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Addis Ababa University
College of Development Studies
Center for Rural Development

**Climate Smart Agriculture: Assessing Level of Adoption and its
Contribution to Food Security of Smallholder Farmers in Artuma-Fursi
Woreda, Oromiya Special Zone of Amhara Region, Ethiopia**

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June, 2019

Addis Ababa, Ethiopia

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Contribution to Food Security of Smallholder Farmers in Artuma-Fursi
Woreda, Oromiya Special Zone of Amhara Region, Ethiopia**

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**A Thesis Submitted to Center for Rural Development, College of Development
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**June, 2019
Addis Ababa, Ethiopia**

Declaration

I, the undersigned, declare that this Thesis is a result of my original work and has not been presented for an award of any degree in Addis Ababa or any other university. Sources of information other than my own have been acknowledged and a reference list has been appended.

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Definition of Key Terms

Climate Change: The meaning of climate change in this case ranges from an increased climate variability and gradual changes in temperature and precipitation, to increased frequency and intensity of extreme weather events, which are projected to have a larger impact, according to Eitzinger et.al, 2013 and Porter et.al, 2014, on agricultural production than gradual increase in temperature or gradual change in precipitation.

Climate Smart Agriculture (CSA): A definition adopted from FAO (2013) as agriculture that sustainably increases agricultural productivity and income (food security), enhances resilience of agricultural livelihoods (adaptation) and reduces and/or removes GHGs, whenever possible (mitigation) commonly known as ‘triple wins’ through adopting efficient practices, technologies, policies, institutions, research and finance.

Climate Smart Agricultural Practices: In this study CSA practices refer agricultural activities practiced by smallholder farmers in the study area as part of their traditional farming system and farm technologies adopted by them to achieve all or part of the triple CSA objectives.

CSA Adoption Level: Refers to the rate of use or level of uptake of existing CSA practices and technologies by the farm households, and hence used interchangeably throughout this research work.

Smallholder Agriculture: In this study agriculture refers to the traditional mixed crop-livestock farming system, a dominant livelihood base of local farmers in Oomiya Special Zone of Amhara regional state, where the study area is located.

Household Food Security: Given that households are the basic economic units that determine resource allocation decisions and consumption, the food security assessment in this study was made at farm household level. Thus, household food security in smallholder farm households’ context specifically refers the complementarities of availability and accessibility (entitlement), which were determined based on the Household Food Balance Model (HFBM) and Household Food Insecurity Access Scale (HFIAS), respectively.

Abstract

Climate-Smart Agriculture (CSA) is a new agricultural approach emerged to improve resilience and productivity, leading to improved food security among smallholder farmers in the face of the menace of climate change. This study thus assessed adoption level of CSAPs and its contribution to food security of smallholder farm households in Artuma-Fursi Woreda. A multistage sampling technique was employed to select 259 sample households. Primary data was collected through structured interview questionnaire using pre-tested cross-sectional survey schedules; and KII and FGDs. Content analysis and close examination of existing CSAPs in the study area were used to identify and group the CSAPs actively used by farmers. Then, a descriptive statistics, called Adaptation Strategy Use Index (ASUI) was used to identify the extent of adoption of each CSAPs in terms of their frequency of use by farmers. To assess links between farm households' level of adoption and their food security status, the researcher went through two steps. Firstly, a Composite Score Method was used to classify farm households based on their level of adoption, while the second step involved assessment of households' food security status as measured by the HFBM and HFIAS. Finally, an ordered Probit model was employed to assess factors influencing adoption level of CSAPs in the study area. Results revealed that some 30 CSAPs were actively in use by farmers at different extent and combination, and were presented in five groups, namely CMPs, LMPs, SWCPs, AEPs and IFES. Further results indicated that CMPs (use of improved crop varieties, alley cropping, mechanical weed control, and change planting dates), LMPs (applying fodder conservation, diversify livestock species and use cut and carry feeding) and SWCPs (conservation tillage, crop rotation and in situ water conservation) were the most widely adopted CSAPs, while AEPs (integrating trees in croplands and bee-keeping) and IFES (biogas production and use of efficient biomass stoves) were the least adopted CSAPs in the study area. Regarding level of adoption, 44.4% of the households were medium adopters, followed by the low adopters (32.8%). Only 22.8% were high adopters. It was evident that CSAPs had a great potential to improve food security of farm households. Results of the HFBM indicated 49.2% of high adopters were in the acceptable calorie consumption category ($\geq 2,100$), in which only 4.7% were low adopters. In contrast, 64.7% of the low CSA adopters were in the poor calorie consumption category ($\leq 1,680$), in which only 13.56% were high adopters. Likewise, results of the HFIAS indicated that the prevalence of food security was the highest among high adopters (79.7%) compared to low (47.1%), in which the prevalence of food insecurity was the highest (52.9%), indicating that greater level of adoption had the highest effect on food security. Results of the ordered probit model indicated that age, gender, years of education, household size, farm size, group membership, access to credit, farm income, off-farm income and value of productive assets were all negatively related, implying that an increase in all these variables will cause low and medium adopters to increase their level of CSA adoption. All these explanatory variables were positively related implying that an increase in these variables will boost adoption in high adopters, providing wider spectrum of interventions to improve the demand for CSA, including the launching of new programs with the potential to diversify farm and non-farm income sources and enhance the institutional support through improved access to extension and credit services. Households should be encouraged to incorporate as much CSAPs as possible to have a higher effect on their food security status. Beside, households should be sensitized on the need to invest on productive assets to enable them absorb risks associated with climate change simultaneously enhancing their ability to uptake more and more CSAPs.

Table of Contents

Declaration	i
Acknowledgement	ii
Definition of Key Terms	iii
Abstract	iv
Table of Contents.....	v
List of Tables	vii
List of Figures	viii
List of Abbreviations and Acronyms	ix
CHAPTER ONE	1
1. INTRODUCTION	1
1.1. BACKGROUND OF THE STUDY	1
1.2. STATEMENT OF THE PROBLEM	3
1.3. OBJECTIVE OF THE STUDY	6
1.3.1. GENERAL OBJECTIVE	6
1.3.2. SPECIFIC OBJECTIVES	6
1.4. RESEARCH QUESTIONS	6
1.5. SIGNIFICANCE OF THE STUDY	6
1.6. SCOPE OF THE STUDY	7
1.7. LIMITATIONS OF THE STUDY	7
1.8. ORGANIZATION OF THE PAPER	8
CHAPTER TWO	9
2. LITERATURE REVIEW	9
2.1. CLIMATE CHANGE-AGRICULTURE-FOOD SECURITY NEXUS	9
2.2. THE CONCEPT OF CLIMATE SMART AGRICULTURE	12
2.2.1. FOOD SECURITY	14
2.2.2. CLIMATE CHANGE ADAPTATION	15
2.2.3. CLIMATE CHANGE MITIGATION.....	15
2.3. THEORETICAL BACKGROUND.....	16
2.4. DEVELOPMENT OF CSA IN ETHIOPIA	20
2.5. REVIEW OF EMPIRICAL STUDIES	23
2.6 GAPS IN LITERATURE REVIEW	28
CHAPTER THREE	30

3. METHODOLOGY	30
3.1. DESCRIPTION OF THE STUDY AREA.....	30
3.1.1. LOCATION	30
3.1.2. THE PHYSICAL ENVIRONMENT	31
3.1.3. SOCIOECONOMIC CHARACTERISTICS	31
3.2. SAMPLING PROCEDURES AND SAMPLE SIZE DETERMINATION	31
3.3. DATA COLLECTION METHODS AND INSTRUMENTS	33
3.4. METHODS OF DATA ANALYSIS	34
3.4.1. ADAPTATION STRATEGY USE INDEX (ASUI)	35
3.4.2: ASSESSING LEVEL OF ADOPTION OF CSA PRACTICES AMONG HOUSEHOLDS.....	36
3.4.3. ASSESSING FOOD SECURITY STATUS WITH DIFFERENT CSA ADOPTION LEVELS	36
THE HOUSEHOLD FOOD BALANCE MODEL (HFBM)	36
THE HOUSEHOLD FOOD INSECURITY ACCESS SCALE (HFIAS).....	38
3.4.4. ORDERED PROBIT MODEL.....	40
3.4.6. ANALYTICAL FRAMEWORK OF THE STUDY.....	43
CHAPTER FOUR	44
4. RESULTS AND DISCUSSIONS.....	44
4.1. BACKGROUND OF HOUSEHOLDS AND TYPE OF CSA PRACTICES	44
4.1.1. DEMOGRAPHIC AND SOCIOECONOMIC BACKGROUND OF HOUSEHOLDS	44
4.1.2. TYPE OF CSA PRACTICES AND EXTENT OF ADOPTION IN THE STUDY AREA.....	49
4.2. CONTRIBUTION OF CSA PRACTICES TO FOOD SECURITY	57
4.2.1. ADOPTION LEVEL OF CSA PRACTICES AMONG SURVEY HOUSEHOLDS.....	58
4.2.2. LINKING HOUSEHOLDS' FOOD SECURITY STATUS AND CSA ADOPTION LEVEL	59
I. HOUSEHOLD FOOD BALANCE MODEL AND ADOPTION LEVEL OF CSA PRACTICES.....	59
II. HOUSEHOLD FOOD INSECURITY ACCESS SCALE VIS-À-VIS CSA ADOPTION LEVEL.....	63
4.3. FACTORS INFLUENCING CSA ADOPTION LEVEL IN THE STUDY AREA	66
CHAPTER FIVE	72
5. CONCLUSIONS AND RECOMMENDATIONS	72
5.1. CONCLUSIONS	72
5.2. THE NOVELTY OF THE STUDY.....	73
5.3. RECOMMENDATIONS.....	74
REFERENCES	76
APPENDICES.....	82

List of Tables

Table 2.1: Summary of some common CSA practices in Ethiopia	22
Table 2.2: Summary of Empirical Findings on Potential Benefits of CSA	27
Table 3.1: HFIAS Generic Questions	39
Table 3.2: Explanatory variables used in econometric analysis and expected signs	42
Table 4.1: Demographic background of the sample households	45
Table 4.2: Socioeconomic background of households.....	47
Table 4.3: Descriptive statistics showing type and number of CSA practices	50
Table 4.4: CSA practices and their rank of adoption in the Study Area.....	51
Table 4.5: Extent of adoption of CSA Practices Ranked as per the Value of ASUI.....	53
Table 4.6: Summary of the descriptive statistics for CSA adoption groups	58
Table 4.7: Distribution of mean dietary energy available by CSA adoption level	60
Table 4.8: Distribution of Households' Calorie Consumption by CSA adoption.....	61
Table 4.9: Distribution of affirmative responses to HFIAS questions by CSA adoption level	64
Table 4.10: Distribution of households' food security status by CSA adoption	64
Table 4.11: Descriptive Statistics for Adoption level, HFBM and HFIAS	66
Table 4.12: Pearson Product-Moment Correlations b/n CSA Adoption Level, HFBM and HFIAS	66
Table 4.13: Ordered probit model for determinants of CSA adoption level.....	69
Table 4.14: Households Perception on Farm Characteristics and Climate Changes	70

List of Figures

Figure 2.1: Linkages between Climate Change and Food Security.....	11
Figure 2.2: The Conceptual Framework for CSA	13
Figure 2.3: Climate-resilient transformation pathways for agriculture.....	18
Figure 2.4: The Conceptual Framework of the Study	19
Figure 3.1: Location Map of the Study Area	30
Figure 3.2: Analytical Framework of the Study	43
Figure 4.1: Partial views of selected CSA Practices in Artuma Fursi Woreda	56
Figure 4.2: Types of CSA Practices and average number of adoptors.....	57
Figure 4.3: Proportion of households (%) in different CSA adoption groups.....	62
Figure 4.4: Distribution of Food security status of households by CSA adoption level.....	65

List of Abbreviations and Acronyms

AEPs:	Agroecological Practices
ASUI:	Adaptation Strategy Use Index
AEZs:	Agroecological Zones
CMPs:	Crop Management Practices
CSA:	Climate Smart Agriculture
FGD:	Focus Group Discussion
GDP:	Growth Domestic Product
GHG:	Greenhouse Gas
HFBM:	Household Food Balance Model
HFIAS:	Household Food Insecurity Access Scale
HAG:	High Adoption Group
IFESs:	Integrated Food Energy Systems
IPCC:	Intergovernmental Panel on Climate Change
KII:	Key Informant Interview
LAG:	Low Adoption Group
LMPS:	Livestock Management Practices
MAG:	Medium adoption group
SLM:	Sustainable Land Management
SSA:	Sub-Saharan Africa
SWCPs:	Soil and Water Conservation practices
UNFCCC:	United Nations Framework Convention on Climate Change
WFED:	Woreda Finance and Economic Development Office
WANRO:	Woreda Agriculture and Natural Resource Office

CHAPTER ONE

1. INTRODUCTION

1.1. BACKGROUND OF THE STUDY

Climate change happens in different ways ranging from increased climate variability and gradual changes in temperature and precipitation, to increased frequency and intensity of extreme events. The impacts are being felt in national economies, greatly affecting people's life and livelihoods (UN, 2015). Same source indicated that climate change affect people differently depending on their livelihood base and socio-economic status. People depend on climate-sensitive livelihoods and with limited access to resources and information are the most affected. By 2020, climate change will have impacted lives and livelihoods of about 250 million people in Africa, and will result in low agricultural production and food security (FAO, 2012).

The IPCC 4th Assessment Report predicts that climate change could cause yields to decrease by as much as 50% in highly vulnerable regions like SSA, where agriculture is still the main source of livelihood providing employment to more than 60% of the population and contributing about 30% of the GDP. With likely long-term changes in rainfall patterns and shifting temperature zones, it is one of the key causes of food insecurity in SSA, and expected to significantly affect agricultural production that could be detrimental to food security of the region (Elizabeth and Sophie, 2014).

Ethiopia is one of the most agrarian countries in SSA that are dominated by subsistence small-scale farmers. Agriculture is the principal economic sector in the country, accounting for about 36% of the GDP, 85% of the employing, 90% of the national exports and serves as main source of input to the industrial sector. At present, smallholders' productivity is being constrained by climate change and weather extremes like droughts and floods periodically reverse performance gains with devastating effects on food security (ATG, 2014). Vulnerability to extreme climate events is greatest in food-insecure districts of the lowlands, where climate-induced food insecurity is further exacerbated by the limited adaptive capacity and inadequate contingency planning for the threat of climate change (EPCC, 2015).

The problem has been evident in Oromia Special Zone of Amhara Regional State, an area laid at the junction of the two drought-prone belts in northeastern Ethiopia, where erratic rainfall

patterns, droughts, floods and other extreme events including excessive heating, hailstorms and frosts are the major climatic predicaments liable for repeated production failures and resultant seasonal food shortages (Degefa, 2002). A sizable proportion of the sedentary subsistence farmers and agro-pastoralists still rely on conditional/unconditional transfers from social safety net programs mainly due to the prevalence of climate change-induced seasonal and chronic food shortages (Degefa, 2005; Yared et al. 2000 in Degefa, 2005; WFP. 2016).

Specifically, the study area, Artuma Fursi Woreda, has always been identified as one of the food insecure areas in the region. The major causes of food insecurity in the study area are both natural and socio-economic in nature. The most common natural factors that contribute to food insecurity in the area include, but not limited to insufficient and unpredictability of the rain, recurrent droughts and disasters (commonly flood), degradation of the natural resource bases for agriculture, crop pests and animal diseases outbreaks that have been worsening smallholders' vulnerability condition year after year. Crops often fail due to uneven rainfall distribution over the growing periods and recurrent droughts (Zone DFED Statistical Bulletin, 2007-2017; Degefa, 2005). According to the Woreda PSNP coordination office nearly 35% of the rural households experience broader food shortage gaps even at times of normal rainfall, and the Woreda has been a recipient of food aid for a significant period in the past. Currently, about 36,260 people are targeted by the PSNP under public works and direct support components (WANRO, 2018/2019).

The strongly pronounced local need to address the food security challenges under the new realities of climate change has led to the introduction of the concept of Climate Smart Agriculture (hereafter CSA). The operational definition of the concept was first given by FAO, in which the three pillars of CSA are presented as sustainably increase productivity, and hence food security, enhance resilience (adaptation) and reduce/remove GHG emissions (mitigation), where possible. Since its establishment as a new approach, a wide variety of CSA options has been proposed to reduce the negative impacts of climate change, build climate resilient agricultural production systems, and harness the benefits of global warming. The options range from simple adjustment in crop management practices to transformation of agricultural production systems to adjust to new climatic conditions in a particular location (Vermeulen et al., 2012; Howden et al., 2007).

However, no interventions are climate-smart everywhere because what is climate-smart in one place may not be climate-smart in another. The CSA concept could thus be very much context specific particularly in countries like Ethiopia where farming systems and farm typology are very diverse making locally specific CSA interventions very essential (CSA Scoping-Ethiopia, 2016). Thus, it is pertinent to assess farm-level CSA activities being practiced by smallholder farmers in Artuma-Fursi Woreda and their contribution on food security of the local farm households.

1.2. STATEMENT OF THE PROBLEM

The challenges of climate change, agricultural productivity and food security are so inter-twined that addressing them separately makes no sense anymore (World Bank, 2011; HLPE, 2013). Given this, FAO and partners have come up with the concept of CSA as the latest solution to deal with this trinity of problems. The CSA approach is comprised of three main pillars often termed as triple wins. These are sustainably increase agricultural productivity and income (food security); building resilience to climate change (adaptation) and reducing and/or removing GHG emissions, where possible (mitigation). However, this does not imply that every practice applied in every location should produce these triple-wins meaning that the relative importance of each objective varies across locations and situations (Lipper et al., 2010).

In CSA scholarship, food security is the first pillar because increasing agricultural productivity has been identified as a primary way of addressing food insecurity (FAO, 2013). Increasing food security is the most important goal of CSA in developing countries (Lipper et al., 2010), where a major focus is on smallholder farmers as a group in most need to increase food security (Arakelyan, 2017). In Ethiopian context, increasing productivity among smallholder farmers is government's top priority understanding the importance of the smallholder sub-sector, the high prevalence of rural poverty and the large productivity gap (PIF, 2010). As such, agricultural practices are considered climate smart, if they maintain or achieve increases in productivity, and at least one of the other objectives signifying that the food security objective has always been given the highest priority (ATA, 2014).

Smallholder farmers in Ethiopia are reluctant to compromise short run production losses (food security) over long-term productivity gains while practicing CSA indicating that they always tend to prioritize the food security goal over the goals of adaptation and mitigation. This has been consistent with what was argued by Arakelyan (2017) that the promotion of productivity as

a pillar alongside adaptation and mitigation accords has been recognized as a priority in many developing countries suffering from chronic food insecurity. The performances of CSA practices have the potential to improve adaptation and mitigation, and they are determined mainly by their contributions to achieve/maintain increases in food security through increased productivity and income (MoANR, 2015, FAO, 2016).

As such, it is imperative to prioritize the food security outcome while assessing the contribution of CSA practices among smallholder farmers in Ethiopia. The reason to emphasize the short run food security effect can also be justified, at least partly, by the fact that it may be too early now for most CSA interventions to (fully) produce the long run effects because most CSA projects are at implementation stage provided that it is a new area of intervention in Ethiopia as elsewhere in Africa.

It is also imperative to note that CSA is context specific and interventions must take into account the type, location and scale of the production system because what is climate-smart in one place may not be climate-smart in another making it particularly difficult to transfer experiences from one context to another (<http://csa.guide.csa>). It is thus essential to invest in site-specific and household level assessments in order to understand CSA practices in specific agro-ecological and socio-economic conditions. Hence, albeit masses of CSA practices are being promoted in many rural communities, their level of adoption considerably varies across households may be due to variations in socio-economic characteristics, and the effects on food security are not yet clear. It is thus of paramount to assess contribution of CSA practices on food security across households under different adoption levels and factors influencing level of adoption.

Despite numerous donor-funded climate smart projects being implemented globally, there is limited evaluation evidence to judge the outcomes (Westermann et al., 2015). This is particularly true in countries like Ethiopia, where the majority of the empirical evidence come from recent impact evaluation research endeavors conducted on projects implemented in SSA. Some of these researches focused on level of adoption (Affholder et al. 2010; Meybeck and Gitz 2012), while others on barriers to adoption (Thiong'o, 2016; McCarthy et.al. 2011; Uzamukunda, 2015) or factors influencing adoption (FAO, 2016; Arslan et.al. 2014). Results indicated that level of adoption of CSA practices remains low for their inherent complexity (Shames et.al. 2012 in

Arakelyan, 2017) or multiple challenges as financial, infrastructural and knowledge and weak or unsystematic policy and legislation (Adego et.al. 2018). A study by Zeleke, Bewket and Alemu (2010) indicated that most on-farm climate change adaptation practices in Ethiopia have low-to-medium adoption rates.

Some studies also attempted to assess the impact of selected CSA practices, including Mulching (Shikuku et.al. 2015), Conservation Agriculture (Arslan et.al. 2015; Lopez-Ridauraa et.al. 2018), Agroforestry and SLM (Arslan et.al. 2014) and reduced tillage, crop rotation and legume intercropping (McCarthy and Brubaker, 2014) for their effects on reducing chemicals and energy consumption, at times enhancing crop yields under different AEZs and land use types. A recent study in West Africa concluded that agroforestry, SWC technologies and climate information services are promising options for climate change adaptation and risk management (Partey et.al. 2018).

Only few studies attempted to assess the effect of CSA practices on food security (Maxwell et al. 2014; Thiong'o, 2016; Masakha, 2017; Partey et.al. 2018) or using yield increment as a proxy for food security (Simret, 2014; Richards et al. 2014 as in Arakelyan, 2017; McCarthy and Brubaker 2014; Maguza-Tembo et.al. 2016). Results indicated that CSA is the way to a more resilient and higher agricultural productivity leading to improved food security even though a recent MDP-IFAD Internship Report found out that CSA Practices have not impacted positively on food and nutrition security in Uganda (Abinye, n.d).

To date, empirical studies for diverse agro-ecological and socio-economic conditions in Ethiopia cannot be obtained from literature in sufficient amount. Most of the available literature reports only anticipated outcomes like improving yield of crops, productivity of livestock, food security and income, improve resilience, reduce emission of GHGs or remove it by creating carbon sinks, rather than actual results. As a result, adequate data on CSA practices and the effects particularly on food security are insufficient at all levels. Even in cases where we have such data, they are mainly based on small samples of farmers, who took part in CSA or related promotion activities, thus provide only suggestive remarks about the expected outcomes. Therefore, the present study will make a substantial contribution to endeavors of bridging this research gap by assessing adoption level of CSA practices and its contribution to food security of smallholder farmers in Artuma-Fursi Woreda, Oromiya Special Zone of Amhara Region, Ethiopia.

1.3. OBJECTIVE OF THE STUDY

1.3.1. GENERAL OBJECTIVE

The general objective of this study was to assess level of adoption of CSA practices and its contribution to food security of smallholder farm households in Artuma-Fursi Woreda

1.3.2. SPECIFIC OBJECTIVES

Specifically, this study intended:

1. To identify the type and extent of adoption of existing CSA practices in the study area
2. To assess adoption level of CSA practices and food security status of farm households
3. To analyze the contribution of CSA practices on food security status of the farm households
4. To assess factors influencing level of adoption of CSA practices in the study area

1.4. RESEARCH QUESTIONS

1. What are the CSA practices widely applied by farmers in the study area?
2. To what extent farm households adopt CSA practices (level of adoption/uptake)?
3. What is the food security status of households as measured by the HFBM and HFIAS?
4. How far households' level of adoption of CSA practices and their food security status relate?
5. What are the factors influencing level of adoption of CSA practices in the study area?

1.5. SIGNIFICANCE OF THE STUDY

A body of empirical evidence produced by previous studies (Degefa, 2002 and 2005; Yared et al. 2000 in Degefa, 2005) identified climate change (mainly variability, extreme weather events) as one of the major challenges adding considerable stress on agriculture and food security of smallholder farmers in Oromiya special zone of Amhara region, Ethiopia. Knowledge of CSA practices leading to improved resilience, and hence food security, and the institutional and socio-economic factors affecting adoption level of CSA practices is one step towards advancing local strategic plans and helping farm households achieve an optimal solution in their farming practices. Therefore, this study is important in that it reveals the contribution of adoption level of CSA practices on food security status of farm households, and the factors influencing adoption level of CSA practices among smallholder farm households in the study area. Besides, the report of the study will also be a useful tool to government agriculture and climate change policy makers at all levels and international institutions and NGOs who seek to foster wider adoption of CSA by up-scaling and out-scaling the practices in smallholders' context across the country.

1.6. SCOPE OF THE STUDY

This study will be geographically delimited to smallholder farm households in Artuma-Fursi Woreda of the Oromiya Special Zone, Amhara Region, who are vulnerable to environmental effects as well as climate variability and change and have least coping capabilities depending on subsistence mixed agriculture as a dominant source of their livelihood. The study is also thematically restricted to the assessment farm-level CSA practices adopted by farm households and their food security status (as measured by the HFBM and HFIAS) focusing side-by-side on the various socio-economic, institutional and environmental factors influencing adoption level of CSA practices among the farm households. Thus, this study particularly emphasized on the food security outcome, while the CSA approach consisted of various policy/strategic, institutional and financial issues that guide its practical aspects and the triple outcomes. Besides, the study was bounded to farm household level analysis disregarding gender based disparities observed in the level of adoption of CSA practices and the differential contributions on food security status of male- and female-headed households. Besides, seasonal variation in food production and utilization was not taken in to account while measuring household food security.

