ADDIS ABABA UNIVERSITY

COLLEGE OF DEVELOPMENT STUDIES

CENTER FOR ENVIRONMENT AND DEVELOPMENT

CLIMATE SMART CROP PRODUCTION PRACTICES: EVIDENCE FROM WOLISO WOREDA, OROMIA REGION OF ETHIOPIA

BY: HIWOT LEMA

DECEMBER, 2020

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ADVISOR: PROF. BELAY SIMANE

THE THESIS SUBMITTED TO THE COLLAGE OF DEVELOPMENT STUDIES OF ADDIS ABABA UNIVERSITY, IN FULFILLMENT OF REQUIREMENT FOR THE DEGREE OF MASTERS OF ARTS IN ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

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DECLARATION

I declare that this thesis submitted for the partial fulfillment of the degree of masters of Science in Environment and sustainable development. The thesis entitled Climate-Smart Crop production practices: Evidence from Woliso Woreda, Oromia Regions of Ethiopia. This thesis is my work and it has not been presented by others. And also all sources of materials used for this thesis have been acknowledged and references by APA style were listed at the end of the main body of the thesis.

Student name: Hiwot Lema Debele

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CERTIFICATION

This is to certify that the thesis prepared by Hiwot Lema, entitled Climate Smart Crop Production Practices: Evidence from Woliso Woreda Oromia regions of Ethiopia and submitted to the College of Development Studies of Addis Ababa University in fulfillment of requirements for the Degree of Master of Arts in Environment and Sustainable Development specialization in Environment and Sustainable Development.

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Abbreviations and Acronyms

AGP	Agricultural Growth Program
CRGE	Climate Resilience Green Economy
CSA	Climate Smart Agriculture
DA	Development Agent
ENDC	Ethiopia Nationally Determined Contribution
EPE	Environmental Policy of Ethiopia
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Green House Gas
HH	Household
KII	Key Informant Interview
NDC	National Determined Contribution
NMA	National Metrological Agency
SLMP	Sustainable Land Management Program
SPSS	Statistical Data Presentation for Social Science
UN	United Nation
WB	World Bank
WCSA	With Climate Smart Agriculture Practice
WOCSA	Without Climate Smart Agriculture
WWANRO	Woliso Woreda Agriculture and Natural Resource Office

Abstract

Climate change is the current worldwide problem and resulting in the land, water, and forest degradation. The problem has an adverse effect on agricultural productivity, natural resource and eco-environmental balances. With the help of climate smart crop production practice, the agriculture activity builds a resilient community to manage climate change impact, to reduce its effect, and to recover quickly from negative impact. Hence the major objective of this study is assessing climate-smart crop production practices in Woliso woreda. To achieve this objective primary and secondary data was collected through household questioner survey, observation, focus group discussion and key informant interview. Qualitative and quantitative data were analyzed by descriptive statistics such as percentage, frequency and presented by chart and table. Different climate smart crop production activities were practiced in the area such as soil and water conservation (terracing, planting tree on the farm, planting cover crop and use of the improved variety), use of fertilizer (chemical fertilizer, compost, farmyard manure, incorporate crop residue on farm).The study evaluated the perception of farmers on the improvement of the adaptive capacity from the adverse effect of climate variability and land degradation by practicing climate smart crop production practices the result shows majority of farmers are effective on the return of each practices. The study also revealed that climate-smart crop production practices improve the yield of productivity. The average change of crop yield of climate smart crop production practices is 61% more with compared to without climate smart crop production practices. The increasing rate of yield with practicing climate smart crop production exceeded than without practicing the climate smart agriculture activities.The progress of productivity of crops and the generated incomes of households were increased over the consecutive years.On the other hand. This research also identifies the major barriers to the implementation of climate smart crop production practices, such as lack of farm tools, financial resources, land shortage and limitation of input supply. This research recommends that the woreda agricultural office has to identify the soil type and select the appropriate climate smart crop production practices. Furthermore, climate-smart crop production practice should be implemented based on the investigation of appropriate climate smart crop production practices for the study area.

Keywords: productivity, resilience, sustainable land management, climate-smart agriculture

CHAPTER ONE

INTRODUCTION

1.1.Background of the study

According to the UN (2019) report, 821 million human beings face hunger and 3.2 billion people are living in areas that will be eroded, flooded, turned into deserts, or destroyed by wildfires, hurricanes, or cyclones in the coming decades. Climate change is the cause of social crises like the transformation of arable land into desert, the disappearance of coastal areas resulting from rising ocean levels, and the sinking of cities.

Developing countries like Ethiopia are vulnerable to climate-related impacts in agricultural productivity as the majority of their land surface cultivated under rain-fed agriculture systems (Lioyd, 2016). The emission of greenhouse gases is one of the climate change-related problems that are predominantly derived from high-income countries while the negative effects of climate change are predominantly occurred in low-income countries (Satterthwaite, 2007).

The climate-smart agriculture concept comes as an approach to dealing with the interlinked challenges of climate change, environmental sustainability and food security holistically and effectively. It was launched by FAO in 2010 in a background paper prepared on the Hague Conference on Agriculture, Food Security and Climate Change, in the context of national food security and development goals (Long et al., 2016). CSA was launched based on the growth of the agricultural sector and highly effective in reducing poverty and increasing food security for which the populations dependent on agriculture (Gelaw, 2017).

Therefore, CSA ameliorates the impacts of the risks both in the short term (increase the amount of production per farm, hectare and season) and in the long term (decrease the variability in production over time despite climate change) (Bell et al., 2018).

According to the Ministry of Agriculture, sustainable land management takes climate-smart agriculture as one of its components. CSA is designed to enhance the livelihood resilience/ adaptive capacity to climate change, to come up with a sustainable increase of agricultural productivity and incomes of beneficiary households and reduce greenhouse gas emissions through SLM interventions in selected micro watersheds and assisted by the governmental and non-governmental institution (MoA, 2019).

Besides the sustainable land management program, the climate-smart entry point for the SLM approach is the micro-watershed and focus on the rehabilitation of degraded lands (hillsides, gullies, etc.) through soil and water conservation (SWC) measures. SLMP addresses the challenges and which are achieved through soil and water conservation in the micro-watershed. Finally, the rehabilitated land is available for productive use of agriculture and livestock production. This approach of work system is not only applied in the SLM watersheds but also in any watershed in Ethiopia that aims to achieve land rehabilitation and sustainable use of landscapes (MoA, 2019).

Therefore, this research was conducted to assess the climate-smart crop production practices evidence from Woliso Woreda Oromia rigion of Ethiopia.

1.2.Statement of the problem

Inappropriate agricultural practice, management and environmental unfriendly activities have a negative effect on the environment and productivity. The current farming practices, including land clearing, inefficient use of fertilizers and organic residues have significant contributions to greenhouse gas emissions on the planet. Supply chain activities are an additional major source of greenhouse gas emissions. The agricultural system which depletes soil fertility, biodiversity and water resource affect the real potential of crop yield production (Scherer et al. 2012).

The adverse effect of climate change threatens production’s stability and productivity in many areas of the world. Climate variability is expected to shift production seasons, pest and disease patterns, and modify the set of feasible crops affecting production, prices, incomes, and ultimately, livelihoods and lives (Imran et al., 2018). Consequently, countries that exhibit high vulnerability to weather shocks need to increase the adaptive capacity of the agricultural system (Mccarthy et al., 2011) . Ethiopia is one of disproportionately affected by the destructive effects of global warming on agricultural production and food security, water resources, health, physical infrastructure, and ecosystems (Asrat & Simane, 2017).

Developments of several Climate Smart Agriculture practices are existed. However, it is challenged among smallholder farmers in Africa. Governmental and non-governmental stakeholders have great consensus and recognition on the implementation of the CSA approach but there is a gap in implementation and scaling up/out to the local context (Westermann et al. 2018). The local government of Ethiopia also lacks commitment and responsibility actions over implementations of CSA.

The concept of the new approach of climate smart crop production is not well introduced in the local context and there are different stakeholders existed in the area but few programs such as Sustainable land management (SLM), Agricultural and Growth program (AGP) are being attempted in implementations climate smart agriculture practices in Woliso Woreda. And also there is limitation of empirical studies, evaluation and context-based research on climate-smart crop production practices.

In order to extend the experience and fill the research gaps, this study aimed to assesses climate smart crop production practices delivered by governmental and none governmental institutions in terms of the change of productivity starting from 2007 to 2011. And formulate appropriate evidence based activities to scale up/out the climate smart crop production practices Furthermore, the study identify major barriers affecting farmers from practicing climate smart crop production Woliso Woreda Oromia Rigions of Ethiopia.

1.3. Objectives of the study

General objective

The general objective of this study is to assess climate smart crop production practices in Woliso Woreda, South West Showa Zone, Oromia National Regional State, Ethiopia.

Specifically, the study attempts to:

- ✓ Identify climate smart crop production practices used by farmers to enhance their adaptation/resilience capacity in the study area.
- ✓ Assess the change of crop productivity in terms of yield and income.
- ✓ Identify major barriers affecting farmers from practicing climate smart crop production in the study area

1.4. Research questions

1) What type of climate-smart crop production practices are used by farmers to enhance adaptation/ resilient capacity?

2) At what extent climate-smart crop production practices increase yield and income?

3) What are the barriers affecting farmers from using climate smart crop production practices in the study area?

1.5. Scope of the study

The study was conducted in Woliso woreda, Oromia regions of Ethiopia. It focuses on the assessment of climate smart crop production practices by the intervention of governmental and none governmental institutions.

Due to limited time, the study assesses the climate Smart crop production practices in smallholder farmers by identifying existed practices that enhance the adaptive capacity to climate variability and land degradation effects, taking the average change of productivity in terms of yield and income of the households, and the barriers affecting farmers from using climate smart crop production practices.

The study is limited to two kebeles of Woliso woreda (i.e, Tonbee Anchebi and Werabu Bariyo) due to the present of sustainable land management and climate-smart crop production practices with the integration of governmental and non-governmental institutions adversely due to the existence of soil erosion, scarcity of water and existence of obstacle to implementing the climate-smart crop production practice.

The temporal scope of the study was conducted starting from the production year from 2007 to 2011.

1.6.Limitations of the study

There were different limitations to conduct the research. There is incomplete recorded data in kebeles. Limited information on climate variability at the local level and limited access to CSA-related research works were some of the limitations in the woreda. The reduction of Greenhouse gas emission is one of the objectives of climate-smart crop production practices but this study has limitations on the finance, related data and technology, so, this study did not show the Greenhouses gas emission reduction capacity of crop production practices.

1.7.Significance of the study

This study emerged by taking the major threat of agricultural production and productivity and natural resource that is climate change. As we know the majority of Ethiopian agricultural practices are dependent on rain and it is seasonal whereas highly vulnerable nature to climate change and land degradation. The agriculture sector demands the adoption of climate-smart agricultural practices to enhance sustainable agricultural productivity by improving the resilience capacity of the natural resource. And address the inter linked challenges of food security and climate change. The study identifies the barriers of the climate smart crop production practices that are important to the policy maker, researcher and governmental and non-governmental organizations involving in the application of climate smart crop production practices to a development program to enhance the livelihoods of smallholder farmers and to protect natural resources like water, soil, indigenes plant, birds and animals.

The study will serve as an input for other related studies and academician, develop the awareness of CSA practitioner and extension agent. It indicates possible directions for the problem that faces in the climate smart crop production technologies and practices to enhance evidence-based decision-making process by all concerned stakeholders and by promoting climate-smart crop production practices of the study area.

