaptation. The main constraints and barriers to adaptation are biophysical, economic, social, and/or technological in nature. According to FAO [3] Climate change has strong impact on the agricultural sectors and forestry by modifying or degrading productive capacities and by directly and indirectly increasing the risks associated with production. Due to the fact, most of developing countries are particularly vulnerable to the adverse effects of climate change. In coming decades, millions of people whose food and livelihood security depends on farming, fishing, forests and livestock-keeping are likely to face climatic conditions that are unprecedented in the history of agriculture. To sustain current levels of food production and to meet future challenges adaptation is often underestimated by the international community. Climate-smart agriculture seeks to maximize benefits and minimize negative trade-offs across the multiple objectives that agriculture is being called on to address: food security, development, climate change adaptation, and mitigation. The key elements include increasing productivity and resilience, reducing GHG emissions or enhancing sequestration, and managing interfaces with other land uses. Climate-smart agricultural options will in many cases be sustainable agriculture practices that take into account the need for climate change adaptation and mitigation. Increasing productivity and the resilience of agricultural systems to climate change impacts, both from extreme events and slower-onset changes, as well as enhancing agricultural adaptation by altering exposure, reducing sensitivity, and increasing adaptive capacity, are considered fundamental to the continued viability of agriculture sector [13].

Information on climatic condition very important in order to response the impacts of these changes. Therefore understanding the linkage between climatic condition and socio-economic activities are essential method to minimize impact of climate

change. The understanding of adaptation to the impact of climate change can be decrease the adverse effect of climate change at the presence as well as for future climate. Adapting to present climate is not the same as adapting to future climate change. The responsible bodies can be learned from the past for the future about adaptation options and the process of their adoption. this is due to the fact that the responsible body can be learn from the past satiations. Studies of adaptation to current climate also make it clear that human activities are not now always as well adapted to climate as they might be. In the development context, therefore, a prudent adaptive response to the threat of climate change may be to improve adaptation to existing climate and its variability, including extreme events. Improving adaptation to current climate variability is not an alternative to preparing for adaptation to longer term changes in climate. It is an adjunct, a useful first and preparatory step that strengthens capacity now to deal with future circumstances [27] cited in Muleta, [28]. Adaptation is initiatives and measures to reduce the vulnerability of nature and human systems against or expected climate change effect. There is various type of adaptation, for example anticipatory and reactive, private and public, and autonomous and planned. Adaptive capacity is intimately connected to social and economic development, but it is uneven distributed to the societies. There are a lot of limitations that barriers the effectiveness of adaptation measures. The adaptive capacity is depending on the community productive bases, capital asset, social network, human capital and institutions, government, national income, health and technology. But societies with high adaptive capacity may be vulnerable to climate change [2]. Agricultural sector is adversely affected by climate change and variability. This can minimize the negative impact by using adaptation strategies like adjustment of planting and crop variety, crop relocation, improved land management (e.g. erosion control and soil protection through tree planting) [29-54].

Perception of the peoples about climate change

Local awareness and perception of climate variability and trends related to climate change and associated impacts on natural resources

- i. Changes in rainfall seasonality, abundance
- ii. Observed changes and trends in temperature
- iii. Cyclones – frequency and severity
- iv. Floods – frequency and severity
- v. Droughts – frequency and severity

Water resources – changes in quality, quantity

- i. Forest Cover – changes in extent, wood supply
- ii. Soil fertility, extent of erosion, runoff
- iii. Wildlife/Fisheries/Other natural products