1.7. LIMITATIONS OF THE STUDY

Any research undertaking faces certain limitations. Similarly, this research is not free from such limitations particularly those caused by budget and time constraints, shortage of related researches useful for comparison purpose as it has been mentioned on the background that CSA is a new area of study in Ethiopia as elsewhere in Africa. Particularly the recent ethnic based conflict and local political tensions affected the process of data collection, and hence hindered the researcher to gather sufficient qualitative data by increasing suspicion and reluctance of participants in the FGD and key informants to provide a qualitative data at the required amount and quality. The qualitative gathered through these methods would be important to supplement the quantitative data obtained through household survey as well as to triangulate with results of data analysis made based on quantitative data. However, the researcher tried to minimize the effect of these limitations on the validity of the study by focusing on selected issues/variables, which were most important to achieve the objective of the study.

1.8. ORGANIZATION OF THE PAPER

This research paper is divided into five chapters. The first chapter deals with the introduction part which comprises background of the study, statement of the problem, objectives of the study, research questions, significance and scope of the study. The second chapter reviews the concept of CSA and its theoretical background, empirical studies conducted in Ethiopia and elsewhere in the world and the conceptual and analytical frameworks of the study. The third chapter presents description of the study area and the methodological framework used to collect and analyze data, while results and discussions on major findings of the study were presented in chapter four. Lastly, chapter five presents the conclusion and recommendation parts drawn from the findings.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. CLIMATE CHANGE-AGRICULTURE-FOOD SECURITY NEXUS

Climate change is expressed in both a shift of mean climatic conditions (e.g. temperature and precipitation), and an increase in the frequency and severity of weather extremes. The weather extremes are often projected to have a larger impact on agricultural production than gradual increase in temperature or gradual change in precipitation. More frequent droughts and extreme weather events during the cropping season are likely to increase the number of unfavorable years, which may cause enhanced yield instability and make current agricultural areas less suitable for traditional crops with climate change impacts varying across crops and regions (Klein et al. 2014; Supit et al. 2012).

Climate variability and change impacts directly or indirectly on all economic sectors to some degree, but agriculture is among the sectors most sensitive and inherently vulnerable to climate variability and climate change is most likely to increase this vulnerability. The impacts of increased temperature from global warming and changes in rainfall patterns resulting from climate change are expected to reduce agricultural production and put further pressure on marginal land. Many studies conclude that the strongest impact of climate change on the economic output of agriculture is expected for Sub-Saharan Africa, which implies that the challenge to deal with the negative impacts of climate change will be largest in the poorest and already most food insecure regions. Smallholder farmers in Sub-Saharan Africa are already challenged by the current climate variability and with a business-as-usual development, climate change is expected to pose challenges beyond the current experiences (Cairns et al., 2013).

Climate change and food security are two of the most pressing challenges facing the global community today. Improving smallholder agricultural systems is a key response to both. The latest FAO report estimated that the number of chronically hungry people in the world has reached a total of 925 million people. About 75% of the worst-affected people reside in rural areas of developing countries, their livelihoods depending directly or indirectly on agriculture. Strengthening agricultural production systems is a fundamental means of improving incomes and food security for the largest group of food insecure in the world. As the key economic sector of most low income developing countries, improving the resilience of agricultural systems is essential for climate change adaptation. And, improvements in agricultural production systems

offers the potential to provide a significant source of mitigation by increasing carbon stocks in terrestrial systems, as well as emissions reductions through increased efficiency (FAO, 2009/10; Paustian et al., 2009; Smith et al., 2008; Parry et al., 2007; Adger et al., 2003).

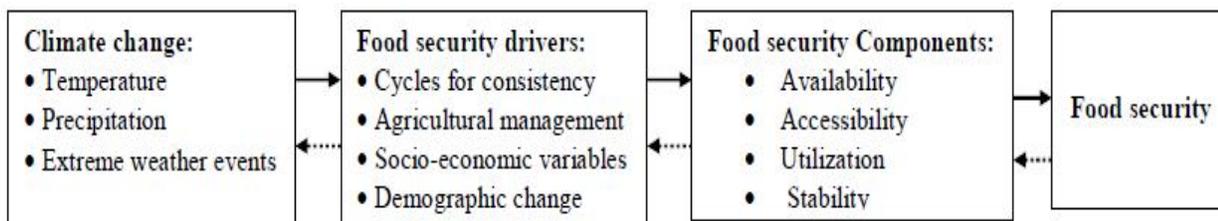
Today nearly one billion people, out of a world population of 7 billion, live in chronic hunger. Most of these are directly or indirectly dependent on agriculture. Growth in population is expected to result in even greater pressure on the smallholder agricultural sector with the largest increases expected in areas of high food insecurity and dependence on agriculture particularly in South Asia and sub-Saharan Africa. At the same time, nearly all researchers conclude that, though average global crop production may not change dramatically by 2050, certain regions may still see average production drop and many more are likely to face increased climate variability and extreme weather shocks even in the near term. With respect to those areas that currently suffer from a high degree of food insecurity, Lobell et al. (2009) studied the potential crop impacts in 12 food insecure regions of the world and found that climate change could significantly impact agricultural production and food security up to 2030 particularly for Sub-Saharan Africa and South Asia due to both changes in mean temperatures and rainfall as well as increased variability associated with both. Changes in pest and disease patterns could also significantly impact agricultural production (Bruinsma, 2009).

In particular, parts of South Asia and Sub-Saharan Africa are expected to be hardest hit, with decreases in agricultural productivity between 15-35 percent (Stern Review 2006; Cline 2007; Fisher et al. 2005; IPCC 2007). And, these are precisely the same regions that already exhibit high vulnerability to weather shocks, meaning that increasing the adaptive capacity of agricultural systems of these regions is required to ensure that such gains are not lost where negative climate change impacts increase in the future.

The transmission mechanism from climate change to food insecurity via agriculture is complex. Climate change variables influence biophysical factors and how they are managed through agricultural practices and land use for food production. They also influence physical and human capital, which indirectly affect the economic and socio-political factors that govern food access and utilization. Given this, Ziervogel and Eriksen (2010) offer a framework for assessing the impacts of climate change on food security, wherein they discussed linkages between climate

change (temperature, precipitation, and extreme weather events), food security (availability, accessibility, stability and utilization) and its drivers (cycles for consistency, agricultural management, socio-economic variables, demographic change, cultural and political variables and science and technology).

Figure 2.1: Linkages between Climate Change and Food Security



Source: Adapted from Ziervogel and Eriksen, 2010

According to them, the key issues that should be addressed to respond to food insecurity and managing transitions or innovation in cropping system include: chronic poverty, functioning markets, farmer attitudes toward managing risks, and reforming or improving the institutions responsible for managing food and agricultural systems.

Today, nearly one billion people, out of a world population of 6 billion, live in chronic hunger (Bruinsma, 2009). Most of these are directly or indirectly dependent on agriculture. Growth in population is expected to result in even greater pressure on the smallholder agricultural sector with the largest increases expected in areas of high food insecurity and dependence on agriculture particularly in South Asia and sub-Saharan Africa (Schmidhuber & Tubiello, 2007). At the same time, nearly all researchers conclude that, though average global crop production may not change dramatically by 2050, certain regions may still see average production drop and many more are likely to face increased climate variability and extreme weather shocks even in the near term (c.f. IPCC 2001 & 2007; Rosenzweig and Tubiello 2006). With respect to those areas that currently suffer from a high degree of food insecurity, Lobell et al. (2009) studied the potential crop impacts in 12 food insecure regions of the world and found that climate change could significantly impact agricultural production and food security up to 2030 particularly for Sub-Saharan Africa and South Asia due to both changes in mean temperatures and rainfall as well as increased variability associated with both.

2.2. THE CONCEPT OF CLIMATE SMART AGRICULTURE

The concept of CSA was first launched by FAO in 2010 in a background paper prepared for the Hague Conference on Agriculture, Food Security and Climate Change in the context of national food security and development goals. According to FAO, CSA is an approach to achieve food security, adapting to climate change and reducing emission of or removing GHGs through developing and adopting efficient practices, policies, institutions, research, technology and finance. It is designed to transform and reorient agricultural systems to support food security under the new realities of climate change mainly in developing countries. The different food security dimensions and their dynamic interactions with climate change and agriculture sheds light on the complexity of CSA's task and also brings about the vital need for the concept. These links proved that business as usual will not able to address the inter-connected problems of climate change, agriculture and food security (Lipper et al. 2010; FAO, 2013).

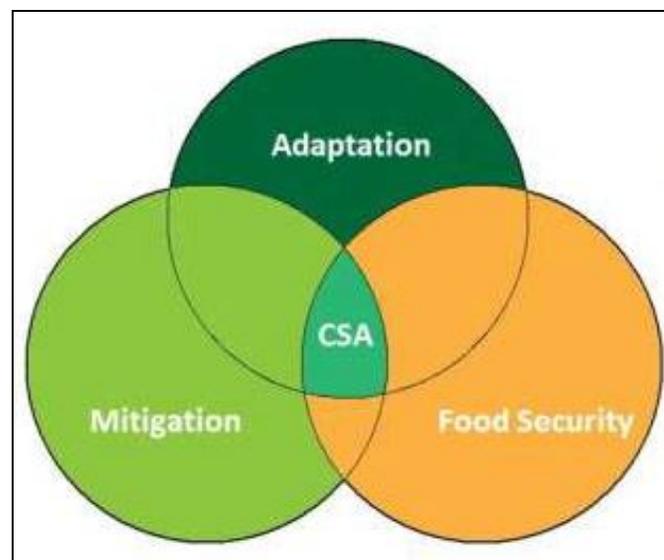
CSA is not a new agricultural system nor is it a new set of approaches. It is rather an approach, away to guide the needed changes in agricultural systems given the necessity to jointly address food security and climate change (FAO, 2013). It is a means of identifying which production systems and enabling 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. CSA shares Sustainable Development and Green Economy objectives and guiding principles as it also aims for food security and preservation of the natural resources. FAO (2013) further notes that CSA takes into account the four dimensions of food security in terms of availability, accessibility, utilization and stability. Still, the entry point and the emphasis is on production, farmers, increasing productivity and income, and ensuring their stability.

Climate-smart measures includes proven techniques such as mulching, intercropping, integrated pest and disease management, minimum soil disturbance practices (MSD), crop rotation, agroforestry, integrated crop-livestock management, aquaculture, improved water management, better weather forecasting for farmers and innovative practices, such as early warning systems (FAO, 2010; World Bank, 2011; 2012). It also entails embracing new technologies such as diversifying genetic traits of crops to help farmers edge against an uncertain climate and creating an enabling policy environment for adaptation (World Bank, 2011).

Further still, CSA is concerned with post-harvest handling of crop produce along the value chain to minimize losses as well as the sustainable consumption patterns. In the absence of Climate Smart Agriculture, marginal areas may become less suited for arable farming as a result of land degradation through deforestation, soil erosion, repetitive tillage and overgrazing (World Bank, 2012). However, there is recognition that Climate Smart efforts must have at their heart smallholder farmer in the developing nation who is key to change across the entire agricultural system. Policy accompaniment and financing of the agricultural practices is yet another inclusion in the general scope of the original concept of CSA (FAO, 2013; Porter, *et al.* 2014).

The general conceptual framework of CSA which integrates policies around the triple objectives to improve food security, increase resilience and decrease GHG emissions wherever possible is presented in Figure 2.2.

Figure 2.2: The Conceptual Framework for CSA



Source: CSA Source Book, 2013

A fundamental issue for the CSA approach is identifying and addressing synergies and tradeoffs that arise between the three objectives and developing context-specific and pragmatic approaches to dealing with them. When taken together, the three objectives imply a need for more resource-efficient and resilient systems designed to identify and enable implementation of strategies that explicitly account for each of the objectives, reducing tradeoffs and enhancing synergies between them across varying conditions and scales. However, the relationship between these three pillars of CSA is not well-defined and further scientific investigations are essential (FAO, 2013; Lipper *et al.*, 2014).

Implementation of the new CSA approach requires collaboration and participation of multiple stakeholders and disciplines, sciences, research and technology all enhanced by a political willingness and economical orientation change toward an effective management of resources, inputs and outputs of agriculture for a better future under a changing climate (FAO, 2013). While talking about CSA it is important to explain its three intertwined aspects: food security, climate change adaptation and mitigation.

2.2.1. FOOD SECURITY

Food security has been defined several times where in each definition, an important point have been improved or added. FAO (2003) has provided different agreed definitions of food security from different sources. In 1974, the definition of food security focused on the quantity and stability of food supplies in all times; later in 1984, it included the access of food to vulnerable people (supply fitting with demand). The improvement of the definition has continued where to the previous points, the quality of food: sufficient, safe and nutritious; food preferences and healthy life for all people and at all times have been added. According to FAO (2003), there is food security "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life". Food security is determined by three main indicators which are food availability, food accessibility and stability, food accessibility and utilization (FAO, 2003).

Despite a great effort made in improving agricultural production, food security remains a challenging issue globally. An estimated 0.9 billion were undernourished in 2010, 1.4 billion were depending on less than 1.25 USD per day for their livelihood in 2005; on the other hand, 1.5 billion were overweighted in 2008 and the food produced for human consumption lost or wasted each year is estimated to 1.3 billion tones (Beddington, *et al.*, 2012).

Addressing the issue of food security must be coupled with climate change as both aspects influence each other. Food systems produce greenhouse gases which lead to global warming but also the effect due to climate change are numerous. For example, 2 billion people lived in dryland areas in 2007; 1.5 billion depend on degraded or marginal areas and in 2011, while the cost of losses caused by climatic events was estimated to 11.4 billion (Beddington, *et al.*, 2012).

2.2.2. CLIMATE CHANGE ADAPTATION

According to IPCC (2007), adaptation is defined as the "initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects".

For human systems, adaptation has the purpose of moderating, avoiding or preventing negative impact of these changes or exploiting the advantages or opportunities created by these changes (FAO, 2013). Different types of adaptation exist. It is for example the preventive and reactive adaptation, public and private adaptation, autonomous and planned adaptation (IPCC, 2007; FAO, 2013).

Adaptation to climate change is not new to humans. They have developed the ability of responding to natural or human induced effects of climate change several times in the past (IFAD, 2011). It is for example migrations, extending agriculture to unexploited land, using synthetic fertilizers and pesticides, development of new crops and animal breeds adapted to change. However some of these measures developed have enhanced the effect of climate change. Improved methods of adaptation are required in order to adjust to the changing climate.

2.2.3. CLIMATE CHANGE MITIGATION

Mitigation means technological change and substitution that reduces resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to climate change, mitigation means implementing policies to reduce GHG emissions and enhance sinks (FAO, 2013). Agriculture is a major source of greenhouse gas emissions, responsible for around a quarter total anthropogenic GHG emissions. Agriculture contributes to emissions mainly through crop and livestock management, as well as through its role as a major driver of deforestation and land degradation. Non-CO2 emissions from agriculture are projected to increase due to expected agricultural growth under business-as-usual growth strategies (Smith *et al.*, 2014).

There is more than one way agriculture's GHG emissions can be reduced. The process involves 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. Another important emissions reduction pathway is through increasing the carbon-sequestration capacity of agriculture. Plants and soils have the capacity to remove CO2 from the atmosphere and store it in their biomass – this is the process of carbon sequestration (Smith *et al.*, 2014).

Same source indicated that increasing tree cover in crop and livestock systems and reducing soil disturbance are two means of sequestering carbon in agricultural systems. However, this form of emissions reduction may not be permanent - if the trees are cut or the soil plowed, the stored CO₂ is released. Despite these challenges, increasing carbon sequestration represents a potential source of mitigation, especially since the agricultural practices that generate sequestration are also important for adaptation and food security (Smith *et al.*, 2014).

However, although CSA basically aims to attain all three objectives, it does not imply that every practice applied in every location should generate all three objectives often known as triple wins. The relative importance of each objective varies across locations and situations, as do potential synergies and trade-offs between objectives ranging from local to global scales and over short and long time horizons. Recognizing trade-offs is particularly important in developing countries, where agricultural growth and adaptation for food security are a priority (Smith *et al.*, 2014).

2.3. THEORETICAL BACKGROUND

In agriculture, as elsewhere, popular discourse has a limited shelf-life, as a combination of critique and theoretical evolution drive us to adopt new terminology to describe our ambitions and visions for agricultural development. The language of green revolution of the 1960s and 1970s, through the participatory and environmental movements of the 1980s and 1990s, came to be associated with negative ecological consequences and as attention turned to seeing production growth in Africa a new discourse of sustainable intensification became popularized in the 1990s (Pretty *et al.*, 2011). Perhaps reflecting the growing prominence of climate change within environmental agendas, as well as need for attention to be paid to the adaptive capacities within agricultural production to environmental change, the paradigm of “climate smart agriculture” (brought into popular use by the UN FAO in 2010) has become the well-established usurper of its predecessors (Pingali and Rosegrant, 1994).

The CSA concept emerged at a moment in time of considerable controversy around the concept and approaches to sustainable agricultural development, and when the specificities of agriculture and its role in food security were not well articulated in the climate change policy process. It is put forward as a solution to the dual challenge of climate change and food insecurity, and at the same time focuses on achieving increases in agricultural yield, improved resilience or adaptation to climatic change, and reductions in agricultural GHG emissions. These three pillars of climate-smart agriculture are now well established and have driven major research agendas. In

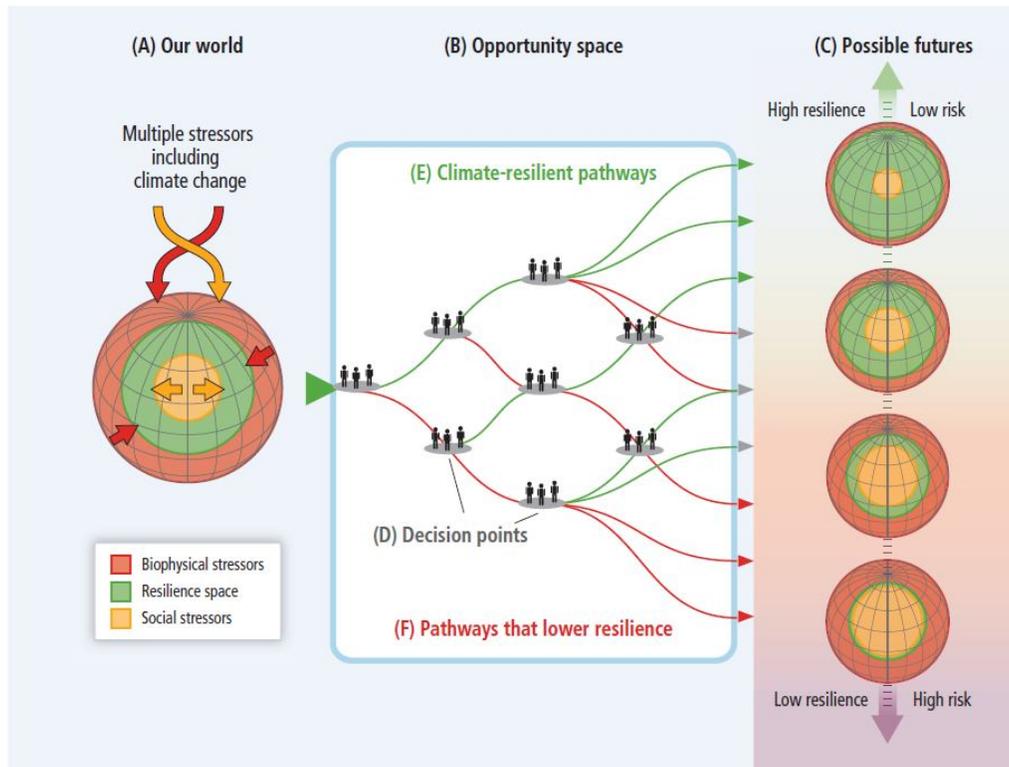
application, CSA tends to place emphasis on new technologies and techniques, such as improved seed varieties, conservation agriculture, alternate wetting and drying rice production, precision fertilizer, etc., all of which have histories that long precede the adoption of the CSA label (Lal et al., 2011; Lipper et al., 2014).

Notably, these technologies do not fit exclusively to one or other end of the extensification–intensification spectrum, and in many cases are platforms or suites of practice, which (at least, at a rhetorical level) are to be adapted to context rather than universally prescribed. It is important to note too that CSA, as described and advocated by the FAO and the CGIAR represents an agenda that is not limited to agricultural technologies, but includes climate services, cooperative governance structures, data processing and information/education (Newell and Taylor, 2018).

Such broad conceptualizations of CSA come in for both praise and criticism; a persistent tension between the value of holistic, non-prescriptive approach, and the dangers of catch-all buzz-word that is used to capture investment and justify questionable agendas. Because, under CSA, combinations of practice are coupled with combinations of objectives, and because of the diverse agro-ecological conditions under which complex technologies are advocated and applied, the scope for research and evidence- building is limitless. Perhaps inevitably, the evidence base for CSA technologies and practices have lagged behind their promotion and advocacy, sometimes resulting in unmet expectations and criticisms of the CSA concept (Whitfield, 2015; Newell and Taylor, 2018).

CSA calls for a set of actions by decision-makers from farm to global level, to enhance the resilience of agricultural systems and livelihoods and reduce the risk of food insecurity in the present as well as future. The concept can be illustrated using an IPCC diagram of climate resilient transformation pathways, adapted to the specific case of agriculture. Agriculture faces a set of biophysical and socioeconomic stressors, including climate change. Actions taken at various decision points in the opportunity space determine which pathway is followed: CSA pathways result in higher resilience and lower risks to food security, whereas business as usual leads to higher risks of food security and lower resilience of food and agricultural systems (IPCC, 2014).

Figure 2.3: Climate-resilient transformation pathways for agriculture

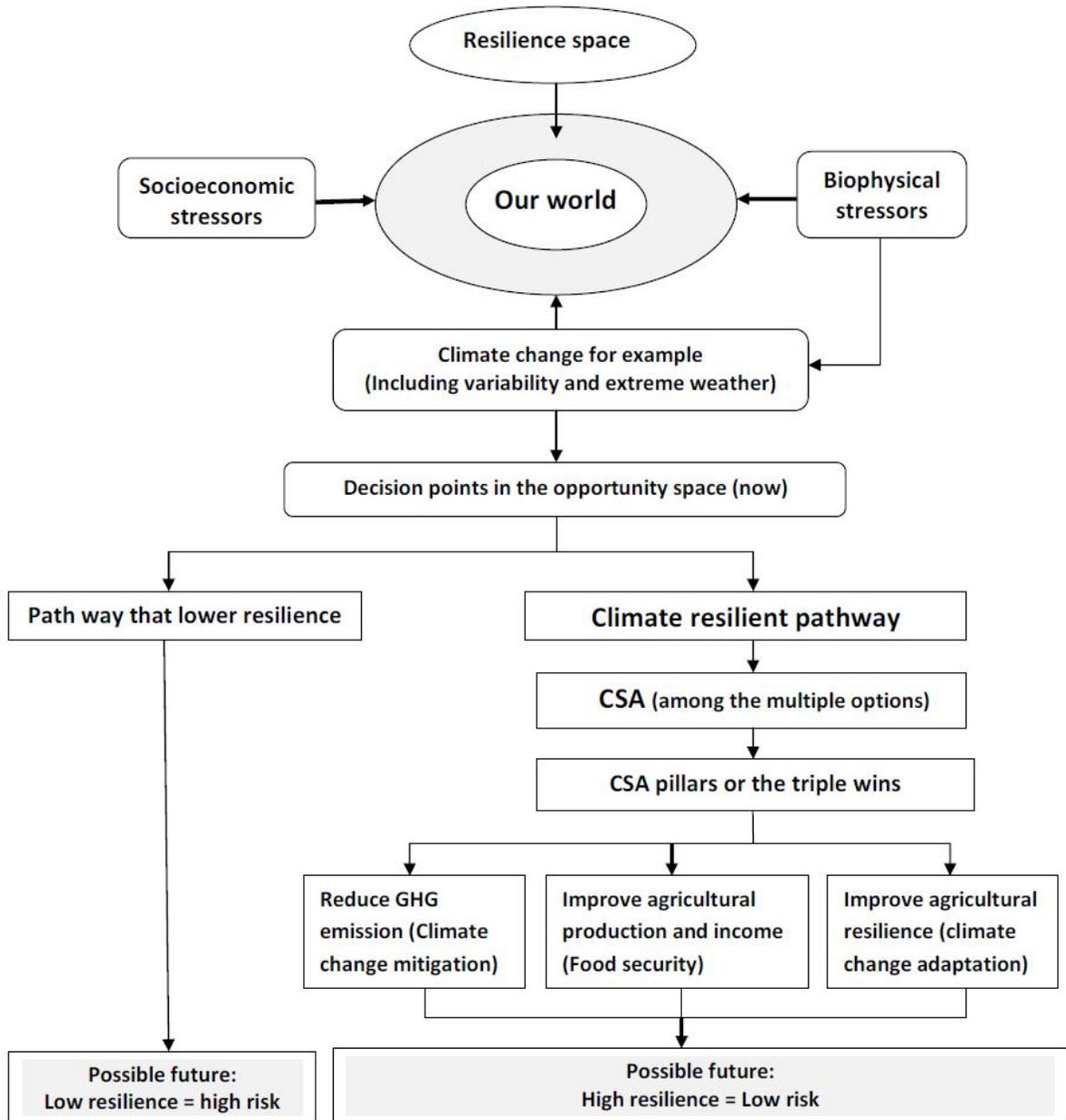


Source: Adopted from IPCC, 2014

On Figure 2.3, (A) Our world [Sections A-1 and B-1] is threatened by multiple stressors that impinge on resilience from many directions, represented here simply as biophysical and social stressors. Stressors include climate change, climate variability, land-use change, degradation of ecosystems, poverty and inequality, and cultural factors. (B) Opportunity space [Sections A-2, A-3, B-2, C-1, and C-2] refers to decision points and pathways that lead to a range of (C) possible futures [Sections C and B-3] with differing levels of resilience and risk. (D) Decision points result in actions or failures-to-act throughout the opportunity space, and together they constitute the process of managing or failing to manage risks related to climate change. (E) Climate-resilient pathways (in green) within the opportunity space lead to a more resilient world through adaptive learning, increasing scientific knowledge, effective adaptation and mitigation measures, and other choices that reduce risks. (F) Pathways that lower resilience (in red) can involve insufficient mitigation, maladaptation, failure to learn and use knowledge, and other actions that lower resilience; and they can be irreversible in terms of possible futures. CSA should, therefore, be embedded into identified development pathways for transforming food systems, landscapes, farming systems and practices adapted to communities.