It also enhances Woliso woreda smallholder farmers to be more productive with less greenhouse gas emission and cope with climate change risks and indicate the contribution of smallholder farmers to global environmental problem reduction.

1.8.Organization of the thesis

This thesis consists of five chapters. The first chapter deals with the background of the study, statement of the problem, objectives, research questions, scope of the study, Limitation of the study and significance of the study. Chapter two treats the review of related literature and conceptual framework. Chapter three focuses on research methodology including a description of the study area, research design, sample size and sampling technique, data sources, methods of data collection, and analysis of the study. Next to this, chapter four consists of the result and discussion parts while the last chapter deals with conclusions and recommendations.

CHAPTER TWO

RELATED LITERATURE REVIEW

2.1. Climate change and agriculture

Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity (Lal, 2016). It is long-term fluctuations of temperature, precipitation, wind and other elements of Earth's climate system, attributed directly or indirectly to human activity that alters the composition of the global and regional atmosphere. Climate variability occurs because of internal variability within the climate system and external factor observed over comparable periods in the types of changes in temperature and rainfall (Neate, 2013).

Agriculture is the most important economic sector of many developing countries and the production systems are expected to produce for the global population it needs to improve productive capacity and stability of smallholder agricultural production as well as improved technologies and practices are the basic to feed the global population (Bryan et al., 2009). However, Climate change becomes the major threats to its development. Agriculture is, particularly at risk. Without suitable adaptation strategies for each farming system the challenge of climate change cannot be effectively tackled (Nyasimiet, 2014). Similarly, global climate change affects the production of crops, which are the major foods for many people especially for developing countries (Calzadilla et al., 2013).

Agriculture has a high potential contribution to climate change. Clearing forests for fields, burning crop residues, raising large herds of cattle and other ruminants and fertilizing with nitrogen, all release greenhouse gases to the atmosphere (Adams et al., 1999). In addition to the effects of higher CO_2 concentration levels and changes in temperature, climate change is likely to affect the volume and the spatial and temporal distribution of rainfall and runoff, which in turn affect the number and distribution of people under water stress and the productivity of world agricultural systems (Calzadilla et al., 2013).

Ethiopia has little emission compared to other countries that are only 0.3% of global emissions. Therefore, different researchers' advice adaptation has to be of greater immediate importance to Africa than mitigation; there are possibilities for devising growth strategies that entail lower emissions than a "business-as-usual" scenario of development and for facilitating the planning, implementation and financing of such strategies that may form of climate-smart agricultural efforts (Amsalu, & Adem, 2009)

Like most developing countries the agriculture-related sub-sectors have a greater share of GHG emissions. Figure 2.1 shows the calculated break down of GHG emissions. The agriculture sector represents an estimated 63% of total emissions. Out of the total GHG emissions of 150 metric tons CO_2 equivalent (Mt CO_2e) in 2010, the livestock subsector had the highest share with 65 Mt CO_2e (42%) followed by deforestation and forest degradation due to agricultural expansion, cutting and burning of fuel wood and logging with 55 Mt CO_2e (37%) and crop cultivation with 12 Mt CO_2e (9%).

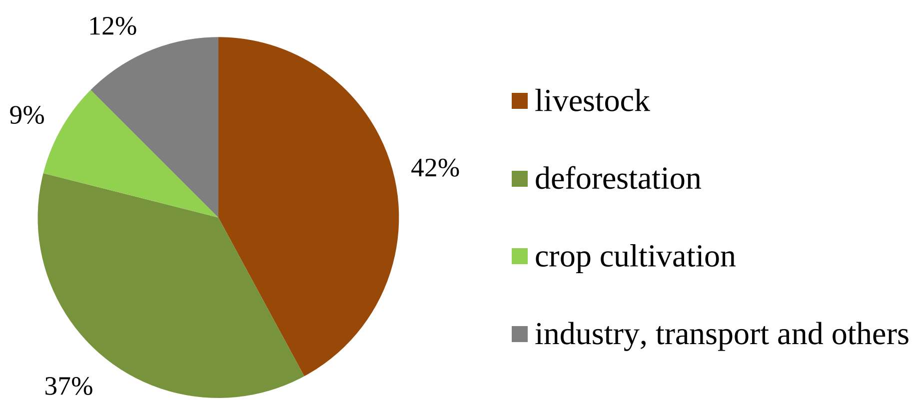


Figure 2.1: Economic sub-sectors emitting a total of 150 Mt CO in Ethiopia 2010

Source: Ethiopia NDC, 2010

Furthermore, meeting food demand for a highly growing population is a big challenge for the agricultural sector. And it is affected by climate change. As a result of increasing climate change, it needs to adapt faster and more profound than in the past. For a developing country like Ethiopia adaptation is recognized as being of greater immediate importance, there are possibilities for devising growth strategies that entail lower emissions than a "business-as-usual" scenario of development and for facilitating the planning, implementation, and financing of such strategies that may form part of climate-smart agricultural efforts change (Branca et al., 2012). If the agriculture increase food security, improve adaptive capacity and reduce GHG emission in a sustainable way we can say agriculture is climate-smart (Neufeldt et al., 2013).

Table 2.1: Agricultural stresses and shocks of Global Warming

Stresses: slow onset impacts	**Shocks: sudden onset impacts**
Sea level rise	Cyclones / storms
Loss of biodiversity	Heavy rainfall events
The occurrence of new pests and diseases	Hail
Displacement of climatic zones	Landslides/soil erosion
Shift in the seasonal calendar due to growing irregularities in timing of the rainy season	Inundation / flood surges
Reduced productivity of crops and livestock due to increased temperatures	Major drought events at times of failing rainy season

Source; adopted from Conway 2013, Lal, 2016 and MoAN, 2016

2.2. Effect of climate change on crop production

The impacts of climate on crop production have been recognized for as long as people have been farming (Neate, 2013). Climate change will affect the productivity of rain-fed crops and forage, reduce water availability, change the severity and distribution of crop, livestock and human health (Branca et al., 2012).

Impact on crop growth: Different crops have different growth parried and nature. Crops grow through the process of photosynthesis, uses the energy of sunlight to convert water from the soil and carbon die oxide from the air into sugar, starch and cellulose. Therefore greater atmospheric concentration tends to increase the difference in partial pressure between the air in and out the plant leaves as a result more carbon die oxide is absorbed and converted in to carbohydrate. Crop species vary in their response to carbon die oxide (Adams et al., 1999). Whereas, climate change have a negative effect on the yield of food crops. All plant pathogens have different responses to climate variability (Luck et al., 2011).

Extend potential growing season: Climate change and variability have the ability to extend the period of the growing season, allowing earlier planting of crops in the spring, earlier maturation and harvesting, and the possibility of completing two or more cropping cycles during the same season (Adams et al., 1999).

Impact on availability of water: Agricultural product is highly influenced by the availability of water. As a result of climate change, rainfall, evaporation, runoff and soil moisture storage variability occurred. The occurrence of moisture stress during flowering, pollination and grain-filling are harm full to crops. Increasing of evaporation from the soil and accelerated transpiration in the plants themselves will cause moisture stress (Adams et al., 1999).

Impact on Soil fertility and erosion: Higher temperature speed the natural decomposition of organic matter and increase the rate of soil processes, cycling of plant nutrients carbon, nitrogen, phosphorus, enhance carbon dioxide and N_2O greenhouse gas emission (Adams et al., 1999).

In Ethiopia major land surfaces are cultivated under a rain-fed agriculture system this is the main reason for being vulnerable to suffer on the climate-related impacts in agricultural productivity. Moreover, the semi-arid climate zone country has been affected by droughts due to global warming (Adams et al., 1999). Climate variability causes crop pest and disease, difficult on the planning of farm operation, loss of biodiversity, sea-level rise (Bazzaz et al., 1996).

In general, global climate change and agricultural production has direct and indirect effects of changing hydrological and plant physiological processes. Climate-smart agriculture is targeted to improve the integration of agriculture development and climate responsiveness. Ethiopian environmental policy also encourages actively participating in protecting the ozone layer because it results in agricultural loss and adverse health effects from exposure to ultraviolet rays (Abegunde et al., 2020).

2.3. Concept of Climate Smart Agriculture

According to Lal (2016), climate-smart agriculture is an approach for transforming and reorienting agricultural systems to support food security under the realities of climate change. Rainfall variability and temperature pattern are the main challenges for agricultural productivity.

According to Beyene (2018), local communities have knowledge developed for a long time in their surrounding through experience. The adoptions of climate-smart agricultural practices maintain or improve soil fertility and have a positive effect on agricultural productivity.

Climate-smart agriculture requires actions beyond the farm scale. Through climate-smart agricultural landscapes, important synergies for agricultural production, climate adaptation and mitigation, as well as other livelihood and environmental objectives, can be generated through coordinated action at farm and landscape scales (Lal, 2016).

The climate-smart agriculture movement emerged to require the inclusion of climate change concerns in agriculture development, to ensure a foothold for the sector on the international agenda of climate change negotiation. The agricultural sector criticized the level of deforestation in the name of increasing productivity (Karuku, 2018).

The triple win solution in agriculture corresponds to an issue within the negotiation with fighting against poverty, food security and mitigation both nationally and internationally. CSA initiative clarifies the political agenda and underlay agricultural transformation path ways. That appears crucial at national and international dialogue on climate strategy in agriculture and it lines with the climate agreement expected in Paris in 2015 (Maya, 2017)

According to Csa et al. (2014) climate-smart agriculture as an agricultural practice which consisting of three main pillars such as sustainably increasing agricultural productivity and incomes (food security); adapting and building resilience to climate change (adaptation); reducing and/or removing greenhouse gas emissions (mitigation), where possible.CSA has to be socially and culturally appropriate for the area because of biophysical and social conditions change. CSA practice today may not be appropriate after the same years as a result of its dynamic nature (Bell et al., 2018).The three pillars of CSA described below:

Increasing Productivity: Preserving and improving food security needs agricultural production systems, to change in the direction of higher productivity. In order to stabilize output and income, production systems should be more resilient, more capable of performing better in the face of disruptive events (Csa et al., 2014). Improving smallholder farmer production through amplification of agricultural technologies and focus on the appropriate use of farmland practices are key for meeting production productivity (Schmidt & Tadesse, 2019).

Adaptation/resilience: According to Change (2013)**,** adaptation/resilience is the ability of a community or ecosystem to resist, absorb, and recover from the negative effects of hazards on time and appropriately and also preserving or restoring essential structures, functions, and identity. It is about to minimize the potential damage and to maximize the potential benefits as well as the resilient community is well placed to manage hazards to minimize the effects and to recover from any negative impacts, resulting in a similar or improved state as compared to before the hazard occurred. There are two types of adaptation technologies such as hard (improved variety, crops fertilizer and irrigation technologies) and soft (crop rotation pattern, knowledge of varieties and organizational capacities) adaptation technologies.

Adaptation/ resilience is about the reduction of vulnerability to drought, pests, diseases and other socks; increase capacity to adapt and grow in the face of longer-term stresses like short-term seasons and erratic weather patterns (WBG, 2019).To enhance the resilience capacity of agro-ecosystems, increasing ecosystem services through the appropriate use of agro ecology principles and landscape approaches need to apply. Reducing risk exposure through diversification of production or incomes, and building input supply systems and extension services that support efficient and timely use of inputs, including stress-tolerant crop varieties, livestock breeds fish and forestry species are also examples of adaptation measures that can increase resilience. Adaptation measures can provide a good starting point for developing effective adaptation strategies for any particular site (Maya, 2017). Improved crop varieties, switching cropping sequence, sowing earlier, adjusting the timing of food operations, covering soil moisture through appropriate tillage methods, improving irrigation efficiency are some of the actions of resilience improvement or enhance adaptive capacity (Adams et al., 1999).