- Consequences and impacts of climate related changes and

trends, with particular attention to

Livelihoods and socio-economic impacts

- i. Impacts on human health
- ii. Changes in food security
- iii. Changes in principal sources of income, livelihoods
- iv. Changes in crop yields, productivity of rural production systems
- v. Changes in land use mix changes in labor/time devoted to secure water supply
- vi. Changes in availability of fodder, fuel-wood, non-timber forest product (NTFPs)
- vii. Changes in incidence of bush fires or other consequences
 - Expectations of future changes and perceptions of vulnerability
 - i. Expectations for rainfall
 - ii. Anticipated patterns for cyclones, floods, drought
 - iii. Anticipated changes in land use
 - iv. Anticipated situation regarding food security
 - v. Observations on major drivers of observed changes in rainfall, temperature, food production
 - vi. Other sources of major impacts on local livelihoods and the conservation of biodiversity
 - Observations on responses and adaptation
 - i. Local initiatives and adaptations adopted in terms of mix of crops planted
 - ii. Adoption of soil/water conservation practices
 - iii. Other measures taken to intensify or diversify agricultural production
 - iv. Other major changes in use of natural resources or shifts in relative importance of local
 - I. Livelihoods.
 - Observations about barriers or principal constraints to adaptation to climate change and Implementation of interventions to reduce vulnerability
 - i. Principal interventions that could be implemented to reduce risks and negative impacts
 - I. Associated with climate change
 - i. Major constraints or barriers to implementing recommended interventions
 - ii. Potential actions that could facilitate and support local level adaptations to climate change

Conclusions

In spite of this disparity in the perceived direction of changes in these elements of climatic change, the adaptation strategies such as different crop variety and improve crop and livestock are the most commonly practiced adaptation strategies to climate change by the households. These includes lack of knowledge, lack of capital, lack of sufficient land, lack of information and unobserved climatic related problems are the major ones. In addition, lacks support from the governmental body as well as not giving emphasis by the farmers themselves are also among the barriers to climate change adaptation in the study area. For instance, age of the household head has positive effect on the probability of farmers to use soil and water conservation adaptation strategy to climate change. An increase in age of the household head, increase the probability of farmers to use soil and water conservation adaptation strategy. On the other hand, a family size of the household has positively influence on the probability of farmers to use crop variety and irrigation adaptation strategies. An increasing in family size of the household head, increase the probability of farmers to use different crop variety and irrigation adaptation strategies. Similarly, the household income from farm is also positively effects on the probability of farmers to use irrigation and soil and water conservation adaptation methods. An increase in household income from farm, increase the probability of farmers use irrigation and soil and water conservation adaptation methods. Farm size of the household head has positively influenced the probability of farmers to use crop variety adaptation strategy. Moreover, Access to climate information has also positively influence the probability of farmers to use soil and water conservation strategy to climate change.

In addition, access to credit, farm to farm extension and livestock size are positively determines the probability of farmers use different crop variety and improve crop and livestock adaptation strategies to climate change. Distance to the farm and distance to the market are also positively influence on the probability of farmers no to adopt any adaptation strategies to climate change. On the other hand, distance to the farm is negatively determine the probability of farmers to use improve crop and livestock adaptation strategy. Besides, Social and physical infrastructure should be improved and institutions dealing with climate related issues including the meteorology agency be strengthened to increase adaptive capacity and also access climate information is very crucial for pre-informing the farmers about the future weather condition. Therefore, in this case the role of metrological agency is very worthwhile in communicating information about weather condition to the farmer using different mechanisms like radio and/or television. This awareness creation effort should be combined with the different types of crop and livestock production and management practices that farmers could use different adaptation mechanisms to climate change. Policies aimed at promoting farm-level adaptation need to emphasize on the crucial role of providing information on better production

techniques and enhancing farmers' awareness on climate change to enable farmers adapt to climate change. In addition, addressing the climate related problems calls for the government as well as NGOs working on this issue to first tackle the barriers to climate change adaptation in the study area.

These include provision of the necessary capital inputs at reasonable price, initiating the farmers to give emphasis for the issue of climate by creating detailed awareness about the causes and consequences of climate change as well as the adaptation methods together with continuous follow up from agricultural extension officers. For example, provisions of material and technical support for the farmers necessary to tackle the adverse impact of climate changes. Moreover, Government policies should support the provision of access to education, credit, extension services on crop and livestock production, and information on climate and adaptation measures are necessary to better cope with climate change in the study area. Additionally, policy interventions that encourage informal social networks i.e farm to farm extension services can promote group discussions. This is very necessary for farmers to share experience, information and knowledge among them. Therefore, policy program which is intended at reducing the climate related problems should also focus on accessing improved inputs such as better seeds, improved livestock and fertilizer to farmers with fair price. In addition, provision of crop and livestock insurance has very crucial role in supporting the smallholder farmers to recover from risks against climate related problems.

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