The conceptual framework of the study developed based on the above theoretical background is as shown in Figure.2.4.

Figure 2.4: The Conceptual Framework of the Study



Source: Modified from IPCC'S (2014) Climate-resilient transformation pathways for agriculture

2.4. DEVELOPMENT OF CSA IN ETHIOPIA

Global climate change is recognized as one of the greatest threats to agricultural productivity in several regions of the world. Many African countries is projected to be severely compromised by climate variability and change in agricultural production, including access to food, the length of growing seasons, and yield potential. Sub-Saharan Africa (SSA) has been particularly exposed to the impact of climate variability due to the high reliance on rain-fed agriculture in this region. The world population is projected to be about 10 billion in 2050, with such a population trend, agriculture will require a significant transformation to ensure adequate food supplies for the growing population and meet the challenge of climate change ((Lipper et al. 2014; BFS/USAID, 2017).

Climate-Smart Agriculture (CSA) is defined by the FAO (2013) as the farming practices that sustainably increase agricultural productivity and income, adapt and build resilience to climate change, and reduces and/or removes GHGs. While the concept is still evolving, CSA has gained considerable attention among governments, policy and research circles and donors in directing new resources mainly to the smallholders sub-sector in developing countries. Today, more than 30 countries mostly in SSA, including Ethiopia refer to CSA in their nationally determined contributions agreed at the UNFCCC Conference in Paris in December 2015. However, the adoption of such CSA practices remains generally low, mainly in sub-Saharan Africa (Lipper et al. 2014).

Ethiopia submitted its Intended Nationally Determined Contribution (INDC) to the UNFCCC in June 2015, pledging a 64% reduction in emissions by 2030 compared to the business-as usual scenario. The INDC is based on Ethiopia's Climate-Resilient Green Economy (CRGE) Strategy established in 2011, which represents the first attempt to integrate climate change and green growth efforts across all sectors of the economy. The CRGE's overall goal is to enhance the population's adaptive capacity and climate resilience, while achieving middle-income status by 2025. The strategy is based on four pillars, two of which relate to CSA, namely: 1) Agriculture: improving crop and livestock production practices for greater food security and better income for farmers, while reducing emissions; and 2) Forests: protecting and re-establishing forests for their economic and ecological values, including carbon stocks. In agriculture, CSA-related strategies include soil fertility management, conservation agriculture, residue management, efficient irrigation and watershed management for crops, as well as controlled grazing and improved feed

production for livestock. In total, 41 options are identified to facilitate the attainment of the CRGE objectives in agriculture and forestry sectors. One of the strategies highlighted in the CRGE is the use of energy-saving stoves as a means of reducing deforestation (BFS/USAID, 2017).

In addition, a multitude of agricultural development activities are conducted in Ethiopia as part of livelihoods and food security improvement, both traditionally and innovatively. Of the typical traditional CSA practices that have been implemented and adopted in Ethiopia, mention should be made to the Derashe Traditional Conservation Agriculture, Konso Cultural Landscape, Hararghe Highland Traditional Soil and Water Conservation, Hararghe Cattle Fattening, Hararghe Small-Scale Traditional Irrigation, Ankober Manure Management and Traditional Agroforestry in Gedeo, East Shewa, East Wollega and West Gojam Zones. Some of the innovative CSA practices in Ethiopia include improved weather forecasting, early-warning systems and climate-risk insurance, while cropping calendars and development of small-scale irrigation are increasingly being practiced (Joosten and Grey, 2017; MoANR, 2015; FAO, 2016).

The aim of CSA is thus to get existing technologies off the shelf and into the hands of farmers, as well as to develop new technologies such as drought-tolerant or flood-tolerant crops to meet the demands of the changing climate. The benefit of these crop- and livestock-based CSA activities, which are conceptualized in this paper as CSA Practices is the possibility of using a mixture from the list of practices to achieve the desired outcomes in any region as it has been recognized that choice of practices differ depending on local conditions (Joosten and Grey, 2017). List of the common CSA practices in Ethiopia, which was adopted from FAO CSA Scoping study (2016), is presented in Table 2.1.

Table 2.1: Summary of some common CSA practices in Ethiopia

CSA practice	Components	Why it is climate smart
Conservation agriculture	<ul style="list-style-type: none"> • Reduced tillage • Crop residue management – mulching, intercropping • Crop rotation/intercropping with cereals and legumes 	<ul style="list-style-type: none"> • Carbon sequestration • Reduce existing emissions • Resilience to dry and hot spells
Integrated soil fertility management	<ul style="list-style-type: none"> • Compost and manure management, including green manuring • Efficient fertilizer application techniques (time, method, amount) 	<ul style="list-style-type: none"> • Reduced emission of nitrous oxide and CH₄ • Improved soil productivity
Small-scale irrigation	<ul style="list-style-type: none"> • Year-round cropping • Efficient water utilization 	<ul style="list-style-type: none"> • Creating carbon sink • Improved yields • Improved food security
Agroforestry	<ul style="list-style-type: none"> • Tree-based conservation agriculture • Practised both traditionally and as improved practice • Farmer-managed natural regeneration 	<ul style="list-style-type: none"> • Trees store large quantities of CO₂ • Can support resilience and improved productivity of agriculture
Crop diversification	<ul style="list-style-type: none"> • Popularization of new crops and crop varieties • Pest resistance, high yielding, tolerant to drought, short season 	<ul style="list-style-type: none"> • Ensuring food security • Resilience to weather variability • Alternative livelihoods and improved incomes
Improved livestock feed and feeding practices	<ul style="list-style-type: none"> • Reduced open grazing/zero grazing • Forage development and rangeland management • Feed improvement • Livestock breed improvement and diversification 	<ul style="list-style-type: none"> • Improved livestock productivity • GHG reduction • CH₄ reduction
Other	<ul style="list-style-type: none"> • <i>In situ</i> water conservation/harvesting • Early-warning systems and improved weather information • Support to alternative energy – fuel-efficient stoves, biofuels • Crop and livestock insurance • Livelihoods diversification (apiculture, aquaculture) • Post-harvest technologies (agro-processing, storage) 	<ul style="list-style-type: none"> • Resilience of agriculture • Improved incomes • Reduced emissions • Reduced deforestation • Reduced climate risk

Source: adopted from CSA Scoping-Ethiopia, 2016

Besides, the Ethiopian government has put in place a number of policies, strategies and laws that are designed to support climate change mitigation and adaptation and sustainable development as a whole. Policies, laws and strategies relevant to climate change in Ethiopia include the Climate Resilient Green Economy Strategy (2011), National Adaptation Program of Action, Ethiopian Program of Adaptation to Climate Change of 2011, Nationally Appropriate Mitigation Actions

of 2010, Rural Development Policy and Strategies (2003), Growth and Transformation Plan, CAADP Compact and the National Environmental Policy of Ethiopia (1997). Institutions working on CSA in Ethiopia include CRGE Coordination Unit, Rural Economic Development and Food Security, National Conservation Agriculture Taskforce, National Committee for Promotion of Climate-Smart, Push-Pull Strategy, The National SLM Steering Committee and The National SLM Technical Committee (MoANR, 2015; FAO, 2016).

Regardless of the fact, weak capacity on climate change adaptation and mitigation at all levels remains a key challenge. Besides, there is a lack of adequate research findings on CSA practices in Ethiopia for the various agro-ecology, soil type, rainfall pattern, farming system, temperature and moisture ranges. This would have been an opportunity to use this information to inform agricultural related policies, programs and projects in the country with the aim of increasing agricultural production; building resilience to climate-related hazards; and contributing to climate change mitigation (FAO, 2016). Nevertheless, there are still untapped opportunities to support the up scaling of CSA in Ethiopia given that (FAO, 2016):

- There is willingness and commitment from the government to reduce poverty and ensure food security while addressing climate change.
- The country has developed a comprehensive green growth strategy that encompasses agriculture in the form of the Climate Resilient Green Economy (CRGE) Strategy.
- Regional states have embarked on the promotion of integrated watershed management to improve farm productivity, with major emphasis on avoiding open and uncontrolled grazing.
- Resources are available in the form of projects and programs like AGP, SLM, PSNP, etc.
- There are private sector organizations and numerous NGOs in the country, and adequate numbers of extension/development agents at grassroots levels to create climate-related awareness, provide capacity-building training and promote CSA activities.

2.5. REVIEW OF EMPIRICAL STUDIES

The empirical review focuses on the effect of the adoption of farm level CSA practices on agricultural resilience and food security as well as on factors influencing the adoption of CSA practices among smallholder farmers. The concept of food security has been used extensively at the household level as a measure of welfare. A household is considered food secure if all

members at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Climate change disrupts food markets, posing population wide risks to food supply. Increasing the adaptive capacity of farmers as well as increasing resilience and resource use efficiency in agricultural production systems is paramount. Indeed climate change alters agricultural production and food systems, and thus the approach to transforming agricultural systems to support global food security and poverty reduction is through CSA (FAO 2013).

CSA prioritizes food security with a consideration of mitigating climate change (Lipper *et al.* 2014). Food security in an era of climate change may be possible if farmers transform agricultural systems by use of means such as improved crop seed and fertilizer (Bryan *et al.* 2011). An integrated, evidence based and transformative approach to addressing food and climate security at all levels is required. It calls for a coordinated action from the global to local levels, from research to policies and investments, and across private, public and civil society sectors to achieve the scale and rate of change required.

Through CSA, more efficient resource use agricultural production systems offer considerable potential for increasing agricultural productivity, incomes, food security and the resilience of rural livelihoods while reducing the intensity of agricultural emissions (FAO, 2010). With the right practices, policies and investments, the agriculture sector can move into CSA pathways, resulting in decreased food insecurity and poverty in the short term while contributing to reducing climate change as a threat to food security over the longer term.

Regarding the factors influencing the adoption of CSA practices, there are different factors including socio-economic, institutional, and factors related to farm characteristics and exposures to the effects of climate change as they are perceived by the smallholders. Socio-economic factors that influence adoption of adaptation strategies include household characteristics and farm characteristics. The household characteristics that can potentially influence adoption decisions include age, education level, gender of the head of the household, household size, years of farming experience, attitude towards risk and wealth. The age of a farmer may positively or negatively influence the decision to adopt new technologies (Gbegeh and Akubilo, 2013).

Older farmers have more experience in farming and are better able to assess the characteristics of modern technology than younger farmers, and hence a higher likelihood of adopting the practice. On the other hand, older farmers are more risk-averse and less likely to be flexible than younger farmers and thus have a lesser likelihood of adopting new technologies (Adesina and Forson, 1995). According to Ayuya *et al.* (2012) attitude towards risk both influence the decision on willingness to accept and the extent of adoption. The explanation is that farmers who are risk taking would be willing to adopt the project to a larger extent than those who are risk averse.

Education level is often assumed to increase the likelihood of embracing new technologies as it enhances the farmer's ability to recognize the effects of climate change (Nkonya *et al.*, 2008). Similarly, education enables households to access and conceptualize information relevant to making innovative decisions (Adesina and Forson 1995; Owuor and Bebe, 2012). The effect of gender of household head on adoption decisions is location-specific culture driven (Gbetibouo, 2009). In many parts of Africa, women are often deprived of property rights due to social barriers (Gbegeh and Akubuilu, 2012). Consequently, they have fewer capabilities and resources than men (De Groote & Coulibaly, 1998; Marenya and Barrett, 2002). However, female-headed households are more likely to take up climate change adaptation measures (Nhemachena and Hassan, 2007; Gbetibouo, 2009).

The possible reason for this observation is that in most rural smallholder farming communities in Africa, more women than men live in rural areas where much of the agricultural work is done. Therefore, women have more farming experience and information on various management practices and how to change them, based on available information on climatic conditions and other factors such as markets and food needs of the households (Nhemachena & Hassan, 2007). The influence of household size on the decision to adopt new farming techniques in response to climate change is uncertain. Household size as a proxy to labor availability may influence the adoption of a new technology positively as its availability reduces the labor constraints (Marenya and Barrett, 2007; Teklewold *et al.*, 2013).

Given that the bulk of labor for most farm operations in Sub-Saharan Africa is provided by the family rather than hired, lack of adequate family labor accompanied by inability to hire labor can seriously constrain adoption practices (Nkonya *et al.*, 2008). Nonetheless, households with many family members may be forced to divert part of the labor force to off-farm activities in an

attempt to earn income to ease the consumption burden imposed by larger household size (Tizale, 2007; Gbetibouo, 2009). Farm characteristics could also influence adoption decisions and they include farm size and soil fertility, soil erosion and slope of land. Farm size influences both the access to information and the adoption decisions. Soil fertility may influence adoption of recovery practices. Sloppy Terrain may influence soil erosion and hence adoption of recovery measures (Marenja and Barrett, 2007; Gbetibouo, 2009).

On the other hand, institutional factors could also influence adoption of new technologies and they include; access to credit, access to information, off-farm employment, land ownership, group membership and government policies (Adesina and Forson, 1995; Gbetibouo, 2009). Adoption of new farming strategies require funds and lack of borrowing capacity may limit ability of farmers to embrace adaptation measures that require heavy investment for instance in strategies such as irrigation, terracing, tree planting soil testing and fertilizer use (Gbetibouo, 2009).

Access to information may influence farmers' decision to adopt new technologies as they were made aware about its existence. Similarly, farmer to farmer extension and information sharing about future climate change may enable them to adjust their farming practices in response to climate change (Smit *et al.*, 2001; Mariara and Karanja 2007; Gbetibouo, 2009). Land ownership has an implication on the property rights and long term investment in climate change adaptation strategies. For instance, tenure security can contribute to adoption of technologies linked to land such as irrigation equipment or soil conservation practices. Farmers lack economic incentives to invest their time or money if they cannot capture the full benefits of their investments (Gbetibouo, 2009; Shiferaw *et al.*, 2009).

Off-farm employment may provide alternative sources of income to the household hence limiting dependence on agriculture and may further lower the chances of climate change adaptation. Farmer groups also may serve sometimes as the means through which farmer training and information dissemination can take place. Government extension service officers target farmer groups for demonstration of new technology. Finally, government policy on climate change could set conditions for agricultural operations to be observed as a rule. Hence farmers may be mandated to perform conservation agriculture within the legal framework (Smit *et al.*, 2001; Mariara & Karanja 2007; Gbetibouo, 2009). Empirical findings on the potential benefits of CSA practices undertaken by smallholder farmers in developing countries are presented in Table 2.2.

Table 2.2: Summary of Empirical Findings on Potential Benefits of CSA

CSA Practices	Potential Benefits
Improved forages	Saves time (20%), environmental conservation, increased income and access to forages (10%), Environmental conservation, and increased yield and save time (20%), increased income, yield, save time and access to forage (50%). Environmental conservation, increased income and access to forage (25%), increased income, yield, save time and access to forage (75%)
Terracing	Environmental conservation (33%), Environmental conservation, increased yield and save time (67%)
Composting including vermiculture	Environmental conservation, increased yield and save time (40%), cost reduction and increase soil fertility (60%). Composting of crop residues and organic domestic wastes is used for soil fertility and improve crop productivity. Also contributes to improved soil structure, moisture retention and reduced emissions from application of raw animal manure. Reduced GHG emissions and environmental pollution compared to the traditional practice of not using livestock waste; increased use of bio-fertilizer in crop and livestock production
Tree nursery and tree planting	Environmental conservation and income (33%), Environmental conservation, income, timber, firewood and shade (67%) Environmental conservation, income, timber, firewood and shade (100%). Environmental conservation, increased yield and save time (20%), Environmental conservation and income (40%). The planted trees increase soil fertility and can help control erosion, as well as provide fuel wood and timber, medicines and fruits. Trees can also store substantial amounts of carbon.
Improved drought tolerant varieties	High yield and early maturity (25%), yield, income and resistant to pests, disease and drought (75%). High yield and early maturity (80%), yield, income and resistant to pests, disease and drought (20%). Yield, income and resistant to pests, disease and drought (100%), Saves time (20%), yield, income and resistant to pests, disease and drought (60%), high yield and early maturity (20%). High yield and early maturity (60%), yield, income and resistant to pests, disease and drought (40%)
Home garden	Improved efficiency of home garden components: waste of one component becomes compost for another; diversified and increased household income; diversified and improved household nutrition
Intercropped with grasses (strips) and legumes	Reduced soil erosion; improved soil fertility (N and moisture); improved resistance to termites in cassava; stabilized cassava yield; additional feed for cattle from grasses
Pits	Promotes an integrated soil, water and nutrient management by retaining water and the use of crop residues to support the pits leads to improved and sustained soil fertility and crop productivity, reduced soil erosion, and enhanced soil carbon sequestration.
Irrigation	Small-scale irrigation offer key opportunities for adaptation as water supplies dwindle and rainfall becomes more erratic. Through irrigation, farmers can diversify into high value vegetable production thus reducing risks of crops loss and increasing incomes.
Terracing	Promotes soil and water conservation, especially on steep slopes to reduce soil erosion and increased water percolation. The terraces are reinforced with grass strips and agroforestry trees (for timber and fruits), thus contributing to mitigation and increased incomes.
Traditional-Scientific weather forecasts	Reduces risks associated with failed seasons or variable rainfall and enable farmers to make better farming decisions for improved productivity and risk management.

CSA Practices	Potential Benefits
Agroforestry	Establishment of deep root, drought tolerant leguminous trees that fix nitrogen and shade leaves during the rainy season, providing organic residues and nutrients. Contributes to carbon sequestration, reduced soil erosion and moisture stress, and tree products sold for income.
Biogas and use of efficient stoves	Reduces greenhouse gas emission by utilizing methane from cow dung to generate energy for household consumption. Replaces purchase of kerosene and harvesting of trees, thus saving families income. Bioslurry is used as manure, hence increasing soil fertility. Efficient stoves are combustion and fuel-efficient and reduce particulate air pollution, cooking time and time spent acquiring firewood.
Crop rotation	A crop diversifying practice that is used to achieve crop diversity, reduce incidences of pest and diseases of particular crop, improves soil structure and soil fertility through nitrogen fixing crops and reduces soil erosion.
Drought and diseases tolerant crop varieties	Adaptive crop varieties that are stress tolerance and disease resistance; early maturing to avoid crop loss from shorter growing seasons or unreliable rains. Improved productivity and reduced risk of crop failure
Drought tolerant and deeper rooted fodder grasses and/or legumes	Contributes towards food security and increased livestock productivity. Use of improved fodders leads to reduction of emissions from enteric fermentation of livestock through improved digestion. Increased milk production and heavier animal weight leads to more income.
Early planting, use of early maturing crops	Varieties that are more adapted to low and unreliable rains shortened growing seasons thus leading to reduced risk of crop failures.
Minimum tillage	Conserves soil moisture and control erosion through minimum soil disturbances. It improves crop productivity and reduces soil compaction thus reducing emission
Intercropping	Intercrop of legume and non-legume crop and trees contributes to nitrogen fixation, improved water retention, and reduced crop failures to drought, pest and diseases. Leaves of trees intercrop are used as mulch and compost, thus contributing to above ground carbon sequestration.
RSACCOs	Offers safety nets to give farmers through stronger marketing power. SACCO offers access to credit to farmers to start CSA practices such as irrigation and purchase of food during droughts.
Livelihood diversification	Diversification of crops, livestock (bee-keeping), trees and irrigation is potential response to overcoming unreliable rainfall and drought. Thus minimize weather-induced losses and stabilize incomes.

Source: *Compiled from Apeldoorn et al. (2011); Rowhani et al. (2011); Agrawala et al. (2003); Thierfelder and Wall (2009); Lobell and Burke (2008).*

2.6 GAPS IN LITERATURE REVIEW

A wide variety of literature covers the possible impacts of climate change on agricultural production and ways of adapting to climate change (Adams *et al.*, 1998; IPCC, 2007; Boruru, *et al.*, 2011; Okumu (2013). These studies generally indicate that farmers can overcome the adverse impact of climate change by implementing adaptation measures. Much of the literature review on agricultural adaptation to climate change has drawn attention to a range of factors affecting the adoption of such methods by small-scale farmers. Many of these studies merely identify farm household characteristics and institutional factors as the key determinants of adoption (Adesina and Forson, 1995; Maddison, 2006; Marenja and Barrett, 2007; Nkonya *et al.*, 2008; Gbetibouo,

2009; Shiferaw *et al.*, 2009; Ayuya *et al.*, 2012; Ochieng *et al.*, 2012). However, studies on the impact of CSA on food security status of smallholder farm households in Ethiopian context have generally been rare.

The CSA Scoping Study-Ethiopia initiated by FAO Sub-regional Office for Eastern Africa was done at the national level targeting major stakeholders in workshops. The study was done to identify and document existing CSA practices in Ethiopia that enable stakeholders to understand the opportunities and constraints to adopting particular CSA technologies or practices. There is opportunity to use this information to inform agricultural related policies, programs and projects in the country with the aim of sustainably increasing agricultural production and productivity; building resilience to climate-related hazards; and contributing to climate change mitigation (FAO, 2016).

As presented in the report, this study did not target households at grassroots for survey. Further still, the study did not assess the impact of CSA practices on household food security status. Therefore, the present study will focused on undertaking a household and farm level analysis on adoption level of CSA practices and their contribution on food security status of smallholder farmers thereby make a substantial contribution to the ongoing research endeavors intending to narrow the existing literature gap in this regard.

CHAPTER THREE

3. METHODOLOGY

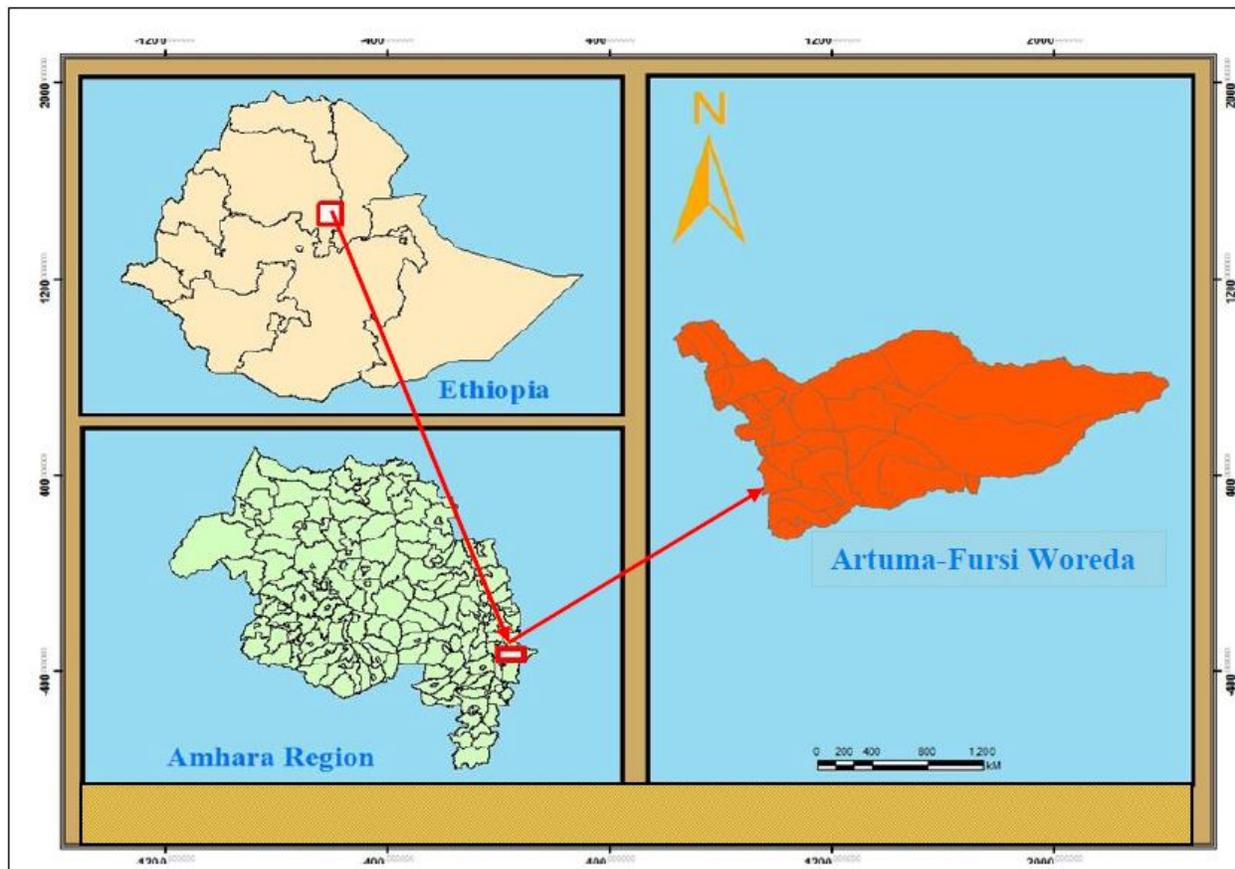
The general methodological framework employed in this research is outlined under the following sub-sections.