GHG reduction (Mitigation): Involves reducing emissions from production systems, avoid deforestation, manage soils and vegetation (crops, pastures and trees) that maximize their potential to carbon sinks and absorb CO_2 from the atmosphere (MoA, 2019). Plants and soils have the capacity to sequester CO_2 from the atmosphere and store it in their biomass; this is the process of carbon sequestration. Increasing tree cover in crop and livestock systems (e.g. through agroforestry) and reducing soil disturbance (e.g. through reduced tillage) are two means of sequestering carbon in agricultural systems. Increasing carbon sequestration represents a huge potential source of mitigation, especially since the agricultural practices that generate sequestration are also important for adaptation and food security. Another important emission reduction pathway is the implementation of new practices that enhance the efficiency of input use so that the increase in agricultural output is greater than the increase in emissions and by increasing the carbon-sequestration capacity of agriculture (Maya, 2017).

Table 2.2: Description of CSA outcome and its indicator

CSA Outcome	**Indicator**	**Rationale**
✓ Crop production	✓ Increasing yield ✓ Increasing HH income	✓ Increase the yield of crop per hector ✓ Increase income and food accessibility and contribute to poverty alleviation
✓ Resilience/adaptation capacity(Biophysical Economic and social)	✓ Biodiversity ✓ Soil and water conservation ✓ Stabilizing ecosystem ✓ Improving ecosystem service ✓ Labor gender	✓ Protect natural resource (soil and water ✓ Reduced labor frees up time for income diversification ✓ The workload of women minimized, including nutritional outcomes
✓ Mitigation	✓ GHG Emissions ✓ Emission Intensity	✓ Reduce carbon emission ✓ Carbon sequestration ✓ Enhance removal of C from the atmosphere into on-farm C reservoirs mitigates GHGs from agriculture

Source: Bell et al., 2018

2.4. Climate Smart Agriculture practices

Several interventions have already been identified for the development of CSA in the context of Ethiopia's ministry of agriculture. For each intervention, a specific Infotech has been developed based on current local and international knowledge (MoA, 2019).

There are different climate smart agriculture practices such as soil and water conservation (Physical and biological SWC measure) soil amendments including organic and inorganic fertilizer application, crop rotation, intercropping, mulching, tilling, and water harvesting. Building soil organic matter is critical for increasing agricultural resilience to climate change. Minimal tillage and using cover crops and crop residues enhance the organic matter stored in the soil. The efficient management of water, a resource threatened by climate change, is also critical for reaching the adaptation and livelihood goals of climate-smart agriculture. Best practices for irrigation, water-harvesting technology, and terrace or contour farming systems can contribute to improved water-use efficiency and conservation. Appropriate design, construction processes and water delivery mechanisms can highly reduce GHG emissions associated with conventional irrigation systems (Lal, 2016).

Table 2.3: Description of climate smart agriculture

The outputs of CSA Practices	Land user/ community level	Watershed/ landscape level	National/ global level
Production	+++increased productivity +++greater production +++ greater diversity of crop +++ improved crop yield	+++ maximize production in variable environment +++ reduce risk of production	+++Improved food security
Economic	++ high overall return of agricultural production ++ provide a stable livelihood	++ reduce infrastructure damage ++ enable dray land to be economically exploited	+++ improved livelihood ++ increase economical share of agriculture
Ecological	+++ Increase live plant cover +++ reduce soil erosion +++ enhance biodiversity +++ improve water availability	++ reduce land degradation +++ increased water availability +++ increase carbon sequestration of soil +++ increased soil fertility and soil cover	++ maintain ecosystem integrity and climate variability ++ reduce degradation and desertification incidence and intensity ++ enhanced biodiversity +++ reduce green house gas emissions
Socio-cultural	++knowledge of environment, ++agricultural input selection ++ strength community institution to implement new technologies	++ increased awareness for the environmental health +++ attractive land escape + reduce conflict	++ knowledge leading to sustainability +++ protection of national resources

Where: + slightly positive, ++ positive, +++ very positive

Source: Adopted from, Tainton N.M. 1988

2.4.1. Soil and water conservation

Conservation of soil and water resources is important for the sustainability of agriculture and environmental protection. There are strong links between measures for soil and water conservation. Soil conservation practice includes soil management, crop management, engineering, range management and forestry operation. Water conservation practice also includes plant windbreaks, keeping plant residue on the field and choosing water-conserving species (Safdar et al., 2017).

Physical conservation measures: Physical soil can be degraded through the impact of the raindrop, animal hooves, heavy farm machinery, excessive tillage. And cause surface crusting, compacting, loss of topsoil structure, loss of soil organic matter, and reduce soil rooting depth (.So that, several physical soils and water conservation measures such as stone earth trace, stone earth bunds (walls), check dams, retention reservoirs, dams, grassed waterways and planting pits are implemented (Zachar, 2011).

Biological conservation measures: Among the biological measures of soil and water conservation: vegetative strips, protective bush land, natural drainage way protected by a permanent grass cover (live fences) are recognized. The practice protects soil loss, improve soil moisture it is effective SWC, essentially since they are low in cost and can be used with structural and agronomic measures (Mitiku et al. 2006).

Lack of water availability and soil infertility are the main constraints of agricultural productivity (Kpadonou et al., 2017). And has it has an impact on carbon sequestration. Soil and water conservation are practiced by composting manure and crop residues, more precise matching of nutrients with plant needs, controlled release and deep placement technologies, or using legumes for natural nitrogen fixation. Crop rotations and crop associations that include legumes are capable of hosting nitrogen-fixing bacteria in their roots, Maintenance of a mulch layer provides a substrate for soil-inhabiting microorganisms which helps to improve and maintain water and nutrients in the soil. This also contributes to increasing soil organic matter derived from carbon dioxide captured by photosynthesis in plants, whose residues above and below the surface are subsequently transformed and sequestered by soil biota. Conservation of agriculture offers opportunities for climate change adaptation and mitigation solutions while improving food security through sustainable production intensification and enhanced productivity of resource use (Maya, 2017).

Agricultural conservation practices such as mulching, dry planting, no-tillage, and minimum tillage, crop rotations green-manure cover crop and broad-bed furrows that preserve moisture and enhance in nutrient recycling (Ngara, 2017). Improved water harvesting and retention (such as pools, dams, pits, retaining ridges, etc.) and water-use efficiency (irrigation systems) are fundamental for increasing production (Imran et al., 2018).

2.4.2. Appropriate use of input

It is about using improved variety, using fertilizer and Pesticide in appropriate time, amount and place to be productive as needed and to protect the soil health as well as users. The application of manure and fertilizers provide essential plant nutrients in the soil for better crop growth. The crops with fast growth cover the soil quickly and give higher yields. Essential plant nutrients such as nitrogen, phosphorus, potassium, and sometimes Sulfur required by plants are provided by inorganic fertilizers (Safdar et al. 2018). Improved variety determines a plants' and animals' capacity to resist shocks such as temperature extremes, drought, flooding, and pests and diseases. It also regulates the length of the growing season/production cycle and the response to inputs such as fertilizer, water and feed. The selection of appropriate genetic resources of crops and breeds and their wild relatives is fundamental in developing resilience to shocks, improving the efficient use of resources, shortening production cycles, and generating higher yields (and quality and nutritional content) per area of land. Generating varieties and breeds which are tailored to ecosystems and the needs of farmers is crucial (Imran et al., 2018).

2.4.3. Agroforestry practices

Agroforestry is the Planting of trees or shrubs or protecting the naturally sustaining trees suitable for many types of cropping systems where woody and none woody species can be mixed. It is suitable for dry areas suffering from strong winds and wind erosion and low soil fertility but it is unsuitable for the dry area in a situation where a lack of land (small farming units) makes agroforestry systems such as parklands and improved fallows unsuitable. Trees decrease the magnitude of splash erosion by reducing the raindrop's impacts on the soil. They regulate soil temperature by shading the soil thus reducing water evaporation. They also minimize wind erosion by acting as windbreaks. They also play important role in nutrient recycling in the deep soil; leguminous trees fix nitrogen that benefits food crops (Gurtner et al., 2011).

2.4.4. Use of appropriate harvesting, processing and supply chains

The agricultural productivity system doesn’t help the community unless the post-harvest management is lacking. Appropriate harvesting and early transformation of agricultural practices can reduce post-harvest losses (PHL) and preserve food quantity, quality, creates jobs and income opportunities. It also ensures better use of co-products and by-products, either as feed for livestock, to produce renewable energy in integrated systems, or to improve soil fertility. Ensure greater availability of food and income throughout the season and in years of low production (FAO, 2010).

Table 2.4: CSA Practices and impacts on its output

CSA practice	Expected impact on productivity	Expected impact on resilience	Expected impact on mitigation
Use of improved crop varieties	• Better plant nutrient content • Benefits in the form of higher crop yields • Increase income	• Increased water retention capacity and better soil structure with tangible on-site production • Increased system resilience and reduced vulnerability	• Increase biomass and soil C. • Minimizes soil disturbance and related soil C losses • Improve soil organic C • Reduce N2Oand CH_4 emissions • Reducing post-harvesting food losses will contribute to lower emissions per unit of food consumed
Use of legumes in crop rotation			
Use of cover crops			
Changing planting dates			
Efficient use of inorganic fertilizers			
Use of terraces			
Planting trees on cropland			
Diversified crop			
Irrigation			
Use of an improved variety			
Use of organic fertilizers			
Planting crops on tree land			
Use of mulching			

Source: adopted from Wekesa et al., 2018

2.5. Climate Smart Agriculture practice in Ethiopia

CSA is not a new production system, it is a means of identifying which production systems and enabling institutions are best suited to respond to the challenges of climate change for specific locations, to maintain and enhance the capacity of agriculture to support food security in a sustainable way. Numerous adaptation alternatives exploited by Ethiopian farmers include; soil preservation, use of irrigation systems, growing of different crops, switching of planting times, forestation, and water harvesting (Maya, 2017).

In the context of Ethiopia's sustainable land management program (SLMP), Several interventions have been identified for the development of climate smart agriculture. For each intervention, a specific infotech has been developed based on current local and international knowledge. The infotech contains a list of recommended CSA practices. It is considered documents and expected to be modified, updated and refined by the results and practical experience generated during the pilot phases of CSA implementation in selected SLMP watersheds. Agroforestry, agriculture conservation, compost and acid soil management; agro-biodiversity and crop production, integrated soil fertility management, improved forage development, agricultural water management and climate information and weather forecast the area of interventions.

Therefore, the recent Ethiopian Agricultural system has given prominent attention to the role of chemical fertilizer in ensuring food security however still very low compared to the African average, promotion of improved seeds is even more challenging for the extension system. It is a very important part of addressing current food security without compromising the next generation (Gelaw, 2017).

Ethiopian Ministry of agriculture also promoting CSA practices such as soil and water conservation measures (biological and physical), conservation agriculture, agroforestry systems fodder production (cut and carry), water harvesting, reforestation, seedling production, and improved variety; mainly through various projects and programs implemented by its different units including climate resilience green economy (CRGE), Sustainable land management program (SLMP) coordinate unit, the soil information and fertility directorate, agricultural growth program (AGP) coordination unit and the national agricultural research system among others (Gelaw, 2017).