3.1. DESCRIPTION OF THE STUDY AREA

3.1.1. LOCATION

The study was conducted in Artuma-Fursi Woreda, which is one of the seven (7) administrative Woredas that form the Oromiya Special Zone of the Amhara regional state, Ethiopia. Relatively, the Woreda is bordered by Semen Shewa zone in the west, Afar regional state in the east, Dawa Chefa Woreda in the north and Jille Tumuga Woreda in the South. The center of the Woreda, Chefa Robit town is located approximately 300kms north of the federal capital, Addis Ababa and 560kms east of the regional capital, Bahir Dar along the main asphalted high-way from Addis Ababa to Dessie, the capital of South Wollo zone in the north (WFEDO, 2009/2010).

Figure 3.1: Location Map of the Study Area



Source: Artuma-Fursi Woreda Agriculture sector office, 2019

3.1.2. THE PHYSICAL ENVIRONMENT

Regarding the local climate, Artuma-Fursi Woreda experience a uni-modal rain with the main rainy season (Kiremt) occurring between July and September. The total annual rainfall of the Woreda varies from 600mm to 900mm, with high seasonal variability and unpredictable pattern, and often accompanied by extreme weather events such as droughts, floods, hailstorms and frosts, which are currently the major limiting factor in agricultural production. The annual temperature varies between 15⁰C and 33⁰C with a mean value of 21.2⁰C (Zone DFED, 2007-2017, WFED Office, 2017).

The altitude of the Woreda ranges from 1500-2100masl implying that the topography is marked by absence of high rising peaks and extreme lowlands. Topographically, 38% of the total area of the Woreda is flat, 28% is hilly, 23% is rugged maintain, 6.6% is valley, and remaining 4.4% is wetland. The generally low laying topography made the Woreda flood risky, which has been a common problem in the area. According to local climatic classification, about 76% of the Woreda is classified under Kolla agro-climatic zone, while the rest 24% is classified under Weinadega agro-climatic zone (WFEDO, 2017/18).

3.1.3. SOCIOECONOMIC CHARACTERISTICS

According to the latest projection (2016) the total population of the Woreda is about 109,681 of which about 48,617 are male while the rest 50,134 are female. About 90% of the total population of the Woreda is rural whose livelihood rely on traditional mixed farming system consists of sedentary mixed farming and agro-pastorals. The rest 10% are urban dwellers whose livelihood is dominantly dependant on non-agricultural activities. The total area of the Woreda is about 108,396 hectares, a large proportion (62.9%) of which is occupied by forest and bushlands, while only 10% of the total area is occupied by cultivated land. Cereals crops such as sorghum, maize and teff are dominant in terms of area coverage. Grazing land occupies 18.4%, while the rest 7.8% of the area is used for construction and other purposes. Currently, the Woreda administrative structure is organized in to 1 urban and 24 rural Kebeles (WFEDO, 2017/18).

3.2. SAMPLING PROCEDURES AND SAMPLE SIZE DETERMINATION

A multi-stage purposive and random sampling technique was used for this study. The first stage was purposive selection of the sample Woreda because of the relative magnitude of food insecurity and level of vulnerability to the adverse effects of climate change compared to other Woredas in Oromiya special zone. The Woreda is where CSA interventions have been widely

implemented in order to improve resilience of households and reduce their vulnerability to food insecurity. This also makes the Woreda an information rich case given the objective of the study. Secondly, 19 out of the 24 rural Kebeles, which are classified as 'Kola' based on the local agro-climate classification, were selected using purposive sampling method. Thirdly, from the 19 Kolla Kebeles identified above, two sample Kebeles were selected based on simple random sampling method. Finally, a combination of simple random and proportional sampling methods was employed to select the total sample households required for the study. Given that households are the basic economic units, each sample household served as a unit of analysis for this study. The sample households selected for the study have a total household size of 999 (Chefa-Dire 616 and Edo-Medene 383 households), which was considered as target population for this study. Afterwards, a formula developed by Kothari (2004) was employed to determine the sample size of households required for the study. The formula is as follows:

$$n = \frac{z^2 \cdot p \cdot q \cdot N}{e^2 (N-1) + z^2 \cdot p \cdot q}$$

Where:

- n = The desired sample size
- z = Standard normal variable at 95% level of confidence (z = 1.96)
- p = Proportion of the population estimated to have the characteristic being measured (0.35)
- q = 1 - p (1 - 0.35 = 0.65)
- e = Level of precision (5%), e = 0.05, and
- N = Target population (999 households)

Accordingly, the desired sample size (n) was determined to be 259. Initially, the total sample size was distributed proportionally to sample Kebeles depending on their percentage share of the total household size. Then, the share of each sample Kebele was distributed to male-headed and female-headed households again proportional to their number to make the sample representative to the total population. Finally, a simple random sampling method was employed to select the sample households required for the survey. For the selected households whose heads were absent, next household was chosen and interviewed.

3.3. DATA COLLECTION METHODS AND INSTRUMENTS

To achieve the intended objective, the study applied a quantitative dominant mixed research design to collect the qualitative and quantitative data required for the analysis. The primary data was collected through cross-sectional household survey, FGDs, key informant interviews and field observation. Finally, the data collected through the household survey were substantiated by the data collected through FGDs, key informant interviews and field observation as well as from secondary sources such as official records, periodic performance reports, statistical abstracts, and other documentary and internet sources including books and journal articles. The primary data were gathered through a cross-sectional household survey, and FGDs, key informant interviews and field observations.

- **HOUSEHOLD SURVEY**

A cross-sectional household survey questionnaire was designed and tested at the initial stage, and later administered by enumerators under close supervision of the researcher. To this end, DAs familiar with local community and well versed with their language were recruited in consultation with Woreda agriculture sector officers, and trained as enumerators in order to familiarize them with survey questionnaire module, sampling procedures and ethical considerations important to conduct the actual survey. The questionnaires were revised in the light of discussions, comments and suggestions made during training sessions keeping in view of the feedback received after pretesting.

The household survey questionnaire module was designed in such a way to collect data regarding sample farm households' demographic and socio-economic characteristics; their vulnerability to climate change, variability and extreme weather shocks, as well as the perceived effects of the later on agriculture in general and food security in particular. It was also designed to collect data on adoption level of existing CSA practices by households in response to the changing climate and weather conditions, its contribution in improving households' resilience and hence their food security status, and whether or not households have access to the necessary institutional supports having strong empirical bases to encourage households to adopt potential CSA practices in smallholders' context.

The structured survey questionnaire module also covered a range of closed- and open-ended questions prepared to call for the information required to capture the net and per capita kcal grain available for households over a period of twelve months in the current production year. Besides,

households were asked to fill household food insecurity access scale generic questions prepared to collect information about their food consumption patterns with a recall period of four weeks (30 days) as indicated in the method of data analysis sub-section.

- **FOCUS GROUP DISCUSSION**

To get access to valuable qualitative data with regard to the views of smallholder farmers, two homogeneous focus groups of 8-10 participants were formed in the two sample Kebeles taking into account the existing gender differential in the community to hold manageable discussions on the major themes of the research. Checklists were prepared to provide a framework within which the researcher and his assistants facilitated discussions to explore their in-depth views regarding the issues raised at different phases of the focus group discussions.

- **KEY INFORMANT INTERVIEW**

Interviews with key informants were another mechanism employed to explore a relatively more in-depth qualitative data on the research topic. In-depth interviews with purposely selected key informants such as experts and elders were administered by the researcher using semi-structured interview guide prepared as per their roles and responsibilities.

- **FIELD OBSERVATION**

The researcher also gathered in-depth qualitative data through field observations that were helpful to get first-hand information and rich insights on traditional and new CSA practices being implemented at community and farm household levels. The field observations were assisted with field note and digital photo camera.

Collecting the required data from a variety of sources using different instruments was critical to apply the principle of triangulation during data analysis.

3.4. METHODS OF DATA ANALYSIS

This part of the study is dedicated to present the analytical techniques and procedures employed to analyze the collected data. Both descriptive and inferential data analysis techniques were used to analyze the quantitative data collected from the household survey and secondary sources, while the qualitative data gathered through focus group discussions, key informant interviews, field observations, and from some secondary sources were used to substantiate the quantitative data analysis and triangulate with the result of the analysis. A detail account of the data analysis methods and procedures is presented below based on the sequence of specific objectives listed in the introductory part of the proposal.

3.4.1. ADAPTATION STRATEGY USE INDEX (ASUI)

Next, a descriptive statistics, Adaptation Strategy Use Index (ASUI) was adopted from Adesoji and Famuyiwa (2010) to reflect the relative ranking of CSA practice in terms of their frequency of use by farmers in the study area (Ojoko et.al, 2017). Selection of the potential CSA practices was guided by extensive content analysis conducted on CSA pillars (triple wins) that seeks to address the demand for increasing agricultural productivity and income (food security), building resilience of livelihood systems to climate change (adaptation), while minimizing agriculture's contribution to GHG emission-mitigation whenever possible (Branca *et al.*, 2011; WRI. 2016; FDRE). 2015). Also, the list of CSA practices developed by FARA (2015), those compiled by FAO (2016) in Ethiopian context, and reported by a couple of previous studies conducted in the study area (Degefa, 2000; Alelign, 2017), and the different CSA practices identified in the study area at the preliminary phase of the present study were of paramount in selecting the potential CSA practices and arranging them into different categories as applied in the present study.

The relative ranking of the extent of adoption of the identified CSA practices was determined using a Four-Point Likert Scale i.e. 3, 2, 1, and 0 for frequently adopted, occasionally adopted, rarely adopted and not adopted CSA practices, respectively. The formula used in this approach is mathematically expressed as follows:

$$ASUI = \frac{\{(N_1 \times 3) + (N_2 \times 2) + (N_3 \times 1) + (N_4 \times 0)\}}{M}$$

Where:

N_1 = Number of farm households that frequently adopt a particular CSAP;

N_2 = Number of farm households that occasionally adopt a particular CSAP;

N_3 = Number of farm households that rarely adopt a particular CSAP;

N_4 = Number of farm households that do not adopt a particular CSAP;

$M = n \times 3$;

n = Sample size

To assess links between households' level of adoption of CSA practices and their food security status, the researcher went through two steps. The first step was to determine farm households' level of adoption of existing CSA practices, while the second step determines the food security status of households as measured by the HFBM and HFIAS. The methods were selected because CSA seeks to address the food security pillar via increased agricultural production (availability)

and farm income (accessibility). As such, the availability and access components of food security are represented in this study by the HFBM and HFIAS, respectively.

3.4.2: ASSESSING LEVEL OF ADOPTION OF CSA PRACTICES AMONG HOUSEHOLDS

In this case, a composite score method was used to classify farm households based on their level of adoption of CSA practices identified in the study area. To this end, questions were prepared for sample households to respond relating to their frequency of use CSA practices. Similarly, a four-point Likert scale i.e. scoring 3, 2, 1 and 0 points for frequently, occasionally, rarely and not adopted CSA practices, respectively by sample households was used to compute composite scores. The composite scores did lie in the range between 0 (the lowest possible score point) to 90 (highest possible score point). Then, stratification of households into high, medium and low adoption groups was made using the distribution of composite scores as applied by Salimonu (2007) cited in Adepoju et al. (2011), that is,

- High adoption groups = Between highest points to (mean + S.D) points;
- Medium adoption groups = Between upper and lower categories;
- Low adoption groups = Between (mean – S.D) points to 0 point.

3.4.3. ASSESSING FOOD SECURITY STATUS WITH DIFFERENT CSA ADOPTION LEVELS

Household food security situation in rural areas is whether the household can produce sufficient food from own production and/or purchase food grain of the right quality from the market place implying that availability of enough food and the capacity of the household to acquire it determines its food security. According to Tolosa, D (2000 and 2005), farm households' own production is a crucial determinant of the two critical food security components, namely availability and access in the Ethiopian subsistence farms context. For the purpose of this study, therefore, household food security means the complementarities of availability and accessibility components as determined by the Household Food Balance Model (HFBM) and Household Food Insecurity Access Scale (HFIAS), respectively.

➤ THE HOUSEHOLD FOOD BALANCE MODEL (HFBM)

The Household Food Balance Model (HFBM) was used to measure the available food for the households and determine per capita kcal consumed per annum in the household. It is a modified form of the Regional Food Balance Model (Degefa, 1996; 2002). Data used for the computation were generated through field survey undertaken over a period of twelve months in a given production year except for the estimates given for the total seed reserve and post-harvest loss due

to poor storage facilities. Mesay (2001:73) revealed that, farmers reserve 5% of their total food produced for seed while post-harvest losses are estimated as 10% by Degefa (2002) of the total yield of a household produced. The model enables to estimate adult equivalent per capita daily kilocalories available for home consumption. The model was mathematically expressed as:

$$N_{ij} = (C_{ij} + P_{ij} + B_{ij} + F_{ij} + R_{ij}) - (H_{ij} + S_{ij} + M_{ij})$$

Where,

N_{ij} - is the net food available for household i in year j

C_{ij} - is the total crop produced by household i in year j

P_{ij} - is total grain purchased from market by household i in year j

B_{ij} - is the total food household i borrowed in the year j

F_{ij} - is the total grain obtain through FFW by household i in year j

R_{ij} - is the total relief food received by household i in year j

H_{ij} - is post-harvest losses out of total output produced by household i in year j

S_{ij} - is amount of grains utilized for seed by household i in year j

M_{ij} - is total grain marketed (sold out) by household i in year j

After computing the balance for each kind of grains, conversion of the net available grain into dietary calorie equivalent was carried out based on Ethiopian Health and Nutrition Research Institute's food composition table. The calculated per capita calorie was compared against the recommended minimum daily caloric requirement for a moderately active adult (2100kcal) to look into the dietary caloric status of the households. Although the amount of calories a person needs depends on the person's sex, age, body builds, degree of physical activity, agro-ecology and the type of soil on which the crop has sown, the average value (2,100kcal) will be taken into consideration to ease the analysis of the available daily dietary energy supply of households. To alleviate this problem, attempts were made to convert the household size that was obtained from head count of all household members into adult equivalence (Stock et al., 1999).

Afterwards, the HFBM scores of households was compared with their level of adoption of CSA practices, and used to assess the magnitude and direction of relationship between the two (food security and CSA adoption level of households) by using person's product moment correlation coefficient. Besides, there is no consensus on the specific calorie consumption thresholds to define levels of calorie intake, but it was also decided at a WFP workshop to use the thresholds

of 0 and 20% shortfalls below the average of 2,100 Kcal/person/day, establishing the following classification: Poor calorie consumption ($\leq 1,680$ Kcal/capita/day); Borderline calorie consumption ($> 1,680 - < 2,100$ Kcal/capita/day) and Acceptable ($\geq 2,100$ Kcal/capita/day) (Lovon & Mathiassen, 2014).

Finally, comparison of mean HFBM scores these categories against their counterparts in the low, medium and high adoption categories was made using person's product moment correlation coefficient and one-way between-groups analysis of variance along with the descriptive statistics such as frequency and percentage distribution tables and bar graphs, which were used to assess the distribution of farm households with poor, borderline and acceptable calorie consumption categories in the low, medium and high CSA adoption groups.

➤ **THE HOUSEHOLD FOOD INSECURITY ACCESS SCALE (HFAS)**

The access component of food security was used as it shows the demand side of food security and the relationship between food security and socio-economic factors (Barrett, 2010). Barrett argues that access indicates household's responses to adverse climate shocks such as droughts, floods and loss of livelihood assets. Hence, HFAS developed by USAID's FANTA project and validated in developing countries (Knueppel et al., 2009) was used to measure food security status of households. The nine item scale (see table 3.1) included in the standard questionnaire measures three dimensions of the access component of household food insecurity (anxiety and uncertainty about household food access, insufficient quality, and insufficient food intake and its physical consequences) using a four-week/30day recall period (Coates et al., 2007).

The questionnaire consisted of nine occurrence questions that represent a generally increasing level of severity of food insecurity (access), and nine frequency-of-occurrence questions that were asked as a follow-up to each occurrence question to determine how often the condition occurred. The respondent was first asked an occurrence question that is, whether the condition in the question happened at all in the past four weeks (yes or no). If the respondent answers "yes" to an occurrence question, a frequency-of-occurrence question was asked to determine whether the condition happened rarely (once or twice), sometimes (three to ten times) or often (more than 10 times) in the past four weeks. The frequency-of-occurrence question skipped if the respondent reports that the condition described in the corresponding occurrence question was not experienced in the previous four weeks (FANTA, 2004, Coates, 2004).

Table 3.1: HFIAS Generic Questions

No.	Occurrence Questions
1.	In the past four weeks, did you worry that your household would not have enough food?
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?
4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?
5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?
6.	In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food?
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?

Source: Coates, Swindale and Bilinsky (2007)

Some of the nine occurrence questions inquired about the respondents' perceptions of food vulnerability or stress (e.g., did you worry that your household would not have enough food?) and others asked about the respondents' behavioral responses to insecurity (e.g., did you or any household member have to eat fewer meals in a day because there was not enough food?). The questions address the situation of all household members and did not distinguish adults from children or adolescents. All of the occurrence questions asked whether the respondent or other household members either felt a certain way or performed a particular behavior over the previous four weeks (Coates, 2004). Finally, the responses from the household food insecurity (access) measure were entered into excel software. The HFIAS module yields information on food insecurity (access) at the household level.

Afterwards, a HFIAS score variable was calculated for each household by summing the codes for each frequency-of-occurrence question. Before summing the frequency-of-occurrence codes, the data analyst coded frequency-of-occurrence as 0 for all cases where the answer to the corresponding occurrence question was "no" (i.e., if Q1=0 then Q1a=0, if Q2=0 then Q2a =0, etc.). Accordingly, the maximum score for a household is 27 (the household response to all nine frequency-of-occurrence questions was "often", coded with response code of 3); the minimum score is 0 (the household responded "no" to all occurrence questions, frequency-of-occurrence questions were skipped by the interviewer, and subsequently coded as 0 by the data analyst).

Thus, the higher the score, the more food insecurity (access) the household experienced. The lower the score, the less food insecurity (access) a household experienced.

Besides, a HFIA category variable is calculated for each household by assigning a code for the food insecurity (access) category in which it falls. Following the guideline from Coates et al. (2007), the HFIAS was converted into a categorical variable. As a result, four categories of food security status were created (food secure, mildly food insecure, moderately food insecure and severely food insecure), which were then recoded into two categories namely food secure and food insecure. The former includes food secure and mildly food insecure households whilst the latter constitutes moderately food insecure and severely food insecure households.

Finally, descriptive statistics such as frequency and percentage distribution tables and bar graphs were used to analyze the distribution of farm households in the food secure and food insecure categorical variables in the low, medium and high adoption groups along with person's product moment correlation coefficient to see the magnitude and direction of relationships between farm households' HFIAS and their CSA adoption level.

3.4.4. ORDERED PROBIT MODEL

The probit model is based on the utility theory, or rational choice perspective on behavior, as developed by McFadden (1973). In the probit model, the rate of change in the probability is somewhat complicated and is given by $\beta_j f(Z_i)$, where $f(Z_i)$ is the density function of the standard normal variable and $Z_i = \beta_1 + \beta_2 X_2 + \dots + \beta_k X_k$, that is, the regression model used in the analysis. The threshold I_i^* , like I_i , is not observable, but if we assume that it is normally distributed with the same mean and variance, it is possible not only to estimate the parameters of the index given in preceding equation, but also to get some information about the unobservable index itself.

In this study, an ordered probit model was used since the dependent variables (low ($Y = 0$), medium ($Y = 1$) and high ($Y = 2$) adoption groups assume a natural ordering. to assess factors influencing adoption level of CSA practices in the study area. Thus, the ordered probit model was expressed as follows:

$$Y_i^* = X_i' \beta + \varepsilon_i \quad Y_i \mu_i$$

Where:

Y_i^* is the unobserved discrete random variable, x_i is the vector of independent variables, β is the vector of parameters of the regression to be estimated and ϵ_i is the vector of error term (Greene, 2003). Thus, Y_i , which is the observed ordinal variable, takes on the following values:

$$Y_i = 0 \text{ if } Y_i^* \leq 0$$

$$Y_i = 1 \text{ if } 0 < Y_i^* \leq \mu_1$$

$$Y_i = 2 \text{ if } \mu_1 < Y_i^* \leq \mu_2$$

$$Y_i = 2 \text{ if } \mu_1 < Y_i^* \leq \mu_2$$

$$Y_i = J \text{ if } \mu_{J-1} < Y_i^*$$

3.4.5. DEPENDANT AND INDEPENDENT VARIABLES

In this study, the dependent variable was Y_i =adoption level of CSA Practices (2=high adopters, 1=medium adopters, 0=low adopters), whereas the independent variables were:

X1 = Age of household head (years);

X2 = Gender of household head (Dummy = 1 if male; 0 = otherwise);

X3 = Household size (in AE);

X4 = Educational status of household head (years);

X5 = Farm size (timads);

X6 = Farm income (estimated value in birr);

X7 = Participation in off-farm employment (estimated value in birr);

X8 = Membership in social group (Dummy = 1 if member of RSACCOP; 0 = otherwise);

X9 = Access to credit (Dummy= 1 if accessed; 0 = otherwise);

X10 = Contacts with extension service agents (Ordinal: = regularly=2; rarely=1; never=0);

X11 = Livestock ownership (in TLUs).

X12 = Access to productive farm implements or equipments (estimated value in birr);

X12 = Perceived changes in climate (insufficient/erratic, unseemliness of the rainfall pattern, frequency of occurrence of droughts, floods and hailstorms)

X13 = Exposure to climate change effects (value of losses due to climate change in last 5 years)

These factors usually act in combination to influence adoption level of CSA practices in the study area. STATA and SPSS version 13 and 20, respectively along with excel spreadsheets were employed for all the statistical analysis and management of the data in this regard. Table 3.2 hypothesises the expected influence or direction of relationship between the dependent and independent variables used in the ordered probit regression model.