Ethiopia’s climate-resilient green economy has its own responsibility to manage the adverse impacts of climate variability and also reduce the contribution of conventional agriculture activities to greenhouse gas emissions, mainstream the environmental issues to all development effort in which the climate smart agriculture development is the main component and to become resilient to climate change impact and with no net increase in greenhouse gas emissions from 2010 levels in 2025. It also stated that Ethiopia intends to limit net GHG emissions in 2030 by 64% as compared to a projected “business-as-usual” scenario (Chipeta et al., 2015).

2.6. Factor affecting implementation of climate smart crop production practices

According to Change (2013), there are opportunities for local-level development projects targeted to adapt and manage climate change risk, supported by national and international investments. There is Strong initiation of agricultural investment from the Ethiopian government. However, there are barriers to integrate climate and development at the community level stems from a lack of capable local institutions to coordinate and lead local efforts with lack of active participation by local communities and lack of technically skilled manpower at the local level

Mccarthy et al. (2011) also identify five barriers or costs of adoption of CSA or SLM practices; investment cost such as expenditure on equipment, machinery, materials and labor required to build on-farm agriculture, variable and maintenance costs like the purchase of seed, fertilizer, or additional hired labor, as well as the periodic cost associated with maintaining SLM structure and repayment cost where credit has been obtained), opportunity costs of own assets (allocated own factors of production to SLM activities instead of other use, transactions cost (bargaining, negotiation, and monitoring and enforcement cost and the risk cost (insurance or mechanisms are thin or imperfect, associated with the uncertainty surrounding the like benefit as well as variability in benefits across time that the farmer expects to realize from adoption different SLM practices. Lack of know-how in management, species, improper establishment, community mobilization, village institutional arrangement, are the common socio cultural barriers.

Table 2.5: Factors and description of CSA practice

Factors of CSA practices	**Description**
Economic	High initial investments, Poor access to capital, Competing financial priorities, Long pay-back periods Switching costs/existence of the installed base High implementation costs (actual and perceived) Uncertain returns and results, Over discounting the future The temporal asymmetry between costs and benefits
Institutional/ Regulatory	Low institutional support, Use of overly scientific language Farmer's knowledge not considered, Lack of regulatory framework, Prohibitively prescriptive standards
Behavioral/Psychological	Lack of management support/awareness Conflict with traditional methods, Overly complex technologies Results/effects of technology difficult to observe Farmer's beliefs and opinions The low trust of advisers or consultants/lack of acceptance Irrational behavior, Negative presumed assumptions
Organizational	Lack of required competencies/skills, Poor readiness Poor information, Inability to assess technologies Overly short-term/perverse rewards Organizational inertia/habitual routines

Source: Adopted from Long et al., 2016

2.7. Concept of Sustainable Land Management

The land is the most extensively used factor of production. However, the supply of productive land and its efficient utilization is being increasingly constraint by increased population pressure, and by lack of sufficient soil moisture, and inadequate utilization of land-saving farm technologies, respectively. Smallholder agriculture lacks an adequate capacity to replace nutrients mined from agricultural lands through crop production or fail to counterbalance the negative impact of high population growth (Samuel, 2006).

Whereas, land degradation is one of the greatest threats to food production and manifested as soil compaction, erosion, nutrient depletion and salinity, often results in loss of soil biota, plant and animal species, with risks to the sustainable production of food and ecological goods and services (Robbins & Williams, 2005).

Many sustainable land management practices increase the amount of carbon sequestrated in the soil; including agroforestry, reduced or zero tillage, use of cover crops, and various soil and water conservation structure. It has the long term benefits to households from adaption such activities in terms of increasing yield and reduces the variability of yields, making the system more resilient to change in climate (Long et al., 2016).

SLM is a means of generating a win-win solution to addressing poverty and food insecurity by considering environmental issues. It is important to farmers by increasing and conserving natural capital (soil organic matter, the form of biodiversity, water resource), increase productivity with low cost, significant public environmental goods in the form of improved water shad functioning, biodiversity conservation, and mitigation of climate change (Mccarthy, 2011). To implement the objective of sustainable land management different governmental and non-governmental organizations are emerged. SLMP is one of them initiated in 2009 by the government of Ethiopia to address declining agricultural productivity, effects of climate change, poverty and food insecurity with the aim of scale-up successful practices, approaches and technologies to prevent or control land degradation through integrated and cross-sectional approaches to sustainable land management (Abegunde et al., 2020). Sustainable land management benefited not only for the land-based sector but also based on urban, industrial and other sectors that depend on the ecosystem services and measure in adapting to the effect of climate change (GIZ, 2018).

2.8. Sustainable land management as climate smart agriculture

Climate smart agriculture is a holistic approach that considered practices, public policies and financing to address the food security, adaptation and mitigation challenges. Enabling conditions and practices must be fulfilled to promote climate smart agriculture and consist a complete set of measures unless otherwise the practice could be existing sustainable agriculture technical options such as contour cropping, integrated pest management, water retention, intercropping, etc (Maya, 2017).

SLM and CSA are close linked concepts. CSA focus on the outcomes those are productivity improvement, climate change adaptation and mitigation SLM also crucial to adaptation and mitigation (Campbell et al., 2014). It is the same as climate smart agriculture. CSA is an agricultural system to achieve climate-smart objectives, including improved food security and rural livelihoods as well as climate change adaptation and mitigation. Although, climate change dynamics related to agriculture suggest three key features characterize a climate-smart landscape: climate-smart practices at the field and farm scale; diversity of land use across the landscape; and management of land use interactions at the landscape scale (Lal, 2016).

An integrated landscape approach is fundamental to achieving objectives of climate-smart agriculture, namely adaptation and mitigation goals along with improvements in livelihoods, productivity and other ecosystem services. Climate-smart landscape includes climate-smart practices at the field and farm scale, diversity within farming systems and land use across landscapes, and management of land use interactions to achieve synergies among a range of objectives (Lal, 2016).

In general climate-smart agriculture, the approach is mainly focused on sustainable soil and water conservation and management and also carbon sequestration above and below the ground part to achieve sustainable land and water conservation and to return sustainable agriculture (Perfecto et al., 2009)

2.9. Empirical review

Di Falco (2014) studied on climate change in agriculture by providing a micro perspective on the issue of adaptation and food security and investigate the farm households' decision to adapt, implementation of a set of strategies (e.g., changing crop varieties, adoption of soil and water conservation strategies) in response to long-run changes in key climatic variables such as temperature and rainfall, affects food crop productivity in Ethiopia.

According to Samuel (2006) discussion half of farmers participating in used improved seeds. 20% of adopters discontinued their use of improved seeds immediately after their participation comes to an end. In general, Apart from fertilizers and improved seeds, irrigation and the use of modern farm machinery other components of the modernization package also almost non-existent. Moreover, the use of different complementary inputs to the package recommended by agricultural experts is low. Evaluation of the smallholder intensification program showed that only 22% of the households used a complete package of crop production, i.e., improved seeds, fertilizer and improved cultural practices in the recommended amounts. Most of the households used an incomplete package of crop production, lacking one or more of the major components.

In Branca et al. (2012) in depth analysis, including estimation of adaptation/mitigation potentials using baseline emissions levels and identification of possible eligibility criteria for climate smart programs and activities, linked to investment plans, to enable access to existing, emerging and dedicated financing mechanisms.

Beyene (2018) also studied to answer why some farmers are practicing Climate smart agriculture and why others not, that is the factors affecting adoption of climate smart agricultural practices and find out sex of household heads, education level of household heads, off-farm income, livestock number, farmers' field day participation, knowledge on environmental regulation, access to extension services and being a member of organizations were positively correlated and significantly determine the adoption of CSA practices.

2.10. Methodological review

The study which is conducted by Gelashe (2018) on the adoption of climate smart cattle production practices is none experimental research and has a descriptive and explanatory design type. The household surveys, key informant interview, focus group discussion, and field observation is used to collect qualitative and quantitative data. Yamane (1967) simplified formula is applied to take out the sample size. In his research, the nature of existed socio-economic, demographic and institutional situations described by using across sectional analysis techniques and also Regression model applied to determine the kind and magnitude of the relationship among the dependent and independent variables.

In Beyene (2018) adoption of climate-smart agriculture research also mixed research approach is used to conduct the study. Focus group discussion, household survey, key informant interview and field observation data collection methods are applied to collect qualitative and quantitative data and the logistic regression model is applied to identify the factors that influence the adoption of CSA practice.

2.11. Conceptual framework

Climate smart crop production address the food security problem with the current worldwide concerning issue that is climate change by consideration of three climate smart agriculture output such as productivity incensement, building resilience capacity and mitigation measure. Climate smart crop production practice is targeted to improve the livelihood of the present generation without compromising the future generation. There are different factors affecting the CSA practice and to get the output. Those are biological factor (farm distance, market distance and degradation), Socio-economic factors (age, sex, education, off-farm income, farm size labor) and institutional factors (access to credit, environmental regulation, extension services, training and organization).The farmers who implement the climate smart crop production practice can get high yield or income and better to cope with climate change and its effect and puts their contribution to the reduction of global climate change problems.

The climate smartness practices are normally measured by their contribution to the increasing of productivity and adaptive capacity to climate change and variability. Figure 2.2 describe the conceptual framework as below.