Table 3.2: Explanatory variables used in econometric analysis and expected signs

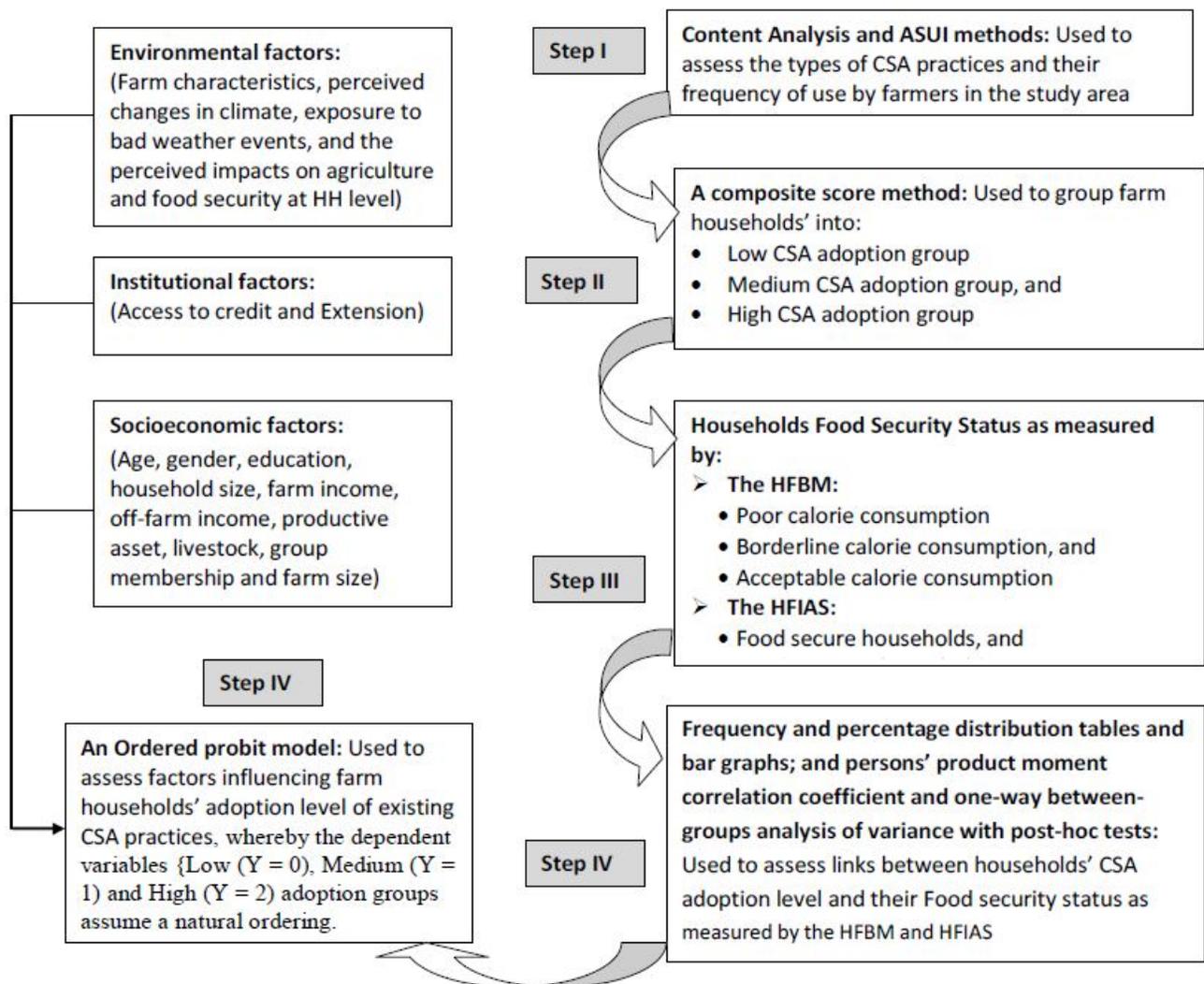
Variable	Description	Measurement	Expected sign
AGE	Age of household head (years)	Continuous	+/-
GENDER	Gender of the household head	Dummy=1 if head is male; 0 if female	+/-
EDUCATION	Education status of the household head (years)	Discrete	+/-
HH SIZE (AE)	Household size in AE	Continues	+/-
FARM INCOME	Log of ave. annual on-farm income	Continues /br	+
OFF-FARM INCOME	Log of ave. annual off-farm income (birr)	Continues	+ /-
FARM IMPLEMENTS	Log value of productive farm equipments (birr)	Continuous	+
MUMBERSHIP	If the household head is a member of a soc RSACOP	Dummy=1 if a member, 0=otherwise	+
CREDIT ACCESS	Whether household received credit or not	Dummy=1 if yes 0=otherwise	+
EXTENTION	Frequency of contacts with extension agents	Ordinal =2 if regularly, 1 if rarely, 0 if never	+
LIVESTOCK	Livestock ownership/TLU	Continuous	+ /-
LAND SIZE	Farm size in <i>timads</i> *	Continuous	+

*1 timad local land measurement unit equivalent with 0.25hectare

3.4.6. ANALYTICAL FRAMEWORK OF THE STUDY

Figure 3.5 shows the analytical framework which depicts the web of links between threats posed by climate change (including variability and extreme weather events) and the CSA approach as a responsive measure to the adverse impacts of climate change through both proactive and planned adaptation measures. It also shows the various socio-economic, institutional and environmental factors intervening in between the framework to influence adoption level of these CSA practices. The framework portrays the extent of adoption of CSA practices, how adoption level of CSA and food security relate, and the factors influencing adoption level CSA practices in the study area.

Figure 3.2: Analytical Framework of the Study



Source: Researchers' own constuct, 2019

CHAPTER FOUR

4. RESULTS AND DISCUSSIONS

This chapter is dedicated to present the findings of the present study along with the discussions regarding their implication on the expected outcomes. For the sake of simplicity and to facilitate understanding, the whole contents covered under this chapter are organized and presented in three sections. Section one dealt on the background characteristics of the survey household, type of CSA practices and the extent of adoption as determined by their frequency of use by the farm households in the study area. While the second section, perhaps the primary section given the main objective the present study intended to achieve, dealt on farm households' level of adoption of existing CSA practices and its contribution on their food security status. The last section dealt on factors influencing farm households' adoption level of CSA practices in the study area.

4.1. BACKGROUND OF HOUSEHOLDS AND TYPE OF CSA PRACTICES

This section presented the findings on the demographic and socioeconomic background of the sample households and the type of CSA practices identified in the study area in line with their extent of adoption. Identification of these CSA practices was guided by results of the content analysis conducted on literature sources that primarily seek to address the three pillars of CSA (Branca *et al.*, 2011; WRI, 2016; FDRE, 2015) and based on CSA practices established by FARA (2015) and those compiled by FAO (2016) in Ethiopian context and mentioned by previous studies (Degefa, 2000; Alelign, 2017) conducted in the study area as well as based on researcher's close examination of the common CSA practice in the study area. To this end, descriptive statistics was used due to its effectiveness in summarizing the dataset in terms of frequencies, averages and totals, which describe the type of CSA practices using tables, charts and graphs. Besides, a descriptive statistics called Adaptation Strategy Use Index (ASUI), was used to reflect the relative position or ranking of the CSA practices identified in the study area in terms of their frequency of use by the sample households.

4.1.1. DEMOGRAPHIC AND SOCIOECONOMIC BACKGROUND OF HOUSEHOLDS

This initial sub-section is intended to describe the demographic and socio-economic background of the sample households in line with their implications on adoption level of CSA as hypothesized by the findings of previous studies conducted on related topics. Table 4.1 summarized the findings related to the demographic background of the sample households along with the implications on the demand for CSA practices.

Table 4.1: Demographic background of the sample households

Variables	Response category	Frequency	Percent (%)
Age of household heads	31-45	34	13.1
	46-60	140	54.1
	61 and above	85	32.8
	Total	259	100
Gender of household heads	Male	197	76.1
	Female	62	23.9
	Total	259	100
Marital Status	Married	207	80
	Divorced	23	8.9
	Separated	16	6.2
	Widowed	13	5.0
	Total	259	100
Household size	Below 5	88	34.0
	5-10	153	59.1
	Above 10	18	6.9
	Total	259	100

Source: Field survey, 2019

As can be seen from Table 4.1, well over half (54.1%) of the household heads fall between the age of 46 and 60, while nearly a third (32.8%) of the household heads were above the age of 60. Only a small proportion of the household heads included in the sample were between the age of 31 and 45. Adoption level of CSA practices is affected by age of the household head. Studies indicated that younger farmers also have better energy to devote, better access to new information, and thus more likely to face the risks associated with new technologies, and thus exhibit high adoption level of CSA practices than their old counterparts (Asfaw and Admassie, 2004). In contrary, Challa and Tilahun (2014) noted that age of farmers positively influenced the probability of adoption of CSA practices and related technologies because it is related to farming experience which improves skills for better farming. As indicated by Hassan & Nhemachena (2008) the influence of age has been mixed in the literature.

Regarding gender of the household heads, the majority (76.1%) of the sample households were male-headed, while a little less than a quarter (23.9%) of the sample households were female-headed. Studies revealed that male headed households had higher likelihood of higher demand for CSA practices than female headed. Perhaps, this can be explained by the dominant culture that males still have exclusive rights to make farm decisions regarding farm adjustments. Therefore, those farm households whose head is male are more likely to adopt a range of CSA practices than those whose characteristics is otherwise (Obayelu, Adepoju, and Idowu, 2014; Balew, Agwata, and Anyango, 2014).

Regarding marital status, majority (80.0%) of sample household heads were married, whereas a small portion of them have got divorced (8.9%). The rest of the household heads were either separated (6.2%) or widowed (5%). Researches that relate marital status of the household head with level of adoption of CSA practices in smallholders' context have so far been so rare, if not absent.

With regard to household size, survey results indicated that the majority (59.1%) of the sample households have family size ranging from 5 to 10, while the household size for about one-third (34.0%) of them was below 5, with a mean household size in adult equivalent of 5.84. Previous studies showed that a small proportion of the sample households (6.9%) had a household size above 10. Assuming households with large family size have a higher labor endowment; families with more household size can rely on their own labor for the most important activities of multiple cropping that is the field operation. In the study area, rural farming households with large family size were assumed to have sufficient labor to carry out time-demanding CSA practices.

Further, the demand for and choice of CSA practices has been determined by the socioeconomic background of the farm households. Table 4.2 summarized the socioeconomic background of the sample households assumed to influence the demand for CSA practices.

Table 4.2: Socioeconomic background of households

Variables	Response category	Frequency	Percent (%)
Formal Education	No formal education	33	12.7
	Primary (1-8)	173	66.8
	Secondary (9-12)	53	20.5
	Total	259	100
Farm size	< 2 timads ¹	93	35.9
	2-4 timads	150	57.9
	> 4 timads	16	6.2
	Total	259	100
Asset value of farm equipments in birr	Below 5000	13	5.0
	5000-10,000	72	27.8
	10,000-15,000	114	44.0
	15,000-20,000	44	17.0
	Above 20,000	16	6.2
	Total	259	100
Farm income sources	Sell of different crops	202	78.0
	Sell of livestock/products	150	57.9
	Sell of firewood, charcoal, grass, crop residues	93	35.9
Non-farm income sources	Remittances	119	46.0
	Pity trade	70	27.0
	Cash transfer/PSNP	137	52.9
	Rental income	36	13.9
	Salary employment	10	3.9

Source: Field survey, 2019

As per the education level of household heads, Table 4.2 indicated that 12.7% of the sample household heads did not attend formal education, while nearly one-fifth (20.5%) of them had the chance to attend secondary education (9-12). The majority (66.8%) of the sample household heads attended some level of primary education (1-8). None of the sample household heads have had the chance to attend TVET training or higher education. It was expected that farmers with higher levels of education are more likely to adapt better to climate change using various methods because a farmer who has more years of education is more likely to adopt improved methods and expected to be more efficient to understand and obtain new technologies than less-educated people.

Studies indicated that the demand for CSA practices is influenced by size of farm owned by farm households. Survey results in this regard indicated (Table 4.2) that the majority (57.9%) of the sample households possess farmland size between 2 to 4 timads, while a significant proportion (35.9) of them possess less than 2 timads, which is, line with what Desalegn Rahmato (2002) has

¹ Timad is a local land measurement unit, whereby a unit of timad is equivalent with 0.25 hectares

phrased as ‘starvation plots’ (less than 0.5ha) . Besides, insignificant proportion (6.2%) of the sample households possesses greater than 4 timads. Nkonya *et al.* (2008) explained that the bulk of labor for most farm operations in sub-Saharan Africa is provided by family members and thus lack of adequate family labor constrains adoption of crucial farming technologies.

A previous study by Deininger *et al.* (2008) reported that land size was strongly correlated with increased likelihood to invest in soil and water conservation activities, and that it more than doubles the predicted number of hours spent on each activity. Similarly, Menale (2010) reported that farm size had a positive association with adoption of many CSA strategies because it represents wealth or financial capital, which relaxes liquidity constraints in implementing the practices. Teklewold *et al.* (2016) observed that larger household size was associated with use of important CSA practices.

As can be observed from the results of the ordered probit model (section 5.2), productive asset value farm implements owned by farm households is a significant factor influencing adoption level of CSA practices in the study area. Regarding this, survey results in Table 4.2 showed that the majority (61.0%) of the sample household owned farm implements (equipments) estimated to value from 10,000 to 20,000ETB. Whereas well over a quarter (27.8%) of the sample households owned productive assets (excluding livestock) estimated to value from 5000 to 10,000ETB. Only insignificant proportion of them owned farm implements with an asset value of less than 5000 (5.0%) or greater than 20,000ETB (6.2%).

It has been suggested that farmers with higher value of productive farm assets had a higher likelihood of having high demand for CSAs. This is in line with Johnson *et al.* (2016) who emphasized that relatively low value of agricultural assets limits technology adoption. Similarly, Obayelu *et al.* (2014) argued that ownership of productive assets represents their ability to bear risks of trying CSA technologies. Studies also indicated that farm income of the households is positively related their CSA adoption level i.e. an increase in farm income increases the likelihood of adopting farm-level CSA practices such as soil conservation, irrigation and livestock. In this regard Table 4.2 indicated that a significant proportion of the households obtain their income from sale of crops (78.0%), sell of livestock and livestock products (57.9%) and from sell of fire wood, charcoal, grasses and crop residues (35.9%).

Nonfarm income of households is also found to be significant factor that affects households' preferences for different CSA practices and strategies. This implies that farmers who were engaged in off-farm activities were more likely to adopt many CSA practices. However, in this regard survey results (Table 4.2 showed that about half (52.9%) of the sample households secured non-farm income sources from PSNP cash transfer, as well as from remittance (46.9%) and Petty trading (27.0%) and rent (3.9%). Only a small proportion (3.9%) of the sample households uses salaried employments as an alternative non-farm income source.

Previous researches also reveal that off-farm income improves farm liquidity as it provides an alternative source of financing agricultural activities. A study by Muzari *et al.* (2012), postulated that off-farm income facilitates adoption of high yielding and resilient adaptation practices. They argued that off-farm income could finance production to meet labor bottlenecks, resulting from higher labor requirements that new technologies demand. In contrast, Mathenge *et al.* (2014) argued that engaging in off-farm activities divert time and effort away from agricultural activities and thus reduces investment in farm technologies and eventual availability of labor.

4.1.2. TYPE OF CSA PRACTICES AND EXTENT OF ADOPTION IN THE STUDY AREA

In this section, results and discussions related to the first specific objective were presented. As described in the introduction sub-section, individual CSA practices identified in the study area were analyzed using a descriptive statistics called Adaptation Strategy Use Index (ASUI), which reflects the relative position (rank) of each of the CSA practices identified in terms of their frequency of use by farmers in the study area.

Accordingly, the present study identified 30 CSA practices that have been adopted by the local farm households for different purposes, and with greater degree of variation in their combination and extent of adoption. Following the guidance given in the introduction section and by applying the practical common sense just for the sake of convention and simplicity, the identified CSA practices were grouped into 5 categories, which are also called CSA strategies. These were Crop Management Practices (CMPs), Livestock Management Practices (LMPs), Soil and Water Conservation Practices (SWCPs), Agroecological Practices (AEPs) and Integrated Food-Energy Systems (IFES). Summary of the CSA practices frequently adopted by the local farm households in the study area are presented in Table 4.3.

Table 4.3: Descriptive statistics showing type and number of CSA practices

Type of CSA practices	No. of CSA practices	Percent (%)
Crop Management Practices (CMPs)	9	30
Livestock Management Practices (LMPs)	5	16.7
Soil and Water Conservation Practices (SWCPs)	10	33.3
Agroecological Practices (AEPs)	3	10.0
Integrated Food-Energy Systems (IFES)	3	10.0
Total	30	100

Source: Field Survey, 2019

As can be seen from Table 4.3, Crop Management and Soil and Water Conservation Practices contribute about two-third (63.3%) of the total CSA practices identified in the study area nearly proportionately (30% and 33.3%, respectively), followed by Livestock Management Practices (LMPs), which contribute some 5 (16.7%) CSA practices. Besides, Agroecological Practices (AEPs) and Integrated Food-Energy Systems (IFES) contribute relatively few CSA practices (3 each), which jointly made up 20% of the total CSA practices identified in the study area. A complete list of the CSA practices and their frequency of adoption by farmers in the study area is presented in table 4.4.

Table 4.4: CSA practices and their rank of adoption in the Study Area

No.	Type of CSA practices and technologies	No. of users	Percent (%)	Frequency of adoption (Number)			
				Frequently	Occasionally	Rarely	Not
1.	Crop Management Practices						
1.1	Use of improved crop	248	95.6	196	37	15	11
1.2	Change planting dates	176	68.0	32	123	21	83
1.3	Apply contingent planting via early maturing varieties	111	42.9	34	44	33	148
1.4	Alley cropping of cereals	227	87.6	150	70	7	32
1.5	Precise fertilizer application (type, timing, amount)	101	39.0	13	36	52	158
1.6	Precise application of chemicals (timing, quantity)	41	15.8	2	5	34	218
1.7	Apply organic fertilizer-compost, animal/green manure	106	40.9	5	35	66	153
1.8	Apply mechanical weed control	228	88.0	57	146	25	31
1.9	Apply on-farm diversification	171	66.0	18	114	39	88
2.	Livestock Management Practices						
2.1	Use of improved breeds	59	22.8	6	32	21	200
2.2	Diversify livestock species	176	68.0	80	88	12	83
2.3	Keep more resilient species	88	34.0	18	24	46	171
2.4	Apply fodder conservation	215	83.0	152	56	7	44
2.5	Use cut and carry feeding	178	68.7	37	118	23	81
3.	Soil and Water Conservation Practices						
3.1	Use small-scale irrigation	88	34.0	30	34	24	171
3.2	Use in situ water conservation	179	69.1	41	132	6	80
3.3	Use conservation tillage (reduced, minimum tillage)	171	66.0	135	26	10	88
3.4	Mulching (stubble retention and planting cover crops)	160	61.8	43	106	11	99
3.5	Apply crop rotation	194	74.9	78	106	10	65
3.6	Intercropping	67	25.9	13	44	10	192
3.7	Strip cropping	82	31.7	6	18	58	177
3.8	Leave vegetative strips or construct Fanya juu	120	46.3	70	44	6	139
3.9	Reinforce conservation structures with grasses or trees	114	44.0	60	40	14	145
3.10	Establish live barriers on farm boundaries and hedges	62	23.9	30	20	12	197
4.	Agroecological Practices						
4.1	Integrate trees in croplands	15	5.8	10	3	2	244
4.2	Plant trees around croplands	80	30.9	50	20	10	179
4.3	Practice bee-keeping	36	13.9	5	12	18	223
5.	Integrated Food-Energy Systems						
5.1	Biogas production and use	18	6.6	6	8	4	241
5.2	Use efficient biomass stoves	60	23.2	30	20	10	199
5.3	Use Improved postharvest storage facilities, techniques	82	31.7	40	35	7	177

Source: Household survey, 2019

A qualitative data obtained from key informants indicated that smallholder farmers in the study area have inadvertently practiced many of the above farm-level CSA practices as part of their traditional farming system. An informant elder explained this idea as follows:

”...farmers in our community integrate many of these CSA practices as part their traditional farming system since the time immemorial, particularly those related to soil and water conservation practices”

A key informant in Edo Medene Kebele

To identify the extent of adoption of each of the identified CSA practices in the study area were analyzed through a descriptive statistics called Adaptation Strategy Use Index (ASUI), which finally reflected the extent to which each of the CSA practices were adopted in the study area. The results of the descriptive analysis carried out to identify the extent of adoption of each of the identified CSA practices in the study area is presented in Table 4.5 in accordance with their rank orders as determined by the Adaptation Strategy Use Index (ASUI).

Table 4.5: Extent of adoption of CSA Practices Ranked as per the Value of ASUI

No.	CSA Practices identified	ASUI	Ranking	Category
1.	Use of improved crop varieties	0.8713	1 st	CMP
2.	Alley cropping of cereals	0.7683	2 nd	CMP
3.	Apply fodder conservation	0.7400	3 rd	LMP
4.	Apply mechanical weed control methods	0.6281	4 th	CMP
5.	Use of conservation tillage (reduced, minimum tillage)	0.6010	5 th	SWCP
6.	Apply crop rotation	0.5869	6 th	SWCP
7.	Diversify livestock species	0.5508	7 th	LMP
8.	Use in situ water conservation practices	0.5058	8 th	SWCP
9.	Use cut and carry feeding	0.4762	9 th	LMP
10.	Change planting dates	0.4672	10 th	CMP
11.	Mulching (stubble retention, planting cover crops)	0.4530	11 th	SWCP
12.	Apply on-farm diversification	0.4131	12 th	CMP
13.	Leave vegetative strips or construct Fanya juu	0.3912	13 th	SWCP
14.	Reinforce conservation structures with grasses/trees	0.3526	14 th	SWCP
15.	Apply contingent planting via early maturing varieties	0.2870	15 th	CMP
16.	Plant trees around croplands	0.2574	16 th	AEP
17.	Use improved postharvest storage facilities, techniques	0.2535	17 th	IFES
18.	Use small-scale irrigation	0.2342	18 th	SWCP
19.	Precise fertilizer application (type, timing, amount)	0.2098	19 th	CMP
20.	Apply organic fertilizer (compost, animal/green manure)	0.1943	20 th	CMP
21.	Keep more resilient species	0.1905	21 st	LMP
22.	Establish live barriers on farm boundaries and hedges	0.1828	22 nd	SWCP
23.	Use efficient biomass stoves	0.1802	23 rd	IFES
24.	Intercropping	0.1763	24 th	SWCP
25.	Strip cropping	0.1441	25 th	SWCP
26.	Use of improved breeds	0.1326	26 th	LMP
27.	Practice bee-keeping	0.0734	27 th	AEP
28.	Precise application of chemicals (timing, quantity)	0.0644	28 th	SWCP
29.	Integrate trees in croplands	0.0489	29 th	AEP
30.	Biogas production and use	0.0489	30 th	IFES

Source: Computed based on the quantitative data obtained from the household survey, 2019

CMPs = Crop Management Practices, LMPs = Livestock Management Practices, SWCPs = Soil and Water Conservation Practices, AEP=Agroecological Practices, IFES = Integrated Food-Energy Systems

Results of the analysis in Table 4.4 indicated which of the CSA practices were adopted most in ranking order in the study area. It can be noticed that the five (5) most adopted CSA practices in the study area included use of improved crop varieties, alley cropping of cereals, applying fodder conservation, applying mechanical weed control methods and use of conservation tillage (reduced, minimum tillage) in descending order. The first two ranks and the fourth were the CSA practices listed under crop management practices, while the third and fifth ranks were livestock management and soil and water conservation practices.

The next five most adopted CSA practices included applying crop rotation, diversify livestock species, use in situ water conservation practices, cut and carry livestock feeding and change planting dates, which were categorized under SWCPs (the 6th, 8th and 9th ranks), LMPs (the 7th rank) and CMPs (the 10th rank), respectively. It can also be noticed that the five (5) least adopted CSA practices in the study area included biogas production and use, integrate trees in croplands, precise application of chemicals (timing, quantity), practice bee-keeping and use of improved breeds, which were part of the CSA practices included under IFES, AEP, SWCP, AEP and LMP, respectively.

As can be seen from the results given in Table 4.4, smallholder farm households in the study area better integrated different CSA practices in their farms, but at different levels of extent and variety. Relatively, crop management practices fall more frequently (4x) in the top 10 (1st to 10th) ranks and they did not occur at all (0x) in the bottom 10 (30th to 21st) ranks. However, despite having one more number of CSA practice (10) than CMPs (9), the SWCPs happened to occur one-less times (3x) in the top 10 (1st to 10th) ranks, whereas they did occur 4x in the bottom 10 (30th to 21st) ranks. CSA practices listed under LMPs category (5) seem to occur proportionately across the top, middle and bottom 10 ranks, 2, 1 and 2 times, respectively.

Besides, of the total three agroecological practices identified in the study area, two (66.7%) were found out to fall under this least adopted category; these were integrating trees in croplands (the 29th rank) and practicing bee-keeping (27th rank). Similarly, of the total three integrated food and energy systems identified in the study area, two (66.7%) were found out to fall under the bottom 10 ranking category; these were Biogas production and use (30th rank) and use of efficient biomass stoves (the 23rd rank). Whereas, the remaining one CSA practice included in each of the

two CSA strategies (AEPs and IFES), namely planting trees around croplands and use of improved postharvest storage facilities and techniques were found in the middle positions (the 16th and 17th ranks) indicating a relatively more wider extent of adoption than the other two's mentioned above.