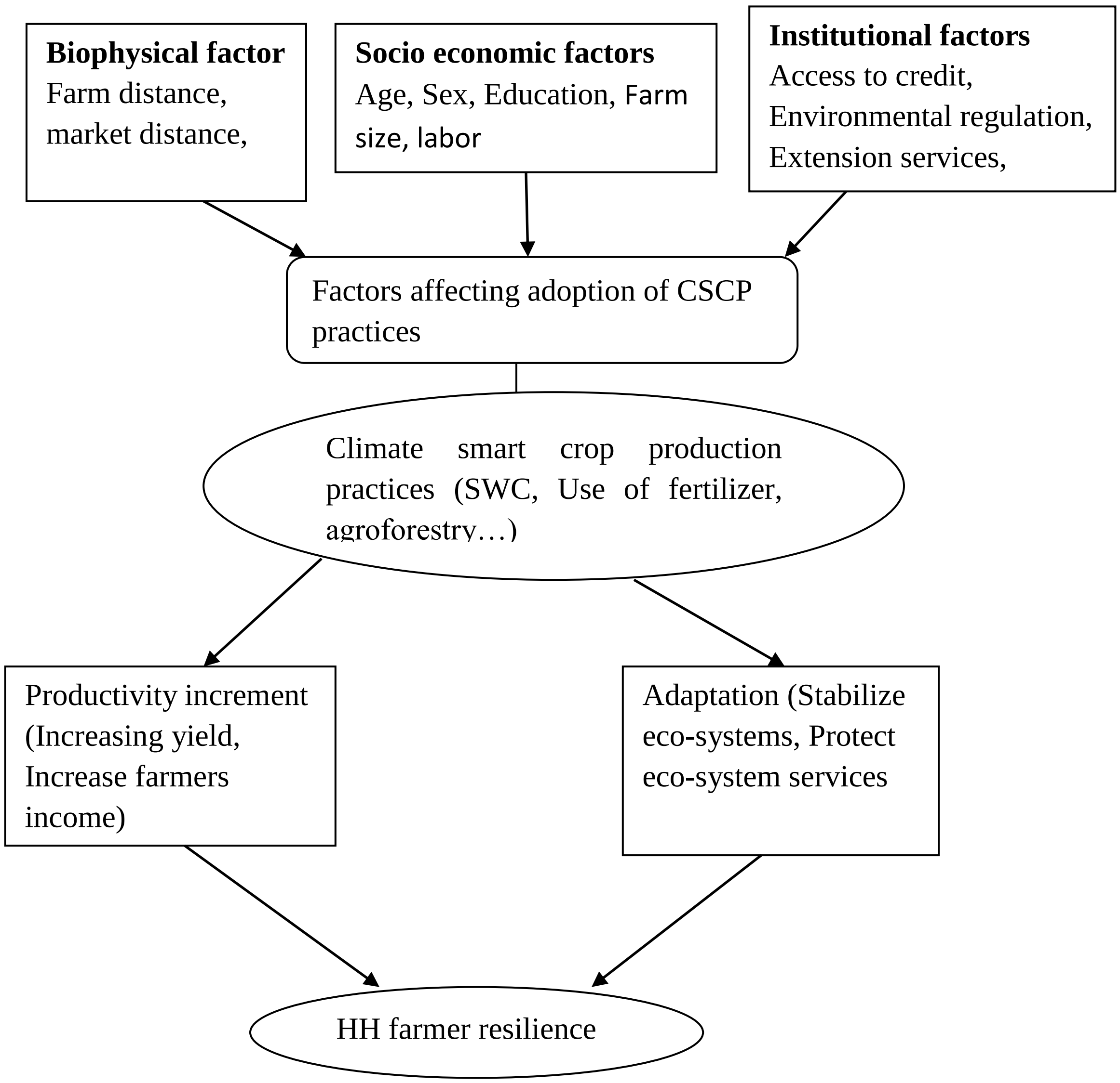


Figure 2.2: a conceptual framework

Source: Adopted from MoNR, 2016

CHAPTER THREE:

METHODOLOGY

3.1. Description of the Study Area

Location

Woloso Woreda is found in Southwest Shoa zone and far about 114 km from Addis Ababa. Its astronomical location is 32’ north latitude and 37° 58’ east longitudes with an elevation of 2063 meters above sea level. The relative location or visional position of the woreda has physically contacts with four woreda, namely Bacho, Goro, Wanchi, and Saden- Sodo woreda and one region namely SNNP. In terms of these woreda location, Woliso woreda is boarded in the North by Bacho, in the west by Wanchi, in the south west by SNNP, in the south by Goro and in the east by Sadden sodo woredas The woreda has a total of 37 kebeles, out of which 35 are rural and 2 are urban kebeles. (Woliso woreda Agricultural and Land protection Bureau, 2018). Figure 3.1 shows the general map of Ethiopia, Oromia rigion, Woliso woreda and two selected kebeles.

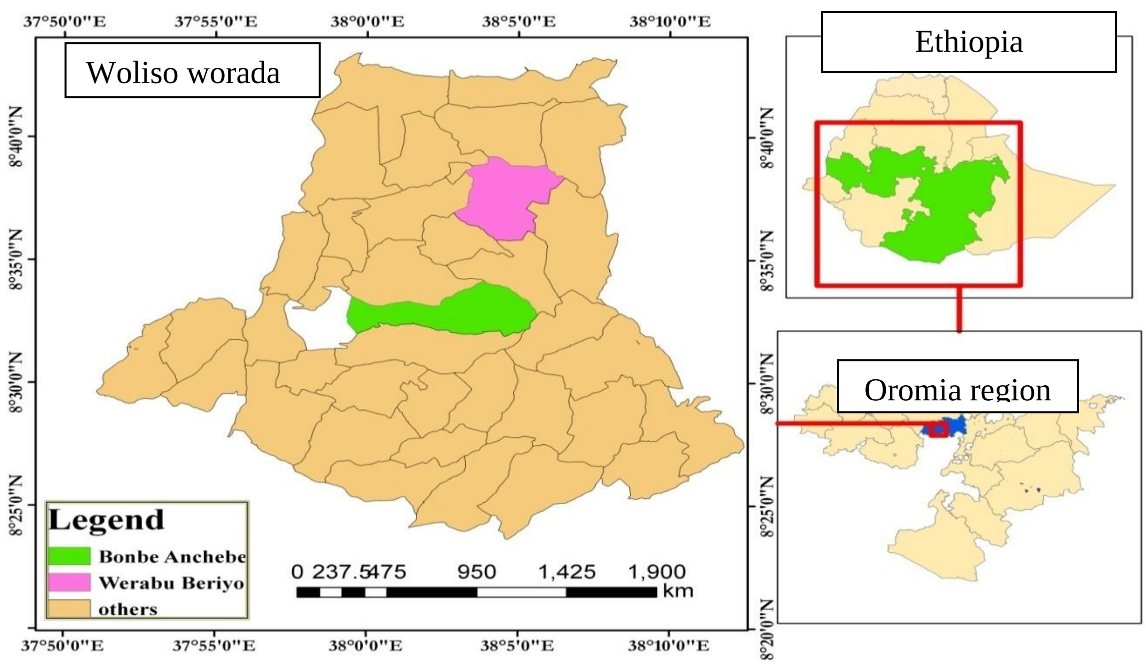


Figure 3.1: Location map of the study area

Source, CSA 2017

Land use: Land use pattern is dominantly utilized for cultivation in the specified kebeles as crop production is the major means of livelihood. Each land use pattern was covered 66% cultivated, 7% grazing, 6% vegetation and 21% for other purposes (WWRDAO, 2019).

Climate Condition of the Study Area: Woliso woreda is located in tropical climate zone and the climate condition is medium that the altitude of the land is Waynadega. The mean annual temperature and rainfall are 180C and 1350 mm respectively. The Woreda has unimodal rainfall nature (the main rainy season occurs in summer (Woliso woreda Agricultural and Land protection Bureau, 2018).

Population: The total population of Woliso woreda in rural and urban are 143,391 from those, male and female are 71567 and 71824 respectively. In those, population 95% are living in rural area and economic activities of these woreda is mixed farming system (Population and Housing Census of Ethiopia, 2007).

3.2. Research Methods

3.2.1. Research approach

The research employed both qualitative and quantitative research approach by using primary data source which complement each other. In the qualitative approach Key Informant Interview (KIIs), Focus Group Discussions, and observations were applied for data collection. Sex of household, marital status, type of household, educational level, rate of effectiveness on climate-smart crop production practices were some of the qualitative indicators in this study.

In the quantitative approach household survey based on questionnaires and a structure unstructured interview was applied during April 2020. Ages, family size, landholding, the distance of farm plot from home (walking distance),were some of the quantitative data. Whereas, area coverage by crop production, amount of post-harvest and price of the product in each year starting from 2007 to 2011 were collected from the secondary data sources.

A mixed research approach was applied to be with appropriate answers to the research questions and also in order to meet the objectives. It helps to identify and analyze the existing physical and none-physical (behavioral) dimensions of determining the climate-smart crop production activities.

3.2.2. Research design

The study applied cross sectional and longitudinal research design to assess the climate-smart crop production practices in Woliso Woreda. In order to address the stated objectives, the study needs the collection of empirical data and describes the existing condition by using qualitative data.

Survey research applied to describe, compare, contrast, classify, analyze and interpret the entities and events that constitute the assessment of climate-smart crop production practices. The phenomena of household survey, key informant interview and field observation methods were applied. A cross-sectional analysis across the climate-smart crop production practices was conducted on responsible sample respondents to clarify the existing situation.

3.2.3. Sampling frame

Woliso woreda has 37 kebeles. Kebeles which are located around water shade are inter in the climate smart crop production practice structure and targeted by sustainable land management program and other stakeholders. Tonbe Anchabe and Warabu Bariyo kebele are participated in the climate smart crop production practice structure and list of smallholder farmers that are targeted by government and non-governmental organizations for climate-smart crop production programs in Tonbe Anchabe and Warabu Bariyo kebele were taken from Woreda Natural resource offices. The total numbers of household farmers who participate in climate smart crop production practices are 360 (240 in Tombe Anchabe and 120 in Warabu Bariyo kebele).

3.2.4. Sample size determination

According to Woliso woreda Natural resource office report 360 households have participated in climate-smart agriculture practice in selected kebeles' micro water shade by the support of SLMP in both Tombe Anchabi and Warabu Baryo kebeles. The sample size was determined according to Yemane, (1967) simplified formula at a 95% confidence interval. It is used to determine the number of representative sample households that should be included in the survey sample size of the respondent was selected based on the formula given as:

$$n = \frac{N}{1+N(e)^2}$$

n=sample size

N= Total population and

e= Precision level at 95% (α= 0.05) normal confidence interval. Therefore, the sample size: N= 360 and α=0.05

$$n = \frac{360}{1+360(0.05)^2}, n=189$$

Table 3.1: Distributions of sample respondents proportional to the size

No	Selected kebeles	M/water shad	No of male HH	No of female HH	Total HH	Sample in No	Sample in %
1	Tombe Anchabi	G/ Sembet	114	6	120	75	75
		Warabo	117	3	120		
2	Werabu Bariyo	D/Werabu	117	3	120	25	25
Total			348	12	360	100	100

Source: WWNRO, 2012

3.2.5. Sampling techniques

This study follows the purposive sampling method to select the study woreda and the two targeted study kebeles intentionally since it is potential area for cop production, better targeted by government and NGOs for climate smart crop production practices program. Due to this case, Woliso woreda purposefully selected to study climate smart crop production practices, change of crop production in terms of yield and income and barriers in the application of climate smart agriculture practices. From the total population list of climate smart crop production program targeted crop producing farmers were selected by simple random sampling techniques for household survey. The Key Informant Interviews were conducted with the agricultural development agents and SLMP coordinators of WWANRO and MoA. Purposefully two Focus Group Discussions were conducted with farmers who are assumed to be model farmers in order to gather appropriate and useful information to complement the survey data and to develop meaning derived from the analysis of the survey data.

Study site selection: Woliso woreda is one of the pilots Woredas which score great by practicing climate smart crop production activities from others selected woredas and potential area for cop production practices, better targeted by government and NGOs for climate smart crop production practices program among the other woredas in the region regards to climate smart crop production practices application. Therefore, Woliso woreda purposefully selected to study climate smart crop production practices.

3.3. Data sources and method of data collection

Primary data: Primary data was collected by using qualitative and quantitative data collection methods like; household survey, focus group discussion, key informant interview and field observation are some of the data collection methods used in this research. Questioner and guidelines data collection tools were used.

Household survey: Household survey was conducted by using structured questioners designed in line with stated research objectives and research questions as determined in the study sample size. That is100 HH surveys were collected. This data collection method is conducted to identify the effective climate-smart agriculture practices in the selected kebeles and to find out the enablers of climate smart crop production practices. The data included the personal background information of respondents. To collect the data researcher employed 4 enumerators. They have experience in conducting the household questionnaires, in addition, they have degree educational levels in agriculture and they are agricultural development agents in kebele. Hence, all enumerators trained about the study issue and orientation on the survey questions for 2 (two) days in Woliso Woreda Agriculture and Natural Resource office.

Focus group discussion (FGDs): There was two group discussions conducted from the two selected kebeles and each group has 5 (five) members. The discussions conducted in each selected kebele. The focus group discussions were conducted to understand the status of climate-smart crop production practices, on the existing climate smart crop production practices and the progressive change of farmers' livelihoods, protection of the environment and to a deep understanding of the challenge farmers faced in the practices. The focus groups were selected purposively from kebeles model farmers.

Figure 3.2: Focus group discussions

Source: Own, 2020

Key informant interview:

Key informant interview conducted to understand the trend of the climate smart crop production practices and challenges to apply climate-smart agriculture practices in the woreda. Participants purposively selected from woreda and kebeles agricultural experts. This study employed three key informant interviews from the Woliso woreda SLMP facilitator and development agents from the Woliso woreda agriculture and natural resource office.

Figure 3.3: Key informant interviews

Source: Own, 2020

Field observation: The study took different descriptive notes of what is existed in the ground. Photographs were taken during field observation. The researcher observed the existing climate-smart agriculture practices and how the agricultural practices influence land management (soil and water conservation), the livelihood of the community and the environment.

Figure 3.4: Field observation inTonbeeAnchabe kebele
Source: Own field observation, 2012

Secondary data sources: Secondary data were collected from report (ministry of agriculture, woreda, kebele), journal article, books, legal documents (proclamation, strategy), study-related thesis and dissertation among others. Data were collected by using different tools internet, library and organizations. Data related to the yield of productivity and product price were collected from the selected WANRO.

3.4. Methods of data analysis

Based on the data collected from the sample HH, descriptive statistics were applied to analyze the quantitative and qualitative data by using SPSS software version 20, to address the three specific objectives of the study.

Qualitative data were collected through key informant interviews, focus group discussions and field observation and organized summarized and interpreted in relation to the survey result and also analyzed by narrative analysis with the purpose to complete the results from the household survey. The survey data were analyzed descriptive statistics such as frequency distributions, percentages and crosstabs and presented by using tables and charts.

The study identifies the climate-smart crop production practices that are applied by the farmers by the integration of governmental and non-governmental institutions specifically by the SLMP. Data that are related to the practice adopted by the selected farmers were conducted from the household survey, key informant interview and group discussions and farmers response about how they evaluated the effectiveness of climate smart crop production practice and takes the perception about how the evaluated the effect on the improvement of adaptive/ resilience capacity analyzed and interpreted by descriptive statistics such as percentage and crosstabs and presented by a table.

The study used the amount of crop yield from climate-smart crop production practice and without using climate-smart crop production practices in quintal/hectare from 2007 to 2011. And the change was analyzed by taking the average yield with climate smart crop production practice and without climate smart crop production practices by taking the formula:

Change of crop yield = Average quintal/hectare with climate smart crop production practices – Average quintal /hectare without climate smart crop production practices

And also the income of household change was calculated by using the average price of crop product and average yield (quintal/ha) of climate crop production user.

The change of yield in quintal/hectare and income was analyzed and interpreted and presented by the chart and table.

CHAPTER FOUR

RESULT AND DISCUSSIONS

4.1. Demographic characteristics

4.1.1. Sex, age, and household head of surveyed HHs

The survey result shows that out of 100 sampled HHs, 88% were males and the remaining 12% are females. The types of the household head have a positive influence on climate-smart agriculture practices regarding decision making and taking responsibilities. Out of the total sample of HH, 88% were male-headed, 11% female-headed and 1% jointly (male and female-headed). Climate-smart agriculture practices are predominantly applied by male-headed households in the area. In the observation, females have great contribution to applying seed, compost preparation and also managing soil fertility. The study which conducted by Obasi et al.(2013) identified that age, level of education, years of farming experience, farm size, extension contact, fertilizer use, planting materials and labor use are the main determinants of agricultural productivity.

Table 4.1: Respondent sex and household head type

Item		Frequency	Percent (%)
Sex of respondent	Male	88	88
	Female	12	12
	Total	100	100
Household type	Male headed	88	88
	Female-headed	11	11
	Jointly holder	1	1
	Total	100	100

Source: Own field survey, 2020

The age of respondents was a significant role in the application of climate-smart crop production practices. Young edged respondents were engaged in the application of climate smart crop production practices more than others in the area. The study grouped the respondent age into four groups those are less than 20, between 21-40, between 41-60, and greater than 60. Accordingly, the survey result shows that the majority (81%) of the respondents' age ranges from 21-60 years. Furthermore, the age of respondents who are less than 20 accounts only 2% and more than 60 years covers 17%. According to Ndagijimana (2019), confirmed that old farmers and those fully engaged in farming are more likely to invest in sustainable land management than the younger ones and those partially engaged. The detail description of respondent age indicated in table:

Table 4.2: Respondent age

Respondent age	Count	Percent
less than 20	2	2.0%
21-40	40	40.0%
41-60	41	41.0%
>60	17	17.0%
Total	100	100%

Source: Own field survey, 2020

4.1.2. Educational background

The result explicitly indicated that 85% of householders can read and write. Teklewold et al. (2013) identified that education level has a positive impact on the adoption of inorganic fertilizers and conservation tillage. From the survey result, the study understands that education is crucial to practice climate-smart crop production and to come with the three outputs of climate-smart agriculture practices. According to Ndagijimana (2019) literacy is significant to sustainable land management and to tackle land degradation.

Table 4.3: Respondent educational background

The education level of respondents	Count	Percent (%)
Can't read and write	15	15.0%
Read and write	51	51.0%
Elementary school completed	18	18.0%
High school completed	14	14.0%
Certificate holder	1	1.0%
Diploma holder and above	1	1.0%
Total	100	100.0%

Source: Own Field Survey, 2020

4.1.3. Characteristics of the household farm distance to homestead

The result in Table 4.3 below shows that the farm distance from home in terms of the time it takes, so 39% of said it takes less than 5 minutes, 52% of HH said 5-6 minutes and 9% said 16-25 minutes. Temesgen (2019) study identified that households who live near to the irrigation scheme have better opportunities to use water as needed than those who live far from irrigation schemes based on the traditional irrigation system like furrow irrigation. The study find out more than half (52%) of respondent farmers e take 6-15 minutes from homestead to farm. According to the field survey, the distance of the farm plot from the homestead has its contribution to climate-smart agriculture practices' effectiveness. Practices like applying compost on time and appropriately needs the farm closer to the homestead area. Detail information about the distance of the farm described in table 4.4.

Table 4.4: Household farm distance to homestead

The distance of farm from the homestead	Frequency	Percent (%)
<5 minutes	39	39.0
6-15 minutes	52	52.0
16-25 minutes	9	9.0
Total	100	100.0

Source: Own field Survey,2020

4.2. Activities used to enhance adaptation capacity

The result shows that 94%, 78%, 76%, 88% of farmers participated in practicing terracing, planting cover crop and water harvesting respectively. Based on fertilizer usage 98%, 48%, 91% and 75% of farmers are joined in the use of chemical fertilizer, compost, farmyard manure and incorporating crop residue on the farm correspondingly. In the same way, 98% and97% of respondent farmers participated in compost production activity and on agroforestry practices respectively. All farmers have participated in the applying of the existed improved variety as they can. As indicated in Agrewal (2008) study, historically communities and institutions develop different strategies and take various measures to cope with the adverse effect of climate variability as well as to increase agricultural production. The results response of farmers on application of climate-smart agriculture practices was presented below.

Table 4.5: Response of farmers on application of climate-smart crop production practices

CSA practice		Response	Frequency	%
		Yes	94	94
	Tracing	No	6	6
	Planting tree on the	Yes	78	78
	farm	No	22	22
	Planting cover crop	Yes	76	76
		No	24	24
Soil and water		Yes	88	88
conservation	Water Harvesting	No	12	12
		Yes	98	98
	Chemical fertilizer	No	2	2
		Yes	48	48
	Compost	No	52	52
		Yes	91	91
	Farmyard manure	No	9	9
	Incorporate crop	Yes	75	75
Fertilizer	residue on farm	No	25	25
		Yes	100	100
Improved variety		No	0	0
		Yes	98	98
Compost production		No	2	2
		Yes	97	97
Agroforestry		No	3	3
Total			100	100

Source, own field survey, 2020

Figure 4.1 Soil and water conservation practices in the study kebeles

Source: own observation, 2020

The group discussion shows that the soil and water conservation practices create progressive changes in the soil structure and fertility. The farmers evaluated the return from the progressive change of farm outputs. The Safdar et al.(2018) finding indicated that the application of manure and fertilizers provide essential plant nutrients in the soil for better crop growth. Currently, in every agricultural product, there is an excess market price increment that resulted in an increment of income. The increment of the product through practicing CSA changes the financial asset of HHs and enhances their saving capacity. As a result, HHs can build modern houses instead of cultural houses and able to pay school fees for their children. As a result of CSA, farmers understood that compost production, agroforestry, the use of improved variety that can protect the soil and water availability as well as environmental protection. Soil and water conservation practices protect soil and water from erosion and sustain the availability. The protection of soil structure and function has a positive influence on the productivity of agricultural products then smallholder farmers can generate income and they can cop up from the adverse effect of climate variability effect. Each practice has a contribution to the protection of the natural environment by reducing greenhouse gas emissions and improving the carbon sequestration process.

Although, the study categorized the perception of farmers how they evaluate the effectiveness of the CSA practices into three levels such as effective, moderately effective, and ineffective. The result shows that 89%, 94%, 80% and 72% of household farmers reported that the use of the improved variety, crop rotation, planting the cover crop and changing planting date were effective in improving crop production. And 73%, 72%, 81%, 79%, 78% and 37% of household farmers also effective on the practice of planting a tree on cropland, diversified crop, irrigation, use of organic fertilizer, planting the crop on tree land and use of mulching respectively. From the identified CSA practices use of mulching takes 11% of ineffective farmers. Detail information is described in table 4.6.

Table 4.6: Respondent response to the rate of effectiveness of CSA practices

CSA practice	Effective in %	Moderately effective in %	Ineffective in %
Use of improved crop	89	10	1
Crop rotation	94	6	0
Planting cover crop	80	16	4
Change planting date	72	20	8
Planting tree on the crop farm	73	19	8
Diversified crop	72	22	6
Irrigation	81	15	4
Use of organic fertilizer	79	18	3
Planting crop on tree land	78	16	6
Use of mulching	37	52	11

Source: own field survey, 2020

According to the group discussions, there was an improvement in community ability and ecosystem ability to resist, absorb, and recover the effects of land degradation and water loss. There is an improvement of resilient capacity to climate change risks and minimize the potential damage and maximize the potential benefits. With the help of CSA practice, the agriculture activity builds a resilient community to manage hazards, to reduce its effect, and to recover quickly from negative impact. The study of Akinnagbe & Irohibe,(2014) identified that improved crop varieties, switching cropping sequence, sowing earlier, and adjusting the timing of food operations, covering soil moisture through appropriate tillage methods, improving irrigation efficiency are some of the actions of resilience improvement or enhance adaptive capacity. After the implementations of agroforestry practice re-existing of new species and increased their number, increasing the population of species in the natural plant, increasing the diversity of local crop varieties, increased the habitat for associated species with increasing related functions were presented in the area. The farmers improve their income and they can provide the basic needs of their families (cloth, school materials for the student) and they change their home from soil made to steel made. The farmers also participated in access to credit and saving. There is also an improvement of wetlands in the area after practicing agroforestry and by practicing rotational grazing. Wild animals, birds, plants, and water sources are protected. IFAD, 2010 identified that climate-smart agricultural practice could increase the farmer's awareness about the importance of grasses and plants for the environment and protection of soil and water sources.