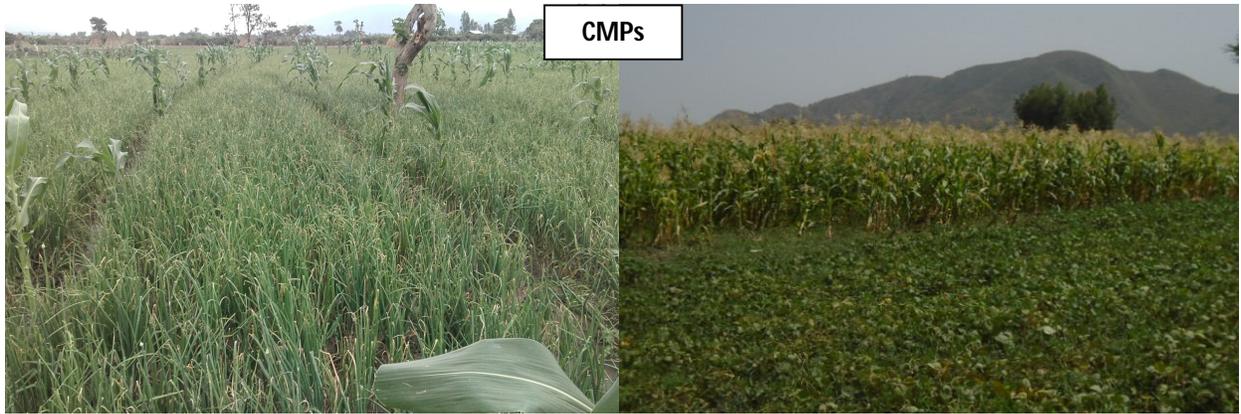
Studies conducted in various places across the developing countries including Ethiopia indicated that energy efficient biogas digesters have been shown to reduce fuel consumption within households by up to 40 percent that would provide a triple win strategy for income, health, and mitigation (AgriFin, 2012). Yet household survey results and secondary statistics indicated that farm households in the study area did not mention it almost at all. As such, the adoption level of biogas production and use remained the least (the 30th rank) in the study area for reasons, which are beyond the scope of this study. A qualitative data obtained from focus group discussants during the survey period highlighted that, perhaps the case doesn't seem to be due to lack of awareness among smallholder farmers in the study area. Women participated in one of the focus group discussions conducted during the survey explained the case as follows:

“..majority of the women in our community understand the importance of using biogas for cooking, lightening and other domestic purposes very well, yet the adoption rate of biogas production and use remained the lowest primarily due to high initial capital investments... “

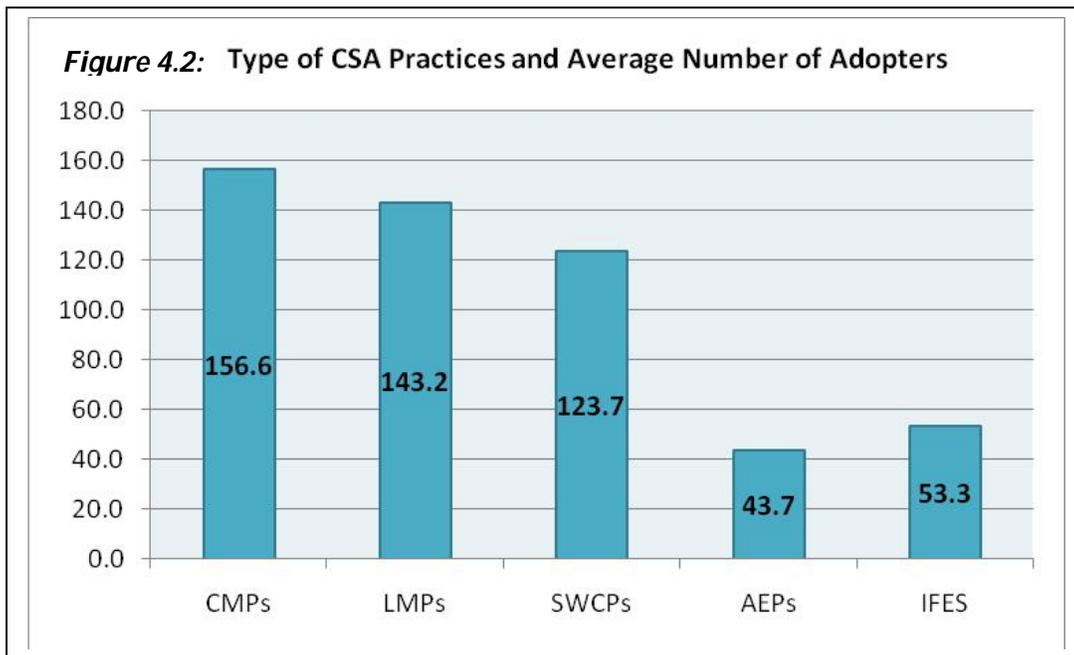
A focus group discussant in Chefa Dire Kebele

The above finding was substantiated by the qualitative data obtained from Woreda agriculture sector experts participated in the key informant interviews that the initial capital investment for biogas production is not affordable for individual farm households even if they are well aware of the benefits and thus willing to adopt the practice. On the whole, the results indicated that adoption level of newer CSA practices such as use of biogas and efficient biomass stoves were lower partly because, according to key informants, government is the sole promoter and provider of these practices to smallholder farm households in the study area. This finding thus calls for increased participation of local as well as international NGOs working in these particular areas of intervention.

Figure 4.1: Partial views of selected CSA Practices in Artuma Fursi Woreda



In a nutshell, household survey results indicated that on average, Crop management practices (CMPs), livestock management practices (LMPs) and Soil and Water Conservation Practices (SWCPs) were the most widely adopted CSA practices, whereas Agroecological Practices (AEPs) and Integrated Food Energy Systems (IFESs) were least adopted CSA practices by farmers in the study area, with slight variations in the average number of adopters. Summary of the descriptive results are as shown in Figure 4.2.



Source: Household survey, 2019

4.2. CONTRIBUTION OF CSA PRACTICES TO FOOD SECURITY

This section presented the findings regarding farm households' adoption level of the identified CSA practices and its contributions to their food security status as measured by the HFBM and HFIAS. A composite score method was used to classify sample households into low, medium and high adoption categories according to their frequency of use of the locally identified CSA practices. This was achieved through a mixture of methods ranging from simple statistical techniques like percentage tables and frequencies; average and composite scores and some advanced household level food security measurement scales such as the HFBM and HFIAS. To achieve this objective, the researcher went through two steps.

The first step was to stratify households' level of adoption of the existing CSA practices, while the second step involved measuring food security status of households as measured by the HFBM and HFIAS. Afterwards, the links between households' level of adoption of the identified

CSA practices and their food security status was compared using distribution frequencies, percentage and mean score values.

4.2.1. ADOPTION LEVEL OF CSA PRACTICES AMONG SURVEY HOUSEHOLDS

In this sub-section, farm households' adoption level of the identified CSA practices was determined through a composite score method, which was used to classify the sample households based on their frequency of use of the identified CSA practices. To this end, sample households were made to respond to questions relating to the level of use of 30 different CSA practices identified in the study area, with an ordinal Likert scale, that is scoring 3, 2, 1 and 0 points for Frequently, Occasionally, Rarely and Not adopted CSA practices, respectively by the households was used to compute the composite scores. The composite score points thus fall between a maximum of 90 (30x3) and a minimum of 0 (30x0) points. Then, stratification of households to High, Medium and Low adoption groups was carried out by using distribution of the composite score points as applied by Salimonu (2007) cited in Adepoju et al. (2011). Accordingly,

- High adoption groups = Between highest points to (mean + S.D) points;
- Medium adoption groups = Between upper and lower categories;
- Low adoption groups = Between (mean – S.D) points to 0 point

Results of the analysis found out that the mean and standard deviation of the distribution of the composite score points were 41.25 and 16.53, respectively. Thus, classification of the sample farm households in to high, medium and low CSA adoption groups was determined as follows:

- High adoption groups: Composite score points between 90 and 57.5
- Medium adoption groups: Composite score points between 57.5 and 25.0
- Low adoption groups: Composite score points between 25.0 and 0

Summary of the descriptive statistics for the classification of the sample households in to high, medium and low CSA adoption groups is presented in Table 4.6.

Table 4.6: Summary of the descriptive statistics for CSA adoption groups

CSA adoption groups	Composite score points	Number	Percent (%)
Low adoption group	0 - 25.0	85	32.82
Medium adoption group	25.0 - 57.5	115	44.40
High adoption group	57.5 - 90	59	22.78
Total	0 - 90	259	100

Source: Household survey, 2019

As can be seen from Table 4.6 relatively large portion (44.40%) of the households fall under the medium adoption groups, followed by the low adoption group, which makes out nearly one-third (32.8%) of the total sample households. Only one-fifth (22.78%) of the households were included under the high adoption group.

4.2.2. LINKING HOUSEHOLDS' FOOD SECURITY STATUS AND CSA ADOPTION LEVEL

To achieve this objective, the food security status of households was determined by the HFBM and HFIAS then the results were compared against the CSA adoptions level of CSA practices computed above for each sample household based of the composite score method in order to assess the links and thus understand the contribution CSA practices to food security status of households as measured by HFBM and HFIAS. The HFBM and HFIAS were selected because in smallholder farmer' context CSA mainly intends to address the food security pillar by improving the availability and access components, which were better captured by the HFBM and HFIAS, respectively.

I. HOUSEHOLD FOOD BALANCE MODEL AND ADOPTION LEVEL OF CSA PRACTICES

Initial data analysis results of the HFBM showed that cereal and pulse grains are the major sources of food widely produced and used for home consumption, whereas food items such as oil seeds, fruit and vegetables and livestock products are produced, but used infrequently for home consumption. As such, only cereal (mainly Sorghum, Teff and Maize) and pulse (mainly beans and chickpea) grains which are often used for home consumption were considered as the main sources of dietary energy supply in the household, hence used to calculate dietary energy supply of the sample households. The finding also showed that food grains that were obtained from households' own production covered 71.5% of the total amount of grains available. A substantial portion of total available food grains were obtained through purchase on market (22.5%), and receiving through relief aid, gifts from better-off relatives and neighbors (6%), indicating that farm households' own production is important dietary source of energy and food availability in the production year in which the present study was conducted.

Furthermore, results of the HFBM showed that the total amount of food energy available for the total sample households was 2,105,952.03 kcal, with a mean and standard deviation daily per capita kcal of 1795.6 and 446.2, respectively (Table 4.6). When compared to the Minimum Recommended Allowance for an adult, 2100 kcal, the available dietary energy covered 85.51% of the recommended daily allowance, indicating that the food security status farm households in

the study area in the given production year was far greater than the results obtained from similar studies conducted in North Shewa Zone of the Oromiya Regional State, where the available dietary energy covered only 45.3% of the recommended daily allowance (Meskerem and Tolosa, 2015).

It was also attempted to look at the variation of the per capita dietary energy available for low, medium and high CSA adoption groups. The result showed that the mean value of dietary energy of the households who were in the high adoption category (1946.0 kcal) was better than those in the medium (1785.82kcal) and low (1692.84kcal) CSA adoption categories. Summary of the descriptive statistics obtained from the HFBM in this regard is presented in Table 4.7.

Table 4.7: Distribution of mean dietary energy available by CSA adoption level

Adoption groups/AG	Households size and %	Av. family size in AE*	Population in AE	Total dietary energy/kcal	Mean DE in kcal	Std.	% of the MRA
Low AD	85/32.8%	4.31	366.35	620,171.93	1692.8	462.4	80.61
Medium AG	115/44.4%	4.54	522.1	932,376.62	1785.8	440.6	85.04
High AG	59/22.8%	4.82	284.38	553,403.48	1946.0	422.8	92.67
Total	259/100%	4.5	1172.83	2,105,952.03	1795.6	446.2	85.51

Source: Household survey, 2019

*AE=Adult equivalent

Results of the one-way between-groups analysis of variance with post-hoc tests conducted to explore the contribution of households' adoption level of existing CSA practices (Low, Medium and High adoption groups) on their food security status as measured by the HFBM indicated that there was a statistically significant difference at the $p < .05$ level in the mean HFBM scores for the three adoption groups $\{F(2, 256) = 3.96, p = .013\}$. Post-hoc comparisons using the Tukey HSD test indicated that the mean HFBM score for Low adoption group ($M=1692.8, SD=462.4$) was significantly different from the Medium ($M=1785.8, SD=440.6$) and High ($M=1946.0, SD = 422.8$) adoption groups. The mean HFBM score for Medium adoption group ($M=1785.8, SD=440.6$) was also significantly different from the High adoption group ($M=1946.0, SD=422.8$). Thus, the difference in food security status of low, medium and high adoption group was not just a matter of chance, but attributable to the variations in adoption level of existing CSA practices.

Alike, compared to the minimum recommended allowance for an adult, 2100 kcal, the available dietary energy covered 92.67% of the recommended daily allowance for households in the high

CSA adoption group, while the coverage was 85.04% and 80.61% for households in the medium and low CSA adoption groups, respectively. Results of the HFBM (Table 4.7) indicated that adoption level of CSA practices by smallholder farm households in the study area were important in determining their food security status.

On the other hand, it is common among literature on measuring food security that there is no consensus on the specific calorie consumption thresholds to define levels of calorie intake, yet it was decided at a World Food Program workshop (Lovon and Mathiassen, 2014) to use the thresholds of 0 and 20% shortfalls below the average of 2,100 Kcal per person per day, which was used to establish the following classification:

- Poor calorie consumption ($\leq 1,680$ Kcal/capita/day);
- Borderline calorie consumption ($> 1,680 - < 2,100$ Kcal/capita/day, and
- Acceptable ($\geq 2,100$ Kcal/capita/day)

An attempt was also made to use the above classification to see the distribution of sample households under low, medium and high adoption groups across the three calorie consumption ranges established above: poor, borderline and acceptable calorie consumption. Summary of the descriptive statistics obtained from the HFBM is presented in Table 4.8.

Table 4.8: Distribution of Households' Calorie Consumption by CSA adoption

Calorie consumption	Consumption ranges	N	%	Mean kcal	Calorie consumption by adoption levels		
					LAG (%)	MAG (%)	HAG (%)
Poor	$\leq 1,680$	103	39.8	1588.4	64.71	34.78	13.56
Borderline	$> 1,680 - < 2,100$	111	42.9	1847.6	30.59	54.78	37.29
Acceptable	$\geq 2,100$	45	17.4	2119.2	4.71	10.44	49.15

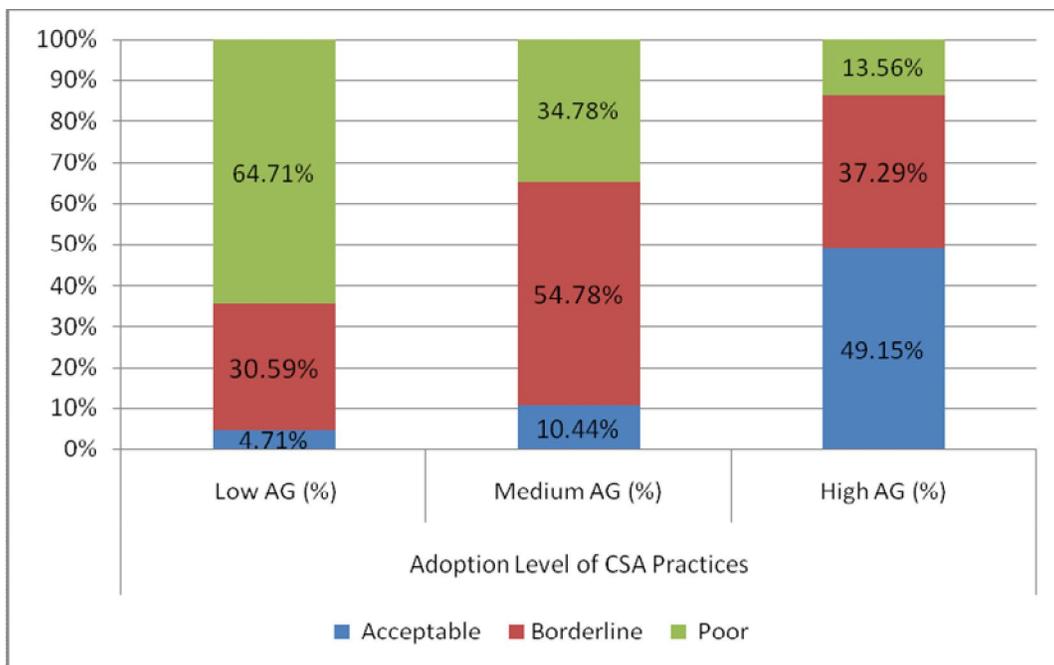
Source: Household survey, 2019

The results in Table 4.8 indicated that about half (49.15%) of households from the high CSA adoption group were found out to be in the acceptable calorie consumption range ($\geq 2,100$), in which only a small (10.44%) and insignificant (4.71%) share of the households were included from the medium and low adoption groups, respectively. In contrary, the results also showed that about two-third (64.71%) of the households from the low CSA adoption group were found out to be in the poor calorie consumption range ($\leq 1,680$), in which over one-third (34.78%) and a small share (13.56%) of the households were included from the medium and high adoption groups, respectively.

Table 4.8 also indicated that well over half (54.78%) of the households from the medium CSA adoption group were found out to be in the borderline calorie consumption range (>1,680–<2,100), in which still significant proportion (30.59% and 37.29%) of households were included from the low and high adoption groups, respectively. Again, results of the HFBM in this regard indicated that adoption level of CSA practices was an important determinant of food security among small holder farm households in the study area.

Moreover, proportion of the sample households (%) according to different calorie consumption ranges under different adoption level of CSA practices is presented in Figure 4.3.

Figure 4.3: Proportion of households (%) in different CSA adoption groups



Source: Computed from the Household survey, 2019

Figure 4.3 indicated a shift of farm households from the low to medium CSA adoption level was likely to filter small portion {5.73% (10.44% - 4.71%)} of households from borderline to acceptable calorie consumption level, but a significant portion {29.93% (64.71% - 34.78%)} of households from poor to borderline calorie consumption levels. However, the implication of CSA adoption level of households on their calorie consumption, and thus food security status was substantially larger when households were shifted from low to high CSA adoption levels as it filtered all the households (100%) from borderline to acceptable and surprisingly helped

13.85% of the households to jump the borderline calorie consumption level and transferred from poor to acceptable calorie consumption levels.

The shift also filtered some 13.57% of households from poor to borderline calorie consumption level, implying that adoption level of CSA practices was important to significantly improve calorie consumption levels, and hence food security status of farm households in the study area. The finding is in line with the results of previous studies (Falco, Veronesi, and Yesuf, 2011; Kangalawe and Lyimo, 2013), which suggest that a high level and diversified adoption of CSA practices are required to address climate-induced food insecurity through increasing resilience and agricultural productivity in smallholder farmers context.

II. HOUSEHOLD FOOD INSECURITY ACCESS SCALE VIS-À-VIS CSA ADOPTION LEVEL

Furthermore, the access component of food security was used to measure the food security of households in the study area because apart from showing the demand side of food security and its relationship with socio-economic factors, access indicates household's responses to adverse climate shocks such as droughts, floods and loss of livelihood assets (Barrett, 2010). Descriptive results of the HFIAS indicated that the mean standard deviation values of the HFIAS score were 12.4 and 4.6, respectively with the minimum and maximum values of 6.41 and 25.36. For the purpose of comparison, mean HFIAS scores will also be calculated for low, medium and high level adoption groups.

Further results of the HFIAS indicated that most of the low (90.6%), medium (83.5%) and high (76.3%) level adoption groups mentioned that they ate a limited variety of foods during the month prior to the survey. The results also indicated that still a large portion of the low (88.2%), medium (78.3%) and high (66.1%) level adoption groups mentioned that they were not able to eat the kinds of foods they preferred during the month prior to the survey. On the other hand, a very smaller percentage of respondents in the low (16.5%), medium (8.7%) and high (3.4%) level adoption groups indicated that they went the whole day and night without eating anything. Similarly, a relatively small percentage of respondents in the low (41.2%), medium (32.2%) and high (10.2%) indicated that they go to sleep at night hungry. However, for all items of the HFIAS, the percentage of affirmative responses was higher among respondents in the low adoption group, whereas it was lower among respondents in high adoption group for all items of the HFIAS. Distribution of affirmative responses to the nine questions of the HFIAS by adoption level of CSA practices is as shown in Table 4.9.

Table 4.9: Distribution of affirmative responses to HFIAS questions by CSA adoption level

HFIAS Questions	Affirmative responses (%)		
	LAG (N=85)	MAG (N=115)	HAG (N=59)
Did you worry household would not have enough food?	76.5	61.7	37.3
Were you or any household member not able to eat the kinds of foods you preferred for of a lack of resources?	88.2	78.3	66.1
Did you or any household member have to eat a limited variety of foods due to a lack of resources?	90.6	83.5	76.3
Did you/any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	82.4	63.5	42.4
Did you/any member have to eat a smaller meal than you felt you needed because there was not enough food?	87.1	79.1	49.2
Did you or any household member have to eat fewer meals in a day because there was not enough food?	77.7	66.1	40.7
Was there ever no food to eat of any kind in your household because of lack of resources to get food?	62.4	40.9	18.6
In the past four weeks, did you or any household member go to sleep at night hungry as there was not enough food?	41.2	32.2	10.2
In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	16.5	8.7	3.4

Source: Computed from the household survey, 2019

The result in Table 4.9 therefore implies that CSA practices made a significant contribution in improving the food security status of smallholder farm households in the study area.

Following the guideline from Coates et al. (2007), the HFIAS was converted into a categorical variable. As a result, four categories of food security status were created (food secure, mildly food insecure, moderately food insecure and severely food insecure), which were then recoded into two categories namely food secure and food insecure. The former includes food secure and mildly food insecure households whilst the latter constitutes moderately food insecure and severely food insecure households. Results of the HFIAS indicated that of the total sampled farm households, 35.91% of were found out to be food insecure. Distribution of food security status of the sampled households by adoption level of CSA practices is as presented in Table 4.10.

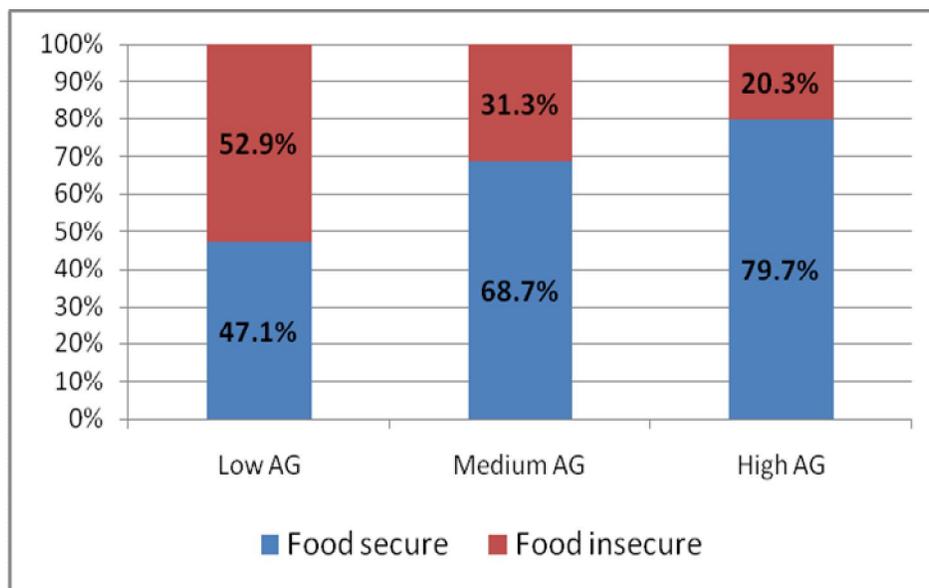
Table 4.10: Distribution of households' food security status by CSA adoption

Adoption level of CSA practices	No. of households	Food security status	
		Food secure	Food insecure
Low adoption group	85	47.1	52.9
Medium adoption group	115	68.7	31.3
High adoption group	59	79.7	20.3

Source: Computed from the household survey, 2019

The results in Table 4.10 clearly indicated that the prevalence of food security was the highest among high adoption group (79.7%) compared to medium (68.7%) and low (47.1%) adoption groups, further indicating that the prevalence of food security was relatively higher for the former than the later. In other words, the prevalence of food insecurity is higher (52.9%) among households in the low adoption group than households in the medium (31.3%) and high (20.3%) adoption groups. This implies that the percentage of food insecure households decreased with increase in adoption level of CSA practices and vice versa. Figure 4.4 showed that households' food security status in the study area was linked to their adoption level of CSA practices.

Figure 4.4: Distribution of Food security status of households by CSA adoption level



Source: Compiled from the household survey, 2019

Figure 4.4 indicated that a shift of farm households from low to medium CSA adoption group, filtered a significant portion {21.6% (68.7% - 47.1%)} of households from food insecurity to food security category. Whereas, relatively the proportion of farm households that could be moved from the food insecurity category to food security category was very substantial {32.6% (79.7% - 47.1%)} when the shift is made from low to high adoption group.

Finally, the relationship between CSA adoption level and food security status of households (as measured by the HFBS and HFIAS) was also investigated using Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. Outputs of the correlation analysis performed by SPSS Version 20 are as presented in Table 4.11 and 4.12.

Table 4.11: Descriptive Statistics for Adoption level, HFBM and HFIAS

	Mean	Std. Deviation	N
CSA Adoption Level	41.25	16.53	259
HFBM	1795.63	446.2	259
HFIAS	12.43	4.6	259

Table 4.12: Pearson Product-Moment Correlations between CSA Adoption Level, HFBM and HFIAS

	CSA Adoption Level	HFBM	HFIAS
CSA Adoption Level	1		
HFBM	.947**	1	
HFIAS	.808**	.769**	1

** Correlation is significant at the 0.01 level (1-tailed). N=259.

Results of the correlation analysis indicated that there was a strong, positive correlation between CSA adoption level and the two food security measures namely the HFBM [$r = .947$, $N=259$, $p < .0005$] and HFIAS [$r = .808$, $N = 259$, $p < .0005$] indicating that high CSA adoption level was associated with high food security status of households in the study area. The existence of strong, positive correlation [$r = .769$, $N=259$, $p < .0005$] also indicated the consistency of the data set used to measure food security status of households, and hence validity of results. Unfortunately, no similar studies have been conducted so far in this particular topic area in Ethiopia, in general and in the study area in particular to further interpret the strength of the above correlation coefficients through a comparative analysis.