4.2.1. Perceptions of farmers on the rate of climate smart crop production practices on the enhancement of resilience capacity

The survey result of respondent response on the effectiveness of the existed climate-smart agriculture practices on the resilience improvement by considering the livelihood change, soil and water source protection and functions improvement, resilience capacity improvement on climate variability and environmental protection. The study categorized the level of effectiveness into three parts. The result shows 72% of farmers thought as they are effective on the improvement of resilience capacity and 28% of farmers are moderately effective. Table 4.7 shows detail information.

Table 4.7: Response of farmers on the improvement of resilience capacity

How do you rate the effectiveness of CSA practice on the improvement of resilience capacity improvement in soil and water	Frequency	Percent
Effective	72	72.0
Moderately effective	28	28.0
Total	100	100.0

Source: own field survey, 2012

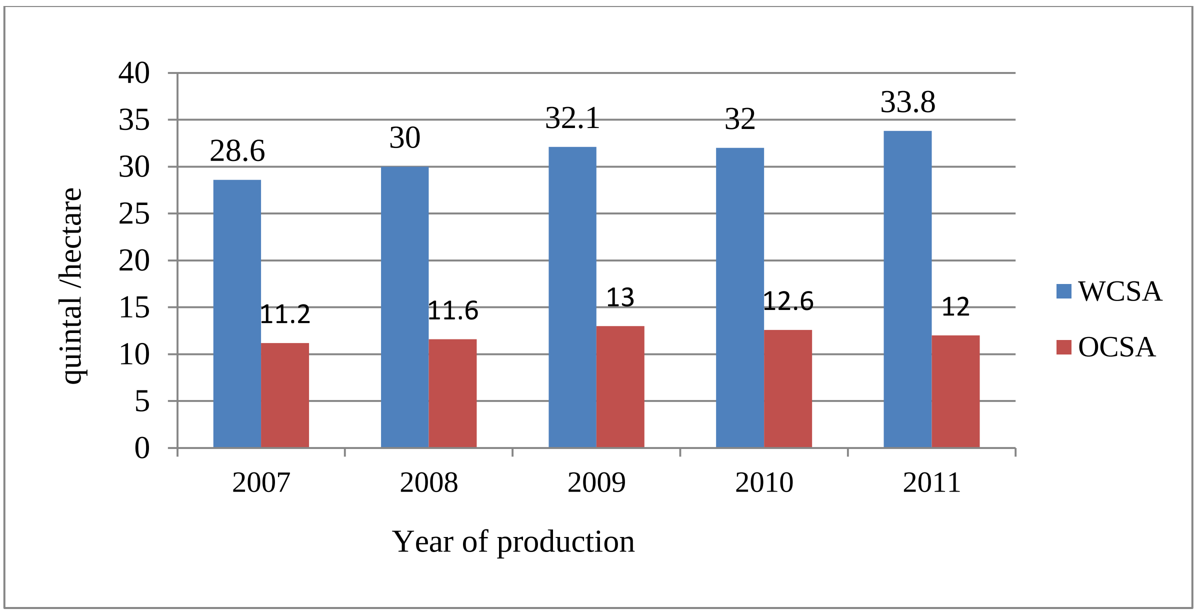
The group discussion described there is a reduction of soil erosion andthe availability of water increments are occurred in the area as compared to before the implementation of CSA practice.

According to the key informant interviews, the status of soil fertility and improvement of wetland existed in the area as a result of practices such as the living by-products in the farm area after post-harvesting and agroforestry.

4.3. Change of productivity in terms of yield per hectare and income

Figure 4.1 indicated that the change of yield of crop such as Teff, Wheat, Barley, Bean and lentil in terms of the climate-smart crop production practices, and without climate smart agriculture practices. Accordingly, the average change of yield of climate smart crop production practices is 61% more compared to without climate smart crop production practice. A large amount of change of yield was registered in the year of 2011 which is 21.8 quintals/hectare and the smallest change of yield amount is registered in 2007 which is 17.4 quintals/hectare. This result reveals that the progress of productivity of crops and the generated incomes of HHs were increased over the consecutive years. The detailed information regarding the change of yield and incomes of HHs described below in table 4.8 and figure 4.2

Figure 4.2: Change of yield with climate-smart crop production practices and without climate smart crop production practice



Source: WWANRO, 2020

Based on the data obtained from Woliso woreda natural resource office, the yield of crops varied from year to year. The amountof yield with CSA practicing was increased as indicated compared with no practicing CSA as indicated in table 4.8. This finding in line with Thewodros, 2018 study that the adoption of climate-smart agriculture practices maintains and improves soil fertility and a positive effect on agricultural productivity. However, without practicing climate-smart agriculture productivity could have an improvement rate but could not be sustainable.

Table 4.8: Change of crop yield, price and household income

Variables	Production years				
	2007	2008	2009	2010	2011
Quintal/hectare	28.6	30	32.1	32	33.8
Average Price	970	1120	1210	1480	2220
Gross Income (ETB)	27742	33600	38841	47360	75036

Source: Own survey, 2020

The data obtained from the interviews indicated that the climate-smart crop production practices were significant to increase the yield of the product.. But, because of the political instability, fluctuation of rain and climate variability the productivity increment rate did not be as expected. The cereal crops were produced based on rain for one time in the year and other vegetables and fruits were produced by an irrigation system that is furrow irrigation from the river called Laga Cheqorsa[1].

According to group discussion, the farmers and agricultural experts identified that climate-smart crop production practices does not arrive for all farmers, only functioned for some farmers who have farm area closed to the watershed that is 75% watershed should have to implement soil and water conservation practices and entered in the structure of climate-smart agriculture practices and helped by SLMP and Governmental and nongovernmental institutions. Therefore, more farmers who have farm place far from the water shad does not

[1]Laga Cheqorsa is the word of affan oromo that is the name of the rever in the study area

included in CSA structure and do not participate in the benefit of CSA practice as a result of climate smart production practice need a financial resource to implement. Group discussion described that more farmers have practiced agricultural activities by taking previous knowledge through experience.

4.3.1. Perceptions of farmers on the increase of productivity by CSA practice

The result of the respondent survey shows that from the total number of respondents 92% of respondents were effective on the other hand 8%of respondents were moderately effective and there is no response on ineffective on the improvement of productivity by employing climate-smart agriculture practices. This shows that if the farmers participate in CSA practice they can be more productive than business as usual. And they can improve their food conception and supply of products into the market.

Table 4.9: perceptions of farmers on the effectiveness of climate smart crop production practices on the productivity improvement

Rate of productivity	Frequency	Percent (%)
Effective	92	92.0
moderately effective	8	8.0
Total	100	100.0

Source: Own field survey, 2020

4.4. Barriers affecting farmers from practicing climate smart crop production

Table 3.12 shows that 61% of household farmers rate ‘problem of farm tools’ as ‘high-challenge and 31% of them rate the same problem of farm tools as ‘very highchallenge.34%s respondents rate shortage of land as limited’ challenge concern on the shortage of land to come up with highly productive, while 79% of HHs rate market access as ‘moderate’ challenge, while 66%s respondents rate access and availability of input supply as moderate challenge. 84%s of respondents also rated water access as moderately challenging, while labor access is also a moderate challenge as replied by 51%s of respondents. Moreover, a large number of household farmers rated transportation access (84%), information access (69%), extension service access and availability (83%),financial resource (88%), lack of governmental (79%), and none governmental support(57) as the moderate source of challenge to climate-smart agriculture practices. Beyene (2018) study identified that adoption of climate-smart agriculture practice depends on farmers' assets such as landholding, labor, availability, knowledge and experience, social capital, financial capital and physical capital. The detailed information about the challenges and the level of concern of household farmers are described in the below table.

Table4.10: Level of the respondent source of concern on the challenge of CSA practice

Challenges for CSA effectiveness	% of respondent response on the source of concern on the factors				
	Not a source of concern in %	Limited source of concern in %	Moderate source of concern in %	High source of concern in %	Very high source of concern in %
Farm tool	2	4	2	61	31
Land shortage	2	34	33	17	14
Market access	7	79	13	1	
Input supply	0	8	66	19	7
Water source and access	1	5	84	9	1
Labor	27	0	51	17	5
Transportation access	0	5	84	10	1
Information access	0	12	69	16	2
Availability and access to xtension service	0	12	83	5	0
Distance to get extension services	0	4	95	1	0
Financial resource	0	3	88	8	1
Government support	2	14	76	8	0
None government support	3	29	57	8	0

Source: own field survey, 2020

The result of group discussions indicated that there is no modern and appropriate farm tools technologies, irrigation technology, limitation of appropriate improved variety, limitation of research on the soil type to the area. And also in line with Gelashe (2018) finding, there were limitations of information and knowledge, fear of risk, free grazing, lack of labor, limited land, cropland computation, poor infrastructure and weak institutional support exist in Woliso woreda.

Besides this, key informant interviews also indicated that as a result of the plantation of eucalyptuses there exists the reduction of water availability and limitation of water access on the farm area because of the practice of irrigation system (furrow irrigation). There are limitations of improved variety of crops, animals, vegetables and fruits. Accordingly, the existed irrigation system needs a high labor force to implement.

Field observation result indicated that there is high initiation of farmers on the practice of climate-smart agriculture but steel farmers are using oxen, use manpower to sew, use donkey for transport. There are limitations of modern and relatively easy agricultural mechanization.

Limited access to appropriate farm tools: Table 4.9 shows 31% of respondents were faced with a very high source of concern on the limited access to appropriate farm tools, 4% with a high source of concern, 2% with limited source of concern, 61% with the moderate source of concern and 2% with no source of concern. As the study observed from the field the farmers still plowing their land by oxen, sew by using their hand. The existing agricultural practices were practiced by using high human power. There were still business as usual agricultural practices. As observed from the group discussions and key informant interviews there is the limitation of finance and the geographic structure of the land not appropriate to the agricultural machinery like tractors and transport material. The study indicated that farmers who have fewer farm tools unable to practice climate-smart agriculture activities as needed and unable to be effective. As indicated in Sterve (2010) lack of farm tools negatively restricting adopting a full package of climate smart agriculture practices.

Land shortage: As a result of the increased population in woliso woreda there has been existed scarcity of lands to practice agricultural activity as needed. Woliso woreda also highly become to urbanized. As we discussed in the group discussion there is inequality in the distribution of land. So the result of survey data indicated that 34% of respondents have limited source of concern on the scarcity of agricultural land, 33% of respondents were the moderate source of concern on the scarcity of land, 17% of respondents with a high source of concern on the scarcity of land, 14% of respondents have a very high source of concern on the scarcity of agricultural land. According to the study conducted by Abebaw et al (2015), the availability of appropriate landholding size is significant to adopt new technologies.

Limitations of input supply: As observed from the key informant interview limitation of input supply directly related to the financial scarcity of woredas agriculture and natural resource office and lack of alternative agricultural input supplier. The survey data indicated that 66% of respondents were limited sources of concern on the limitation of imputing such as fertilizer and seed, 19% of respondents are with a high source of concern on the limitation of imputes, 7% of respondents are with a very high source of concern.

Lack of financial capital: Financial capital consists of cash and liquid asset like livestock and crop sales that are used to finance CSA practices. If farmers gain their income from this source they could easily access input for the needed practices. A shortage of money limits the adoption of climate smart agriculture practices as needed. Lack of access to credit service has a positive and significant relationship for farmers to practice appropriate practices and to be effective in returning the outputs as needed. According to the survey result, 88% of respondents had a moderate source of concern in access to financial resources. If farmers have access to credit, they can acquire appropriate technologies that might be expensive to buy and to be effective.