4.3. FACTORS INFLUENCING CSA ADOPTION LEVEL IN THE STUDY AREA

Several factors (Socioeconomic, institutional and environmental factors) have been demonstrated in substantial numbers of previous studies to influence smallholder farm households' ability to adopt CSA practices, albeit for different practices. It is therefore, in order to gain thorough understanding on factors influencing farmers' current level of adoption of the CSA practices identified in the study area, twelve socio-economic and institutional factors assumed to influence adoption level of CSA practices among farm households were analyzed using inferential (Multinomial Probit Regression) statistics.

Results of the ordered probit model which showed the socio-economic and institutional factors influencing the level of adoption of CSA practices in the study area were presented in Table 5.8. Afterward, some of the perceived environmental factors assumed to influence adoption level of CSA practices among smallholder farm households in the study area were analyzed using

descriptive statistics. Summary of the descriptive statistics is presented on Table 4.13 following results of the ordered Probit model.

The Log likelihood of -98.2285 with a p-value of 0.0000 revealed that the model as a whole was statistically significant. The estimated cut-off points (μ) showed that the categories were ranked in an ordered way of $\mu_2 > \mu_1 > \mu_0$. The dependent variables were low adoption group ($Y = 0$), medium adoption group ($Y = 1$) and high adoption group ($Y = 2$). Since it is considered that the response variables i.e. the three identified adoption levels assume a natural ordering, the study therefore, used the ordered probit model on module of the STATA version 13 to perform the regression.

The marginal effect estimates indicated that years of education of the household head, livestock ownership and membership in SACCOs were found out to be significant explanatory variables that influenced level of adoption of the identified CSA practices among the low and high adoption categories in the study area at the 10%, 5% and 1% level of significance, respectively. On the other hand, none of the explanatory variables significantly influenced the medium user category.

The more educated a farmer is, the easier he or she adopts various CSA practices and technologies because a farmer who has more years of education is more likely to experience high CSA adoption rates and expected to be more efficient to understand and obtain improved practices and technologies than less-educated people. Those farm households whose head having higher education are more likely to portray high rate of adoption of CSA practices than those whose characteristics are otherwise. It is often used by previous studies (Debalke and Mulatu, 2011; Mamudu et al., 2012; Obayelu, Adepoju, and Idowu, 2014), to represent farm household's better access to innovation and technology asserting that education is a vital tool for knowledge acquisition.

The ownership of livestock is positively related to level of adoption CSA practices. Perhaps, livestock ownership is most likely to adopt the identified CSA practices and/or technologies listed under livestock management. Another important factor that influenced the adoption level of CSA practices in the study area was group membership; in this case weather farm households belonging to the rural savings and credit cooperatives (RSACCOs) was considered in the regression analysis. Farmers who belong to such groups are easily enlightened and exposed to

new farming technologies that will help boost adoption rate of farm-level CSA practices, which are assumed to increase agricultural production (Debalke and Mulatu, 2011).

Besides, farmers lobby for external support services like loans that could facilitate acquisition and implementation of these important CSA practices or technologies in group guarantees. This is similar to the findings of Komba and Muchapondwa (2015) and Varma (2016) who reported that farmer groups play an important role in information sharing, technology demonstration and final use. This is consistent with Gido *et al.* (2015) who noted that membership in farmer related groups and organizations increases the ease with which extension agents reach members, reduces the cost of service delivery through economies of scale and guarantees a higher number of contacts between members and service providers.

Access to credit also influenced adoption level of CSA practices among the low user category. Access to credit was also a vital tool that will enable a low user of CSAPs to rise up to being a high user. When farmers are given access to credit, it will enable them to acquire more technology which might be expensive to purchase. This agrees with the findings of Amao and Ayantoye (2015), who opined that access to credit in the form of loanable funds that can be used to expand production through the purchase and use of modern improved inputs. Credit reduces cash constraints and allows farmers to purchase important inputs.

Presumably, with access to capital, farmers tend to use capital-intensive CSA practices and pay costs for labor intensive technologies. Adekemi *et al.* (2016) argued that credit increases the farmers' economy to purchase improved seed, fertilizer and other CSA inputs, while Beshir *et al.* (2012) highlighted that if households get sufficient credit, they are able to purchase climate smart improved seeds and fertilizers on time. The marginal effects of all the variables influencing the three categories of 'low, medium and high adoption groups are shown in Table 4.13.

As it can be seen from Table 4.13, among the low and medium adoption categories, age of household head, gender of household head, years of education of household head, household size in AE, group membership, access to credit, farm size and log value of farm income, off-farm income and productive farm implements were all negatively related. The negative sign implies that an increase in all these variables will cause the farmers who are in low and medium adoption categories to increase their level of adoption of CSA practices, even though the marginal impacts are not significant, except for those mentioned above. Regarding the high adoption group, on the other hand, all the above stated explanatory variables were positively related. This positive sign implies that as these variables increase, there will be a boost in adoption level of CSA practices in the high adoption group.

With regard to environmental factors influencing adoption level of CSA practice, summary of the descriptive results obtained from the household survey is presented in Table 4.14 indicating the influence of some of the environmental factors assumed to influence smallholder farm households' level of adoption of CSA practices in the study area.

Table 4.14: Households Perception on Farm Characteristics and Climate Changes

Perception on farms	Farm characteristics	Low adoption/%	Medium adoption/%	High adoption/%
Perceived soil fertility status of your farmland?	Fertile/good	21	17	14
	Moderate	24	26	21
	Poor	55	57	65
Severity of soil erosion on your farm land?	More severe	42	47	52
	Moderate	28	25	26
	Less severe	30	28	22
Perceived texture property of soil on your farmland?	Sandy	18	21	23
	Loamy	46	47	52
	Clayey	36	32	25
General terrain characteristic of your farmland?	Sloppy	3	5	8
	Moderate	7	13	15
	Flat	90	87	79
Perceived changes in climate	Climate characteristics	Low adoption/%	Medium adoption/%	High adoption/%
Perceived level of satisfaction on sufficiency and timeliness of the rain (RSI ²)?	Low	81	88	93
	Medium	19	12	7
	High	0	0	0
Frequency of bad weather events (drought, floods, hailstorms) in your locality since last 10 years?	Increasing	76	82	88
	Decreasing	0	0	0
	Constant	17	11	11
	Not sure	7	7	5
Average cost of crop damage, loss of livestock or other livelihood assets due climate change in last 5 years?	< 5000Br	36	33	28
	5000-10,000Br	40	35	38
	> 10,000Br	24	15	34

Source: Household survey, 2019

² Subjective rainfall index calculated to represent farmers' perceived rainfall adequacy in the preceding agricultural season (main rainy season).

According to Table 4.14, proportion of households in high CSA adoption group who perceived that their farm land is characterized by poor soil fertility status (65%) and more severe soil erosion (52%) was greater than the proportion of households in the medium and low CSA adoption groups. Besides, the proportion of households in high SA adoption group who perceived that their farmland is physically sandy (23%) and sloppy (8%) was lesser than the proportion of households in the medium and low CSA adoption groups. On the other hand the proportion of households in the high CSA adoption group who perceived a low level of satisfaction sufficiency and timeliness of the rain as measured by a rainfall satisfaction index (93%); increasing frequency of extreme weather events such as drought, floods and hailstorms in the last 5 to 10 years (88%) and high level of damage/loss on livelihood assets (>10,000EthBr-34%) was greater than proportion of households in the medium and low CSA adoption groups.

The above result (Table 4.14) also implied that farm household's perception on the physical property of their farmland (fertility status, severity of erosion, soil texture and general terrain characteristics) and changing pattern of their local climate conditions (rainfall insufficiency and un-timeliness, and increasing frequency of extreme/bad weather events) were influencing adoption level of CSA practices among smallholder farm households in the study area. The result is in line with previous studies by Haghjou *et al.* (2014) and Wekesa (2017), yet a study by Gebeyehu (2016) had a contrary result where frequent extreme climate events such as hailstorms were the main sources of production risks related to climate change that farmers discouraged adoption of production techniques for yield stability in rural Amhara, Ethiopia. This calls for further investigations on the particular topic in the study area or elsewhere. The reason for excluding the perception of farmers on the changing patterns (if any) in temperature condition was because it is widely believed that rainfall pattern (mainly rainfall sufficiency and timeliness) is a vital determinant for the success of the traditional rainfed farming systems.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. CONCLUSIONS

Four conclusions emerged from the analyses of the four specific objectives in chapter four under the title 'Results and Discussions'. These were:

Results indicated that smallholder farm households in the study area adopt a wide variety of CSA practices in their farms at different extent and composition as well as for a variety of reasons. Some of these CSA practices identified in the study area are recently introduced, while others have long been part of the traditional mixed farming system. Further results also indicated that relatively crop management practices (such as use of improved crop varieties, alley cropping of cereals and application of mechanical weed control methods, change planting dates), livestock management practices (such as applying fodder conservation, diversify livestock species and use cut and carry feeding) and soil and water conservation practices (such as conservation tillage, crop rotation and use in situ water conservation practices) were widely adopted CSA practices by farm households in the study area, whereas agroecological practices (such as integrating trees in croplands and practicing bee-keeping) and integrated food energy systems (biogas production and use and use efficient biomass stoves) were the least adopted CSA practices both in terms of extent and variety.

Based on the frequency of use of the identified CSA practices in the study area, farm households were categorized in to three (high, medium and low) CSA adoption groups to show their level of adoption. Results indicated the overwhelming majority (~4/5th) of the households were medium or low CSA adopters, whereas only a fifth (1/5th) of them were happened to be in the high adopters group, which is the empirically identified best adoption level in this study.

The key finding in this study was that CSA practices have a potential contribution to improve the food security status of smallholder farm households in the study area, particularly when it is used by farm households to a large extent and variety. Specifically, the food security contribution of CSA practices would be more substantial when households were shifted from low to high adoption level than when they were shifted from low to medium or from medium to high adoption levels.

The probability of increasing the demand for CSA practices among smallholder farm households was influenced by different socio-economic, institutional and environmental factors. Results further indicated that age of household head, gender of household head, years of education of household head, household size in AE, group membership, access to credit, farm size and farm income, off-farm income and value of productive farm implements were all negatively related, implying that an increase in all these variables will cause the farm households who are in low and medium adoption groups to increase their level of adoption of CSA practices. On the other hand, all these explanatory variables were positively related implying that as these variables increase, there will be a boost in adoption level of CSA practices in the high adoption group.

The above result implied that farm household's perception on physical property of their farmland (soil fertility status, severity of soil erosion, soil texture and general terrain characteristics) and changing pattern of their local climate conditions (rainfall sufficiency and timeliness as well as increasing frequency of extreme/bad weather events) were influencing adoption level of CSA practices among smallholder farm households in the study area. However, the result in this regard raised further questions than answers on this particular section of the analysis, and hence calls for further investigations on the particular topic in the study area or elsewhere.

5.2. THE NOVELTY OF THE STUDY

The novelty of this study emanates from the topic of the area researched and the methodological framework employed to undertake the research.

The food security implications of climate change have been explored largely in relation to climate-related changes in yields of food crops and hence, changes in food production. Much of the literature review on agricultural adaptation to climate change has drawn attention to a range of factors affecting adaptation to climate change grounding more within the theory of positivist tradition. However, CSA is an approach grounded more in constructivist tradition assuming that climate change interventions should be context specific taking into account the type and scale of the given production system. The core principle of CSA thus resides on 'what is climate-smart in one context may not be climate-smart in another' implying the difficulty of transferring experiences from one specific context to another as well as the importance of investing on micro-level analysis to identify CSA practices in a particular socioeconomic and environmental context and thus intervene in such a way to meet the triple objectives namely improving the food

security status of stallholder farmers and resilience of agriculture to climate change, and if possible to reduce agriculture-induced GHG emissions and enhance sinks.

Moreover, despite the variations in the type and level of adoption, the effect of CSA practices being promoted in many rural communities on its primary pillar-food security has not been clear. Therefore, it is on the ground of these premises that this study primarily intended to identify the existing CSA practices, their level of adoption and the contribution on food security of smallholder farmers in the context of Artuma-Fursi Woreda, Oromiya Special Zone of Amhara region, Ethiopia.

To this end, the general methodological framework has brought together a variety of methods and techniques along the qualitative-quantitative spectrum to achieve the indented objective of the study ranging from content analysis to descriptive and quantitative statistical analysis used to assess farmers' adoption level of the empirically identified CSA practices along with some advanced household level food security measurement scales, which were used to for the sake of comparison thereby understand the links between adoption level of CSA practices and food security status of the farm households through averages, totals and other empirical calculations, thereafter draw pertinent conclusions and recommendations on the major research issues.

5.3. RECOMMENDATIONS

Smallholder farm households in the study area should be encouraged to increase the frequency and extent of using newly introduced CSA practices, especially those practices related to agroecology and integrated food energy systems as well as to adopt a combination of newly introduced and existing traditional CSA practices. Besides, farm households should be encouraged to incorporate all CSA practices as much as possible to have a higher effect on food security status. To further enhance the demand for CSA practices, concerned local, regional and national government together with their development partners should roll out rural development programs that could improve households' socio-economic status by diversifying their farm and non-farm income sources, and to enhance the institutional support to farm households by improving their access to extension and credit services thereby make it easier for them to enhance their adoption level both in terms of extent and variety, and thus improve their food security status.

In addition, farm households should be sensitized on the need to invest in productive farm assets to enable them absorb risks associated with climate change at the same time enhancing their ability to uptake important CSA practices. The sensitization should thus be done in groups by extension agents or related service providers in rural areas. To this end, farm households should also be motivated to join and participate in farmers' organizations like RSACCOs so that they could share information on CSA.

Further research should be undertaken to analyze the potential to adopt selected CSA practices on individual bases, which would inform on necessary interventions to promote adoption of these CSA practices. Future studies in the study area should focus on the challenges of CSA adoption with due regard to differences in the level of adoption by gender groups. Analysis on synergies and trade-offs between the three pillars of CSA should also be considered in future studies to testing and form the empirically identified best combinations between different CSA practices, and thus lay the bases for optimizing the triples CSA outcomes namely food security, adaptation and mitigation.

REFERENCES

- Affholder, F. Damien, J. Dang Q., Phuc Tuong, Marion, M., Aymeric, R. (2010): Constraints to farmers' adoption of direct-seeding mulch-based cropping systems; a farm scale modeling approach applied to mountainous slopes of Vietnam, *Agricultural Systems* 103(1): 51-62.
- Adekemi, O. A. Taiwo, T. A. and Akinlade, R. J. (2016): Causal effect of credit and technology adoption on farm output and income: The case of cassava farmers in Southwest Nigeria; *African Association of Agricultural Economists*, September 23-26, Addis Ababa, Ethiopia.
- Agriculture Finance Support Facility (2012): Enabling environment, access to financial services in Ethiopia.
- Aslihan Arslan, Jian Ju, Leslie Lipper and Tran The Tuong (2014): Evidence and Knowledge Gaps on CSA in Vietnam; a review on the Potential of Agroforestry and Sustainable Land Management in the Northern Mountainous Region, Rome, FAO
- Aslihan Arslan, N. McCarthy, L. Lipper, S. Asfaw, A. Cattaneo and M. Kokwe (2015): CSA? Assessing the Adaptation Implications in Zambia, Available at: <http://bit.ly/2no6OMR>
- Agricultural Transformation Agency (2014): Annual Report Transforming Agriculture in Ethiopia 2013/14, Addis Ababa, Ethiopia, Unpublished.
- Beshir, H., Eman B., Kassa B. & Haji J. (2012): Determinants of chemical fertilizer technology adoption in North eastern highlands of Ethiopia: the double hurdle approach. *Journal of Research in Economics and International Finance (JREIF)*, 12:39-49.
- Challa, M. and Tilahun, U. (2014): Determinants & Impacts of Modern Agricultural Technology Adoption in West Wollega; The Case of Gulliso District, *Journal of Biology, Agriculture and Healthcare*, 4(20): 2224-3208.
- CIAT-BFS/USAID (2017): CSA in Ethiopia, Country Profiles for Africa Series; International Center for Tropical Agriculture, Bureau for Food Security and United States Agency for International Development, Washington, D.C. 26 p.
- Coates, Jennifer, Anne Swindale and Paula Bilinsky (2007): HFIAS for Measurement of Household Food Access, Indicator Guide (v. 3); Washington, D.C., Food and Nutrition Technical Assistance Project, Academy for Educational Development.
- Deininger, K., Ali, D.A. & Alemu, T. (2009): Impacts of Land Certification on Tenure Security, Investment, and Land Markets; Evidence from Ethiopia; *Environment for Development Discussion Paper Series Efd DP 09-11*.

- Dula Etana and Degefa Tolossa (2017): Unemployment and Food Insecurity in Urban Ethiopia, *African Development Review*, Vol. 29, No. 1, pp. 56–68
- Ethiopian Health and Nutrition Research Institute (1997): Food composition table for use in Ethiopia. Part III, from 1968-1997. A research project sponsored by Government of Ethiopia through former ENI and EHNRI. Addis Abeba.
- Elizabeth, D., and Sophie, C. (2014): Climate-smart agriculture and REDD+ implementation in Kenya. REDD + Law Project - Briefing Paper, pp. 1-61.
- Emmanuel A. Ojoko, James A. Akinwunmi and Sulaiman A. Yusuf and Omobowale A. Oni (2017): Factors Influencing the Level of Use of CSA Practices in Sokoto State, Nigeria. *Journal of Agricultural Sciences* Vol. 62, No. 3, 2017 Pages 315-327
- Ethiopia's Agricultural Sector PIF (2010): Ethiopia's Agricultural Sector Policy and Investment Framework 2010-2020; Draft Final Report
- Ethiopian Panel on Climate Change (2015): First Assessment Report, Working Group II Agriculture and Food Security, Ethiopian Academy of Sciences, Addis Ababa.
- Falco, S.D., M. Veronesi, and M. Yesuf (2011): Does adaptation to climate change provide food security? a micro-perspective from Ethiopia; *American Journal of Agricultural Economics*, pp. 1-18.
- FAO (2013): CSA Sourcebook, Rome, Italy: FAO of the United Nations.
- FAO (2012a): Crop and Food Security Assessment Mission in Ethiopia, FAO, UN, Rome
- FAO (2012b): Mainstreaming CSA into a broader landscape approach, Rome, Italy: FAO, UN
- Federal Democratic Republic of Ethiopia (2015): Intended Nationally Determined Contribution-INDC. Available at: <http://bit.ly/1GsfauZ>
- Francis Maguza-Tembo Edriss Abdi-Khalil Julius Mangisoni David Mkwambisi (2016): Does Adoption of CSA Technologies Reduce Household Vulnerability to Poverty? *Journal of Economics and Sustainable Development*, available at www.iiste.org
- Furgasa Derara and Degefa Tolossa (2016): Household Food Security Situation in Central Oromia, Ethiopia; A Case Study from Becho Wereda in Southwest Shewa Zone, *Global Journal of Human-Social Science*, Volume 16 Issue 2 Version 1.0
- Gebreselassie S. (2006): Land, Land Policy and Smallholder Agriculture in Ethiopia: Options and Scenarios; *Future Agricultures Discussion Paper 008*
- Gina Kennedy, Terri Ballard and MarieClaude Dop (2011): Guidelines for Measuring Household and Individual Dietary Diversity; Nutrition and Consumer Protection Division, FAO

- HLPE (2013): Investing in smallholder agriculture for food security. Rome: High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security.
- Hoddinott, J. and Yohannes, Y (2002): Dietary diversity as a food security indicator, Food Consumption, Nutrition Division, Discussion Paper 136.
- Interagency Workshop Report WFP-FAO (2008): Measures of Food Consumption, Harmonizing Methodologies, Rome, 9-10.
- International Panel on Climate Change (2014): *Climate Change Impacts, Adaptation, and Vulnerability, Working Group II Contribution to the fifth Assessment Report of the IPCC*, Cambridge University Press, Cambridge, UK and New York
- Irina Arakelyan (2017): Climate-smart agriculture and rural livelihoods, the case of the dairy sector in Malawi, PhD Thesis – The University of Edinburgh
- Jirata, M., Grey, S. and Kilawe, E. (2016): Ethiopia Climate-Smart Agriculture Scoping Study, Addis Ababa, Ethiopia
- Johnson, L., Kovarik, C., Meinzen, R., Njuki, J. Quisumbing, A. (2016): Gender, assets and agricultural development, lessons from eight projects; *World Development Journal*, 83: 295-311.
- Joosten K; Grey S. (2017): Integrating climate change adaptation and mitigation into watershed management approach in Eastern Africa, Discussion paper and good practices, Addis Ababa, Ethiopia.
- Kelvin M. Shikuku, Peter Läderach, Leigh Winowiecki, and Caroline Mwongera (2015): A cost function analysis of trade-offs within CSA, does mulching save the cost of crop production among smallholder farmers in Uganda?
- Kothari C.R (2004): Research methodology, Methods and techniques, New Age International.
- Lal, R., Delgado, J., Groffman, P., Millar, N., Dell, C., and Rotz, A. (2011): Management to mitigate and adapt to climate change, *Journal of Soil Water Conservation*. 66, 276–285.
- Leroy et al. (2015): Measuring the Food Access Dimension of Food Security, a critical review and mapping of indicators?
- Lipper L, Thornton P, Campbell BM, Torquebiau EF (2014): Climate-smart agriculture for food security; *Nature Climate Change* 4:1068-1072.
- Maxwell, D., Vaitla, B. and Coates, J. (2014): How Do Indicators of Household Food Insecurity Measure up? Empirical Comparison from Ethiopia *Food Policy* 47: 107–16.

- McCarthy N. and Brubaker J. (2014): Climate-Smart Agriculture and resource tenure in Sub-Saharan Africa; a conceptual framework, FAO, Rome
- McFadden, D. (1973): Conditional Logit Analysis of Qualitative Choice Behavior In: Zarembka, P. *Frontiers in Econometrics*. Academic Press, London, U.K: 105-142.
- Menale. K., Zikhali, P., Pender, J. and Kohlin, G. (2010): The Economics of SLM Practices in the Ethiopian Highlands; *Journal of Agricultural Economics*, 61: 605-627.
- Meskerem Abi and Degefa Tolossa (2015): Household Food Security and its Determinants in Girar Jarso Woreda, North Shewa Zone of Oromia Region, Ethiopia, *Journal of Sustainable Development in Africa* V. 17, No.7, 1520-5509
- Meybeck, A. and Gitz, V. (2013): Why Climate-Smart Agriculture, Forestry and Fisheries in FAO? CSA Sourcebook, Module 1.
- MoANR (2015): CSA Field Manual/Zero Draft, CSA Working Group, Federal Ministry of Agriculture Natural Resource Management, Addis Ababa, Ethiopia
- Negash Mulatu Debalke (2011): Determinants of farmers' preference for adaptation strategies to climate change; evidence from North Shoa zone of Amhara region, Ethiopia.
- Nkonya, E., Pender, J., Kaizzi, C, Kato, E., Mugarura, S., Ssali, H. and Muwonge, J. (2008): Linkages between Land Management, Land Degradation, and Poverty in Sub-Saharan Africa: The Case of Uganda, IFPRI Research Report No. 00159, Wasington D.C.
- Obayelu, O. A., Adepoju, A. O. and Idowu, T. (2014): Factors Influencing Farmers Choices of Adaptation to Climate Change in Ekiti State, Nigeria; *Journal of Agriculture and Environment for International Development*, 108(1): 3-16.
- Papuso I, Faraby J.A. (2013): CSA Seminar on Climate Change and Risk Management
- Philip Thornton and Leslie Lipper (2014): Does Climate Change Alter Agricultural Strategies to Support Food Security? IFPRI Discussion Paper
- Pollyn Gabriel Abinye (n.d): Gender Analysis of the Disparities in the Level of Adoption of CSA Practices and the Impact on Household Nutrition of Smallholder Farmers in Uganda, MDP-IFAD Internship Report
- Pretty, J., Toulmin, C. and Williams, S. (2011): Sustainable intensification in African agriculture *International Journal of Agricultural. Sustainability* 9, 5–24.
- Ruel, M.T. (2002): Is dietary diversity an indicator of food security or dietary quality? A review of measurement issues and research needs. *Food Nutrition Bull*, 24, 231–232.