The condition about how looks the access and availability of credit services were discussed in group discussion. And as a result of the area located in rural, they cannot access the service when they want and they are used cultural-saving activity. That's why the farmers were not using the full package of climate smart agricultural practices as needed. This result is in line with the finding of Amao and Ayantye, 2015, that access to credit in the form of soft loans can expand production through purchase and use of improved inputs. There is a lack of financial resource access and availability in the area.

According to key informant interviews, there was a limitation of budget allocation for the climate smart agriculture practices from the woreda as well as from the region. That's why there were limitations of access and availability of appropriate practices and technologies for the farmers.

Governmental and non-governmental support: As observed from the data 76% of farmers were challenged with limited support from governmental institution. The climate-related institutions have responsibility for the success of climate-smart crop production practices and implemented through various projects and programs by its different units including climate resilience green economy (CRGE), Sustainable land management program (SLMP) coordinate unit, the soil information and fertility directorate, agricultural growth program (AGP) coordination unit and the national agricultural research system among others. The study of Hagos, 2013 defined that local institutions and stockholders have a great role in addressing climate variability impacts and have contributions to this task. The responsible stakeholders also enforced and managed acceptable adaptive measures). However, the study observed that there is a lack of collaboration within climate-related stakeholders rather they are employing only their needs. Teklewold et al.(2013) identified that if the government and NGOs support properly implemented, can build farmers confidence on implementing sustainable agriculture practices so that they invests despite uncertainty, and can help farm households to smooth consumption and maintain productive capacity.

According to the result of the key informant interview, due to the traditional irrigation system (furrow irrigation system), the scarcity of water existed in the area the farm areas which are located far from the watershed faced water scarcity. As observed from the field almost all respondent farmers practiced agricultural activities depend on watershed and they use traditional irrigation systems (i.e. furrow irrigation). That's why the farmers challenged on water availability and accessibility.

As observed from the WWANRO of sustainable land management office report budget shortage, lack of nursery site, incompatibility of minimum tillage with existing extension, free grazing and lack wheel borrow to transfer matured compost to apply in the field was the major challenge for the implementation.

CHAPTER FIVE:

CONCLUSIONS AND RECOMMENDATIONS

5.1.Conclusions

The study assesses the common climate-smart crop production practice that can enhance the adaptation capacity and protect the natural resource from the adverse effect of climate variability and land degradation. Accordingly, soil and water conservation practices (tracing, planting tree on the farm, planting cover crop, water harvest); using fertilizer appropriately like compost, chemical fertilizer, farmyard manure, incorporate crop residue on the farm; use of improved variety; compost production and agroforestry were practiced in the area. While every practice has the potentials to increase the productivity rate and improve the adaptive capacity to cope with the adverse effect of climate variability and land degradation. And also household farmers were practicing on saving money as well as changing their cultural house into modern and teaching their children in special schools by paying an expensive fee.

The study identifies the average change of yield and income of households. Change of average yield of the crop production increased compared to without CSA practices, this shows climate smart crop production practices is very crucial to local farmers to improve food security as well as sustainable well being of their living standard.

This study also assesses the barriers to the application of climate smart crop production practices in the area. Even though the practices have benefited the farmers, there are various problems to adopt the practices. In the study area lack of farm tools, land shortage and lack of labor force are the main challenges affecting farmers to practice climate smart crop production. Because of the high increment of the population, there is a limitation of land access existed and the available land is not enough for families in order to participate in the full package of climate smart crop production practices.

Therefore, it could be concluded that farmers having higher educational status, young aged and access to financial services more likely to practice climate smart crop production activities, more productive and generate income.

5.2.Recommendations

Based on the empirical findings reported in this thesis, the following recommendations are forwarded.

- The study related policy effort has to be made to strengthen and encourage the application of climate smart crop production practices and should be targeted towards the more disadvantageous small holder farmers.
- Responsible government and non government institutions have to collaborate in strengthen the existing practices and works to avoid or minimize the identified challenges faced by small holder farmers in climate smart crop production practices.
- Government and non governmental institutions have to facilitate and support small holder farmers by expanding availability and access to financial services, establish forum for farmers to farmers experience sharing,
- There is a land shortage in the area so the woreda agricultural office should advertise the optimization of farming land and agricultural systems that produced more output from a small farm area.
- Research-based use of input should be implemented. Woliso woreda Agriculture and Natural resource Office should have to take the responsibility.
- Woredas agriculture and natural resource office and Ministry of Agriculture could have strong follow up on the practice of climate smart crop production and extend for all small holder farmers.
- Further study could be worked on the climate smart crop production practices.

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Questionnaire schedule for the household survey

Interview Schedule on Assessment of Climate Smart Agriculture On Sustainable Land Management In Woliso Woreda, Oromia Regions Of Ethiopia

First of all, I would like to thank you for your willingness to participate in this study. The questionnaire is designed to collect the necessary information to undertake research on the climate-smart crop production practices in Woliso woreda. The study is conducted for the partial fulfillment of the requirements for the degree of Master’s in Environment and Sustainable Development (MSc) at Addis Ababa University. The main objective of this research is to assess the effectiveness of climate smart agricultural practices. Please answer each question by making a tick mark **(√)** to the option that you choose inside the given box or circle according to the given question or write your answer on the blank space provided. Your genuine responses are quite vital for the success of this study. Finally, I would like to confirm that all the information you provide in this questionnaire will be strictly confidential and will exclusively use for this research purpose only.

NB. No need of writing your name. Thank you very much ahead for your cooperation!!!

Part 1: General information

Name of Enumerator			
Date of Data collection			
Region: Oromia	Zone:	Woreda:	Kebele:
Code of respondent			
Checked by			

Part2: Respondent background information

No	Question Item	Response Option	Skip
1	Respondent sex	1) Male 2) Female	
2	Respondent's Age years	1) <20 ☐ 2) 21-40 ☐ 3) 41-60 ☐ 4) >60 ☐	
3	Marital status	1) Married ☐ 2) Single ☐ 3) Divorce ☐ 4. Widowed ☐	
4	Household type	1) Male headed ☐ 2) Female-headed ☐ 3) Joint male and female-headed ☐ 4) Guardian ☐	
5	Educational level	1) Can't read and write ☐ 2) Read and write ☐ 3) Elementary school ☐ completed 4) High school completed ☐ 5) Certificate holder ☐ 6) Diploma holder and above ☐	
6	Total household size	1) Under 15 years old ________________2) 15 years and above __________________	
7	Total landholding in hectare and plots	1) Hectare and number of plots ________	
8	Distance of farm plot from homestead(walk distance)	1) < 5minutes ☐ 2) 6-15minutes ☐ 3) 16-25 minutes ☐ 4) > 26 minutes ☐	

Part3: Commonly used Climate smart agriculture practices and rate of effectiveness on sustainable land management

1. Have you taken any climate smart agriculture practices? 0 No 1 Yes since when? _____
2. If your answer is yes give the information regarding the following climate smart agriculture practices in your farm?

No	Climate Smart agriculture practices	Rate of effectiveness		
		effective	Moderately effective(2)	Ineffective (3)
1	Use of improved crop varieties			
2	crop rotation			
3	planting cover crops			
3	Changing planting dates			
4	Planting trees on crop land			
5	Diversified crop			
6	Irrigation			
7	Use of organic fertilizers			
8	Planting crops on tree land			
9	Use of mulching			
10	Others			
11				
12				

No	Question Item	Response Option	Skip
1	Have you carried out any soil and water conservation practices on your farm plot	1) Yes 2) No(If your answer for Q. NO. 9 is no, you can Skip Q10	
2	If the answer for Q9 is yes, what type of soil and water conservation practices you did? It is possible more than one answer.	1) Terracing on-farm plots 2) Planting trees on the farm plot 3) Application of compost 4) Farmyard manure 5) Incorporating crop residue on-farm plots 6) Irrigation 6) Construction (Trenches, dam, water harvesting structures, Water shade etc.) 7) Water harvesting 8) Planting cover crop 9)Other (specify)_______	
3	Why do you practice	1) Increased water retention capacity and better soil structure with tangible on-site production 2) Increased system resilience and reduced vulnerability 3) Minimizes soil and water loss 4) To protect soil fertility 5) To increase the yield of production 6) Other (specify)_______	
4	Have you apply fertilizer on your farm	1) Yes☐ 2) No ☐ (If your answer for Q. NO. 11 is no, you can	
5	If the answer for Q11 is yes, what type fertilizer you did? It is possible more than one answer.	1) Chemical fertilizer (Dap, Urea, Compost2) Natural fertilizer 3) Application of compost 4) Farmyard manure 5) Incorporating crop residue on farm plots 6)Other(specify)_____________________________	

6	Why do you apply fertilizer?	1) To increase productivity 2) To improve soil fertility 3) Other (specify)	
7	Have you apply improved variety in your farm	1) Yes ☐ 2) No ☐ (If your answer no, you can skip	
8	Why do you apply improved variety in your farm?	1) To increase productivity 2) To improve soil fertility 3) Other (specify)-----------------------------------	
9	Do you produce compost	Yes ☐ 2) No ☐	
10	Why do you produce compost	1) To increase productivity 2) To improve soil fertility 3) To income generation 4) Other (specify)	
11	Do you practice agro-forestry activities	1) Yes ☐ 2) No☐	
12	Why do you practice agroforestry activity	1) To increase productivity 2) To improve soil fertility 3) To income generation 4) To environmental protection 5) Other (specify)	

Part 4:Checking the rate of CSA practices

CSA pillars	Effective	Moderately effective	Ineffective
Increased productivity			
Improvement resilience capacity			

A**Part5: Barriers to applying CSA practice**

Have you ever experienced crop failure? Tick (√)	**Yes**		**No**	
If yes, how many times in the last 5 years?				

Based on last production season, how do you rate the following factors of climate smart agriculture activity?

No	Challenges to adopt climate smart activities	Not a source of concern(1)	Limited source of concern (2)	Moderate source of concern (3)	High source of concern (4)	Very high source of concern (4)
1	Farm tools					
2	Land shortage					
3	Agricultural market access					
4	Access to input supply					
5	Rain/water source and access					
6	Transportation access					
7	Information access and availability of CSA practices					
8	Availability and access to extension service					
9	Distance to get extension services					
10	weather conditions					
11	Financial resources					
12	Governmental institutional support					
13	Nongovernmental institutional support					
14						
15						

Key Informant Interview questions

Name___________________________________

Position/profession_______________________________

Interview with staff from government agriculture and natural resource office, SLMP coordinator, CSA focal person from the Ministry of Agriculture, SLMP

1. What are the impacts of climate smart agriculture practices on productivity in your district or *Woreda*?
2. What are the impacts of climate smart agriculture on the livelihood of farmers and on the environment protection in the context of your Woreda/ district?
3. What is your perception regarding the impact of climate smart agriculture practice to reduce greenhouse gas emission (GHG)?
4. What adoption challenges faced in climate smart agriculture practices?

FGD GUIDING QUESTIONS

1. How do you see the impact of climate smart agriculture practices on the level of productivity?
2. What looks the resilience capacity of the community as well as the environment for climate risk vulnerability after applying the climate smart agriculture practices?
3. What do you think about the barriers to adopt the full package of climate smart agriculture practice? Kindly share with us the failure stories.