- Samuel T. Partey, Robert B. Zougmor, Mathieu Ou_Edraogo, Bruce M. Campbell (2018): An open access article under the CC BY-NC-ND license
- Santiago Lopez-Ridauraa, Romain Frelata,b, Mark T. van Wijkb, Diego Valbuena (2018): CSA-Farm household typologies and food security, an ex-ante assessment from Eastern India
- Simret Mekonnen (2014): The Role of CSA practices for Soil quality and Crop Production; a case study in Ambo Woreda, West Shoa zone of Oromia Region, Ethiopia
- Stephanie Uzamukunda (2015): Improving the existing farming systems towards a climate smart agriculture in Musanze district of Rwanda.
- Teklewold, H., Mekonnen, A., Köhlin, G. and Di Falco, S. (2016): Does Adoption of Multiple CSA Practices Improve Farmers' Climate Resilience? Empirical Evidence from the Nile Basin of Ethiopia; *Environment for Development, Discussion Paper Series 16-21*.
- Terri Ballard, Inge D Brouwer and Marieclaude Dop (2010): Proxy measures of household food consumption for food security assessment and surveillance, Public Health Nutrition
- Tolossa, Degefa (2002): Causes of Seasonal Food Insecurity in Oromiya Zone of Amhara Region: Farmers' View, NTNU, Trondheim, Norway
- Tolossa, Dgeffa (2005): Rural livelihoods, poverty and food insecurity in Ethiopia; a case study at Erenssa and Garbi communities in Oromiya Zone of Amhara Region, PhD Thesis, NTNU, Trondheim, Norway
- Trudi Zundel (2017): CSA as a development buzzword; framework for flexible development or green washing the status quo? Insights from N. Ghana, MA Thesis
- Tsega Adego, B. Simane and Getachew Abebe Woldie (2018): Sustainability, institutional arrangement and challenges of community based CSA practices in northwest Ethiopia
- United Nations (2015): Hunger: United Nations Sustainable Development, Retrieved from United Nations Sustainable Development Goals
- United Nations World Food Program (2015): Consolidated approach to reporting indicators of food security guidelines; UN-FAO, Food Security Analysis (VAM), Rome, Italy, 2015.
- Wangari Thiong'o (2016): Food Security via Permaculture; A Case Study of Samburu County, Kenya
- Wekesa, B. Masakha (2017): Effect of Climate Smart Agricultural Practices on Food Security of Small Scale Farmers in Teso North Sub-County, Kenya
- WFP (2016): Drought in Ethiopia: 10 Million People in Need. Available at <http://bit.ly/2zJkC6u>

- Whitfield S, Challinor AJ and Rees RM (2018): *Frontiers in Climate Smart Food Systems, Outlining Research Space, Frontier Sustainable Food System 2:2*.
- Pingali, L. and Rosegrant, W. (1994): *Confronting the environmental consequences of the Green Revolution in Asia*, Washington DC, IFPRI.
- Wiesmann, D, Bassett, L., Benson, T., Hoddinott, J. (2009): *Validating WFP's food consumption score and alternative indicators of household food security*; IFPRI Discussion Paper 00870, Washington D.C.
- Workneh N. (2006): *Land Tenure and Technological Improvement in Smallholder Agriculture in Ethiopia*. In: Desalegn R, Taye A. (eds.). *Land and Challenge of Sustainable Development in Ethiopia: Conference Proceedings*, p. 147–166. FSS, Addis Ababa.
- WRI (2016): *Climate Data Explorer*; World Resources Institute. Available at: <http://cait.wri.org/>
- World Bank (2011): *CSA, Increased Productivity and Food Security, Enhancing Resilience and Reduced Carbon Emissions for Sustainable Development, Opportunities and Challenges for a Converging Agenda; Country Examples*, Washington DC.
- Zelege G, Bewket W, Alemu D. (2010): *Economics of adaptation to climate change: Ethiopia case study, learning from past experiences with extreme climate events*; unpublished report

APPENDICES

Appendix 1a: Structured Interview Questionnaire for Farm Households

Introduction:

Dear Respondent,

I am an MA student at Addis Ababa University, College of Development Studies Specializing in Rural Livelihood and Development. This research aims to assess ***Adoption Level of Climate Smart Agricultural Practices and its Contribution on Food Security of Smallholder Farmers: A case study of Artuma-Fursi Woreda, Oromiya Special Zone of Amhara Region, Ethiopia.*** It is intended to explain the food security status of smallholder farmers against their level of adoption only from academic/research perspectives. Therefore, your responses will be used for the stated purposes, and also treated or kept confidential in a sense that the results of the interview questionnaire will not be used in any way other than for the purpose of conducting this research.

Thank you for your cooperation.

The researcher, Zeinu Urgessa

No.	General information	
1.	Kebele Name:	[]
2.	Got Name:	[]
3.	Household ID/Code	[]
4.	Date of interview:	[]
5.	Starting time:	[]
6.	Ending time:	[]
7.	Name of enumerator:	[]
8.	Name of supervisor:	[]

- Below are my questions to you:

SECTION A: SOCIO-DEMOGRAPHIC CHARACTERISTICS	
1.	Gender of the household head: Male <input type="checkbox"/> Female <input type="checkbox"/>
2.	Current marital status of the household head: Married <input type="checkbox"/> Single <input type="checkbox"/> Divorced/Separated <input type="checkbox"/> Widow <input type="checkbox"/>
3.	Age of the household head (years): _____
4.	Household size (permanent members): _____
5.	Age and sex composition of the household members (Workforce involved in farming)
	5.1. Below 10 years old: Male _____ Female _____ Total _____
	5.2. 10 to 13 years old: Male _____ Female _____ Total _____
	5.3. 14 to 16 years old: Male _____ Female _____ Total _____
	5.4. 17-50 years old: Male _____ Female _____ Total _____
	5.5. Greater than 50 years old: Male _____ Female _____ Total _____
6.	Level of formal education attained by the household head: Illiterate <input type="checkbox"/> Read and Write <input type="checkbox"/> Formal education <input type="checkbox"/> (Grade Level____) Higher education (Diploma <input type="checkbox"/> Degree <input type="checkbox"/> TVET <input type="checkbox"/>

SECTION B: FARM CHARACTERISTICS	
1.	Do your household own farmland? Yes <input type="checkbox"/> No <input type="checkbox"/>
2.	If 'Yes' size of your farm _____ (timads)
3.	Tenure Security status of your farm land? Registered and Certified <input type="checkbox"/> Registered, but not certified <input type="checkbox"/> Neither registered nor certified <input type="checkbox"/>
4.	Size of land in rented _____ (timads)
5.	Size of land rented out _____ (timads)
6.	Size of land under cultivation _____ (timads)
7.	Average walking time from your homestead to the farm? _____ (minutes/hours)
8.	Perceived fertility status of your farmland: Fertile <input type="checkbox"/> Moderate <input type="checkbox"/> Infertile <input type="checkbox"/>
9.	Perceived physical property of soil on your farmland: Sandy <input type="checkbox"/> Loamy <input type="checkbox"/> Clayey <input type="checkbox"/>
10.	General terrain characteristic of your farmland: Sloppy <input type="checkbox"/> Moderate <input type="checkbox"/> Flat <input type="checkbox"/>
11.	Severity of soil erosion on your farm land: More severe <input type="checkbox"/> Moderate <input type="checkbox"/> Less severe <input type="checkbox"/>
12.	Is there any flood control structure around your farming plot/s? Yes <input type="checkbox"/> No <input type="checkbox"/>

SECTION C: SMALLHOLDERS' AGRICULTURE: SUB-SECTION C1: CROP PRODUCTION								
Quantities of key principal crops harvested in last production year for subsistence and sale (in quintal):								
No.	List of Crops	Total production	Portion of production used for own consumption	Portion of production sold	Portion of production returned to leaders, given as charity	Portion of production reserved as seed	Average post-harvest losses	Quantity of same crop obtained via purchase, borrow, gift, FFW, relief
1.								
2.								
3.								
4.								
5.								

SUB-SECTION C2: LIVESTOCK OWNERSHIP					
1.	Currently, does your household have any livestock? Yes <input type="checkbox"/> No <input type="checkbox"/>				
2.	If 'Yes', indicate the numbers of animals for the different species:				
No.	Livestock species	Number	No.	Livestock species	Number
1.	Oxen		9.	Sheep (Adult)	
2.	Cows		10.	Sheep (Young)	
3.	Bull		11.	Goats (adult)	
4.	Heifer		12.	Goats (young)	
5.	Shoats		13.	Poultry /Chickens	
6.	Calves		14.	Donkey (adult)	
7.	Camel (Adult)		15.	Donkey (young)	
8.	Camel (Young)		16.	Other, specify_____	

SECTION D: ASSET VALUE OF FARM IMPLEMENTS OWNED BY HOUSEHOLDS (In Eth.Br.):							
No.	Farm implements	Number	Unit price	No.	Farm implements	Number	Unit price
1.	Hoe/Meqoferia			9.	Water storage tank		
2.	Spades/shovel			10.	Ox cart /plough		
3.	Axe/Metrebia			11.	Cultivator		
4.	Sickle/Slasher			12.	Generator		
5.	Threshers/sieve			13.	Motorized pump		
6.	Sprayer			14.	Protective equipment		
7.	Watering can			15.	Other, specify_____		

SECTION E: LIVELIHOOD AND INCOME DIVERSIFICATION		If there is any,	Av. Value (Eth.Br)
1.	Farm-income	Put "√"	Month/year
1.1	Sale of cash crops	<input type="checkbox"/>	
1.2	Sell of food crops	<input type="checkbox"/>	
1.3	Sell of pulses, vegetables, fruits	<input type="checkbox"/>	
1.4	Sell of crop residues, firewood, grass, charcoal	<input type="checkbox"/>	
1.5	Sell of livestock	<input type="checkbox"/>	
1.6	Sell of livestock products (milk, better etc.)	<input type="checkbox"/>	
1.7	Sell of honey	<input type="checkbox"/>	
1.8	Casual Farm wage during peak periods	<input type="checkbox"/>	
2.	Non-farm income	Put "√"	Birr/month
2.1	Casual non-farm wage during off-seasons	<input type="checkbox"/>	
2.2	Salary employment, government	<input type="checkbox"/>	
2.3	Small business (including petty trading)	<input type="checkbox"/>	
2.4	Remittances, Pension	<input type="checkbox"/>	
2.5	Handcraft and tool making	<input type="checkbox"/>	
2.6	Artisanship (carpenter, Thatcher)	<input type="checkbox"/>	
2.7	Rental income (oxen, land, farm assets)	<input type="checkbox"/>	
2.8	Mining /quarrying, stone, sand	<input type="checkbox"/>	
2.9	PSNP/HABP, Donation, Charity/Zakha	<input type="checkbox"/>	
2.10	Others, please specify_____	<input type="checkbox"/>	

SECTION F: CLIMATE CHANGE AND CLIMATE SMART AGRICULTURAL PRACTICES		
No.	Perceived changes on rainfall patterns	Responses (tick)
1.	Have you noticed any change in the regular weather patterns in the last 5/10 years?	Yes <input type="checkbox"/> No <input type="checkbox"/>
2.	How do you compare the current rainfall amount during the rainy season with the last 5/10years?	Very low <input type="checkbox"/> Low <input type="checkbox"/> Same <input type="checkbox"/>
3.	How do you compare current temp conditions with last 5/10 years?	Very low <input type="checkbox"/> Low <input type="checkbox"/> Same <input type="checkbox"/>
4.	How do you assess the frequency of drought incidents in your area compared with the last 5/10years?	Increasing <input type="checkbox"/> Decreasing <input type="checkbox"/> Constant <input type="checkbox"/> Not sure <input type="checkbox"/>
No.	During the growing season prior the last main harvest:	Responses (tick)
1.	Did the rainfall come on time?	On time <input type="checkbox"/> Too late <input type="checkbox"/> Too early <input type="checkbox"/>
2.	Was there enough rain on your fields at the start of the rainy season?	Enough <input type="checkbox"/> Too much <input type="checkbox"/> Too little <input type="checkbox"/>
3.	Was there enough rain on your fields during the growing season?	Enough <input type="checkbox"/> Too much <input type="checkbox"/> Too little <input type="checkbox"/>
4.	Did the rains stop on time on your fields?	On time <input type="checkbox"/> Too late <input type="checkbox"/> Too early <input type="checkbox"/>
5.	Did it rain near the harvest time?	Yes <input type="checkbox"/> No <input type="checkbox"/>

SECTION G: HOW MANY TIMES THE FOLLOWING BAD WEATHER EVENTS DID STRIKE YOUR AREA IN LAST 5 YEARS?					
No.	Bad weather events	No. of times struck	No.	Bad weather events	No. of times struck
1.	Droughts incidents		4.	Hailstorms	
2.	Flood disasters		5.	Excessive heating	
3.	Heavy rains		6.	Others, specify	

No.	Section H1: Farm-Level CSA Practices and technologies	Frequency of use by households (scoring)				*Reason/s for not adopting
		Frequently (3)	Occasionally (2)	Rarely (1)	Not at all (0)	
1.	Crop Management Practices					
1.1	Use of improved crop varieties (high yielding, tolerant to moisture stress, pests, diseases)					
1.2	Change planting/harvesting dates,					
1.3	Apply contingent planting using early maturing varieties					
1.4	Alley cropping of cereals					
1.5	Precise fertilizer application (type, timing, placement, amount)					
1.6	Precise application of agrochemicals (timing, quantity)					
1.7	Use organic fertilizer (use of compost, animal and green manure)					
1.8	Use mechanical weed control methods					
1.9	Apply on-farm diversification through vegetables, fruits, Masho					
2.	Livestock Management Practices					
2.1	Use of improved breeds (hy/crossbreeds)					
2.2	Diversify livestock species plus poultry					
2.3	Keep with more resilient animal types (camel, goats)					
2.4	Apply fodder conservation (make silage, hay storage)					
2.5	Use cut and carry feeding					

3.	Soil and Water Conservation Practices					
3.1	Use small-scale irrigation (including boreholes, deep wells)					
3.2	<i>Use in situ</i> water conservation practices (run-off diversion, planting pits or micro catchments, cut-off drains)					
3.3	Use conservation tillage (reduced, minimum tillage)					
3.4	Mulching (stubble retention and planting cover crops/live mulches)					
3.5	Apply crop rotation					
3.6	Intercropping					
3.7	Strip cropping					
3.8	Leave vegetative strips (<5%), Construct Fanya juu (12-35%)					
3.9	Reinforce physical structures with grass strips and multi-purpose trees					
3.10	Establish live barriers on farm boundaries and hedges					
4.	Agroecological Practices					
4.1	Integrate trees in croplands					
4.2	Planting trees around croplands					
4.3	Practice bee-keeping (apiculture)					
5.	Integrated Food Energy Systems					
5.1	Biogas production and use					
5.2	Use fuel efficient biomass stoves					
5.3	Use Improved postharvest storage facilities or techniques					
<i>*1. Lack of Information 2. Lack of Money, 3. Labor Shortage 4. Land Shortage 5. Water Shortage 6. Don't See the Need 7. Other</i>						

SECTION I: HOUSEHOLD FOOD INSECURITY ACCESS SCALE (HFIAS) MEASUREMENT TOOL				
NO	QUESTIONS (Note: If your answer is 'No', skip the question that follow)	RESPONSE OPTIONS		
1.	In the past four weeks, did you worry that your household would not have enough food?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
1.a	How often did this happen?	Rarely <input type="checkbox"/>	Sometimes <input type="checkbox"/>	Often <input type="checkbox"/>
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
2.a	How often did this happen?	Rarely <input type="checkbox"/>	Sometimes <input type="checkbox"/>	Often <input type="checkbox"/>
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
3.a	How often did this happen?	Rarely <input type="checkbox"/>	Sometimes <input type="checkbox"/>	Often <input type="checkbox"/>
4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
4.a	How often did this happen?	Rarely <input type="checkbox"/>	Sometimes <input type="checkbox"/>	Often <input type="checkbox"/>
5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
5.a	How often did this happen?	Rarely <input type="checkbox"/>	Sometimes <input type="checkbox"/>	Often <input type="checkbox"/>

6.	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
6.a	How often did this happen?	Rarely <input type="checkbox"/>	Sometimes <input type="checkbox"/>	Often <input type="checkbox"/>
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
7.a	How often did this happen?	Rarely <input type="checkbox"/>	Sometimes <input type="checkbox"/>	Often <input type="checkbox"/>
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
8.a	How often did this happen?	Rarely <input type="checkbox"/>	Sometimes <input type="checkbox"/>	Often <input type="checkbox"/>
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
9.a	How often did this happen?	Rarely <input type="checkbox"/>	Sometimes <input type="checkbox"/>	Often <input type="checkbox"/>

SECTION J: ACCESS TO FORMAL EXTENSION AND INSTITUTIONAL SUPPORT				
No.	QUESTIONS	Responses (Put '√')		
1.	How often you have access to livestock extension?	Regularly	Rarely	Never
2.	How often you have access to crop extension?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.	How often you receive improved weather information about daily/seasonal forecasts?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.	How often your household receive early warning about climate disasters pending around?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.	How often you have been exposed through training to various CSA practices/capacity development activities (field visits, demonstration, crop /livestock insurance, proper seed, fertilizer supply system, marketing)?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.	Which of the following media/communication device serve as a source of information for your household (multiple answer possible)	Mobile	Radio	TV Set
7.	Is your household integrated with productive safety net program?	Yes	No	
8.	Did you receive agricultural credit (loan) in the last three years? If yes, indicate the amount?	<input type="checkbox"/>	<input type="checkbox"/>	
9.	Does your household belong to the local RUSACCOs or other farmers associations or cooperatives?	<input type="checkbox"/>	<input type="checkbox"/>	
10.	No. of other government programs your household have access to?	[_____]		
11.	No. of other NGO programs your household have access to?	[_____]		
12.	Average walking Distance to the main asphalt road (minutes/hrs)	[_____]		
13.	Distance to the nearest market/Woreda center (minutes/hrs)	[_____]		

Section K: Access to Social (Informal) support systems			
No.	Informal supports received/given	Responses	
1.	How often you discuss (exchange ideas) with fellow farmers about climate change, CSAPs or regular farming activities?	Regularly <input type="checkbox"/>	Rarely <input type="checkbox"/> Never <input type="checkbox"/>
2.	In the past 12 months, did you borrow any money from relatives, friends, and neighbors? If 'Yes', total value (Eth.Br.)	Yes <input type="checkbox"/> [_____ Br.]	No <input type="checkbox"/>
3.	In the past 12 months, did you lend any money to relatives, friends, and neighbors? If 'Yes', total value (Eth.Br.)	Yes <input type="checkbox"/> [_____ Br.]	No <input type="checkbox"/>
4.	How do you evaluate the quality of other external supports (food, labor) your household received from (friends, neighbors, relatives, group members) in the past 12 months?	No support <input type="checkbox"/> Satisfactory support <input type="checkbox"/> Fair support <input type="checkbox"/> Unsatisfactory support <input type="checkbox"/>	
5.	How do you evaluate the quality of other supports (food, labor) your household gave to friends, neighbors, relatives, group members in the past 12 months?	No support <input type="checkbox"/> Satisfactory support <input type="checkbox"/> Fair support <input type="checkbox"/> Unsatisfactory support <input type="checkbox"/>	

**Thank you for your precious time again.
If you have any point to make as a final remark, you welcome...**

Appendix 1b: Key Informant Interview Checklist

Key Informant Interview Checklist prepared for experts from local government offices as per their roles and responsibilities

1. Does your office have information relating to climate impacts and livelihood vulnerability of farming communities that have been supported through your programs/initiatives? If so, what does this evidence show?
2. Based on the available information, what does your office consider to be the major climatic risks in the communities where you work?
3. How does the government address climate change issues in the agriculture sector? How, if at all, are they mainstreamed together?
4. How are existing CSA practices and technologies contributing to food security of farm households, adaptation and mitigation of climate change in the agriculture sector?
5. What synergies and conflicts exist between the production, adaptation and mitigation strategies?
6. In your view, what are effective climate-smart practices in the agriculture sector?
7. What initiatives have been successful and less successful in promoting climate-smart practices and technologies in the agriculture sector?
8. What are the challenges related to the implementation of various CSA practices and technologies among smallholder farmers?
9. Are there any forms of agricultural subsidies available to farmers to implement climate practices in their farms?
10. What policies, planning measures and incentives can contribute to integrate new or upscale existing CSA practices? Please provide some examples.
11. How can government policies better incorporate the concerns of smallholder farmers?

**Thank you for your precious time again.
If you have any point to make as a final remark, you welcome...**

Key Informant Interview Checklist prepared for experts from NGOs, Donors and other Development Partners operating in the study area, as per their roles and responsibilities

1. Does your office have information relating to climate impacts and livelihood vulnerability of farming communities that have been supported through your programs/initiatives? If so, what does this evidence show?
2. Based on the available information, what does your organization consider to be the major climatic risks in the communities where you work? How do climate hazards impact Smallholder producers?
3. What does your organization consider to be the major climatic risks in the communities where you work?
4. What practices have you been implementing with smallholder communities to address climate impacts on their farms? Can you provide examples how practices have contributed to reduce weather-induced impacts? Were these practices effective and successful? Why, or why not? Did you experience any positive or negative flow-on impacts especially related to agricultural production, adaptation and mitigation?
5. Through your organizational programs, how are adaptation and mitigation activities contributing to food production, and hence food security of smallholder farm households?
6. What initiatives were successful and less successful in reducing impacts and contributing to food security? Was there any compromise of livelihoods as a result of adjusted practices?
7. What options are currently available to combine agricultural production, adaptation and mitigation options in the smallholders' sub-sector?
8. Based on the above, what characteristics do you consider important for inter-related food production, adaptation and mitigation practices within smallholder farming systems? How are strategies being mainstreamed within the smallholder sub-sectors' programs and funding areas?
9. What are the key barriers to adopting climate-smart agricultural practices and investments?
10. What are the key barriers/challenges and constraints to the adoption and implementation of new CSA options (practices and technologies)? What are the main constraints for making the necessary adjustments to climatic variation within and between seasons?
11. How would you describe the policy mechanisms in place or needed to address climate change challenges? How have your organizational policies incorporated the concerns of smallholder farmers? What can be done better to reflect the key climate/livelihood concerns of these groups?

**Thank you for your precious time again.
If you have any point to make as a final remark, you welcome...**

Appendix 1c: Focus Group Discussion Checklist

1. What are the overall threats/risks to your livelihoods?
2. Have you noticed any long-term shifts in the temperature and rainfall on your farm(s)? If so, what have these shifts been?
3. What are the climatic risks to your farms that concern you the most?
4. How would you describe the impacts of droughts and other severe weather events on your farms? In what ways, if any, does this impact livelihood?
5. Are there differences in how you plan and work on your farms given the increasing change and variability of the in current climate conditions?
6. How do you characterize your farming farms in terms of number, size, key principal crops you grown, yield in a normal year, type of tenure and farming system, number and type of livestock?
7. What practices have you been implementing to address climate impacts on your farms? Can you provide examples, if any, how the practices have contributed to reduce weather-induced impacts? Were these practices effective and successful? Why, or why not? Did you experience any positive or negative flow-on impacts especially related to food production, adaptation and mitigation?
8. What were the challenges in implementing climate-smart practices? Was there any compromise of livelihoods as a result of adjusted practices?
9. From a farming or farm level perspective, what are the key barriers/challenges and constraints to the implementation of new CSA options (practices and technologies) to address long term and short-term climate risks?
10. What policy measures work? What doesn't work? Why? Ideally, what needs to happen to be able to deal with these kinds of severe climatic impacts on farms?

**Thank you for your precious time again.
If you have any point to make as a final remark, you welcome...**

Appendix 2

The energy content of various everyday food items (1 KJ = 240 Calories)

Food Items	KJ/g	Food Items	KJ/g
Barely	14	Beef	6.7
Wheat	14.2	Chicken	5.8
Wheat bread	10	Fish	3.4
Maize	14.6	Eggs	6.3
Sorghum	14.5	Milk	2.9
Millet	13.9	Banana	4.2
Rice	14.6	Lemon	1.6
Teff	14.2	Mango	2.1
Beans and Peas	13.9	Orange	1.8
Soy beans	14.7	Carrot	2.0
Cow pea	11.8	Green peppers	1.3
Ground nuts	24.0	Tomatoes	0.9
Sunflower seed	23.9	Cabbage	9.8
Lentil	14	Sugar	16.6
Sweet potato	5.1	Abish	1.6
Adenguare	1.44	Oil	33.83

Food items	Units'	Calorie
Milk	1 cup	0.37
Tea	1 cup	1
Coffee	1 cup	1
Onion	1 peace	40

Source: EHNRI (1997)

Appendix 3: Conversion Factors

Appendix 3a: Conversion Factors Used to Compute Adult-Equivalent (AE)

Age groups (years)	Male	Female
Less than 10	0.6	0.6
10-13	0.9	0.8
14-16	1.0	0.75
17-50	1.0	0.75
More than 50	1.0	0.75

Source: Storck et al. (1991)

Appendix 3b: Conversion factors used to estimate tropical livestock unit (TLU) equivalents

Animal category	TLU
Calf	0.25
Donkey (Young)	0.35
Weaned Calf	0.34
Camel	1.25
Heifer	0.75
Sheep and Goat (Adult)	0.13
Cow and Ox	1
Sheep and Goat (Young)	0.06
Horse	1.1
Chicken	0.013
Donkey (Adult)	0.7

Source: Storck et al. (1991)