CLIMATE INFORMATION SERVICES AND ITS DETERMINANTS AMONG SMALLHOLDER FARMERS IN SIDAMA REGION, SOUTHERN ETHIOPIA

MA THESIS

BY:

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OCTOBER 28, 2024.

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MA THESIS SUBMITTED TO HAWASSA UNIVERSITY, DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES, COLLEGE OF SOCIAL SCIENCES AND HUMANITIES, SCHOOL OF GRADUATE STUDIES, HAWASSA UNIVERSITY, HAWASSA, ETHIOPIA.

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE MASTERS OF ART DEGREE (SPECIALIZATION: POPULATION AND DEVELOPMENT PLANNING).

ADVISOR: MAMUYE BELIHU (PhD).

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DECLARATION

I affirm that my thesis, titled "Climate Information Services and Its Determinants Among Smallholder Farmers in the Sidama Region of Southern Ethiopia," is my own original work. This submission is presented as part of the requirements for the Master of Arts degree in Population and Development Planning at Hawassa University. It has not been submitted for any other degree, diploma, fellowship, or similar qualification at any other institution. I have appropriately cited all sources and materials referenced in this thesis.

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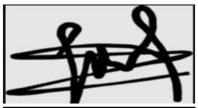
Signature: 

Place: Hawassa, Sidama, Ethiopia.

This MA in Population and Development Planning thesis has been submitted for examination with approval as thesis advisor.

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Place:________________________________

Submission Date: October-28-2024.

HAWASSA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

ADVISOR APPROVAL SHEET

(Submission Sheet-1)

This is to confirm that the thesis titled "Climate Information Services and Its Determinants Among Smallholder Farmers in the Sidama Region of Southern Ethiopia," submitted in partial fulfillment of the Master of Arts degree in Population and Development Planning, complies with the university's guidelines and meets the required standards for originality and quality. The research was carried out by Kereyu Kebede Marassa, ID. No. GPPDPR/0004/15, under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the department.

Approved by;

Mamuye Belihu (PhD) ______________________ __________________

Advisor Signature Date

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EXAMINERS APPROVAL SHEET-1

(Submission Sheet-2)

We, the undersigned members of the examination board, have evaluated the thesis titled "Climate Information Services and Its Determinants Among Smallholder Farmers in the Sidama Region, Southern Ethiopia," submitted by Kereyu Kebede Marassa during the final open defense. We hereby certify that the thesis has been accepted as fulfilling the requirements for the Master of Arts degree with a specialization in Population and Development Planning.

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The final approval and acceptance of the Masters of Art thesis depend on the submission of the completed thesis copy to the School of Graduate Studies (SGS) via the Graduate Committee (DGC/SGC) of the candidate's department or school.

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LIST OF ABBREVIATIONS AND ACRONYMS

ATA: Agricultural Transformation Agency

CHIRPS: Climate Hazards Group Infrared Precipitation with Stations

CGIAR: Consultative Group on International Agricultural Research.

CCAFS : Climate Change Agriculture and Food Security program

CIS: Climate Information Services

DWAB: Dale Woreda Administration Bureau

AWAB: Arbegona Woreda Administration Bureau

LWAB: **L**oka Abaya Woreda Administration Bureau

CSA: Central Statistical Agency

EIAR: Ethiopian Institute of Agricultural Research

EMEFCC: Ethiopian Ministry of Environment, Forest, and Climate Change

ETB: Ethiopian Birr (currency of Ethiopia)

EU: European Union

FAO: Food and Agriculture Organization

FGDs: Focus Group Discussions

GFCS: Global Framework for Climate Services

GHG: Greenhouse Gas

HHs: Households

IGAD: Intergovernmental Authority on Development

IPCC: Intergovernmental Panel on Climate Change

KII: Key Informants Interview

m.a.s.l.: Meters Above Sea Level

MoANR: Ministry of Agriculture and Natural Resources

NMI: National Meteorology Institute

SNRS: Sidama National Regional State

SRAO: Sidama Region Administrative Office

SPSS: Statistical Package for the Social Sciences

SSA: Sub-Saharan Africa

WMO: World Meteorological Organization

ABSTRACT

Climate information services (CIS) play a crucial role in climate adaptation strategies by mitigating climate-related risks and assisting smallholder farmers in their decision-making. This study explored the current status of CIS and the factors affecting its utilization among smallholder farmers in the Sidama region of Ethiopia. A mixed-methods approach was used, which included household surveys, focus group discussions, key informant interviews, and field observations. Multi-sampling techniques were utilized to select woredas, kebeles, and households, with three woredas chosen purposively based on agro-ecological criteria and six kebeles selected through simple random sampling. A systematic random sampling method was applied to gather data from 384 households. Data analysis was conducted using descriptive statistics, qualitatively analysis, chi-square tests, and a binary logistic regression model. The results indicated a moderate overall status of CIS in the study area, with 50.8% of farmers having access to these services, though utilization of CIS was low only 33.9% actively utilized them. The primary sources of CIS included agricultural extension officers, radio, television, mobile phones, peer farmers, and village leaders. Access to and use of climate information services (CIS) differ considerably among the agro-ecological zones. In the Kolla zone, around 39.6% of households make use of CIS, whereas the Woinadega zone has a lower engagement rate of 36.9%, and the Dega zone trails further behind, with only 18.9% of households utilizing these services. The study reveals that climate information services (CIS) significantly enhance farm management decisions among smallholder farmers. The main factors determining the utilization of CIS among smallholder farmers included education level, age, size of the farm, availability of credit, access to extension services, weather information, social protection services, income level, market access, and trust in the information provided. To enhance productivity, stakeholders such as the government, meteorological agencies, and agricultural extension services should focus on improving the availability, accessibility, reliability, and utilization of CIS.

Keywords: *binary logistic regression, Climate information services (CIS), determinants of utilization, Sidama region, smallholder farmers.*

CHAPTER ONE

1. INTRODUCTION

1.1. Background of study

The historical development of climate information services traces back to the emergence of meteorology as a scientific discipline, with early efforts focused on understanding atmospheric phenomena (Jones and Brown, 2012). The provision of climate information services for agricultural purposes began to gain traction in the late 20th century, with the establishment of meteorological agencies and research institutions focusing on climate-related data collection and analysis. Over time, the integration of weather and climate information into agriculture became essential for sustainable practices (Krupnik et al., 2014). The negative effects of climate change are already identified in all sectors, but with more impacts on agriculture (Ekemini et al., 2019; Olorunfemi et al., 2020). Agricultural production is threatened by extreme weather events such as drought and floods, with adverse effects on the fertility of the soil and crop productivity (Ozioko et al., 2022). Climate information services have evolved significantly on a global scale, gaining importance in agricultural practices and decision-making.

The global agricultural community has increasingly recognized the importance of accurate and timely climate information to mitigate risks and optimize productivity (FAO, 2015). The usage of climate information services globally has witnessed a trans-formative journey, with technological advancements and collaborative efforts enhancing their accessibility and accuracy (Smith and Jones, 2018). Climate information services are becoming important and gaining recognition as critical to farmers and other decision-makers to manage climate risks and adapt to changing climatic conditions (Hansen et al., 2019). Climate information aid farmers to tactically plan and adopt farm operations that enhance their adaptive capacity in the event of adverse climatic conditions and risks (Partey et al., 2020). Hence, the place of climate information services in helping farmers, particularly small-scale farmers, cope with climate change cannot be overstated (Eta et al., 2022).

In Africa, the usage of climate information services has been shaped by the continent's unique agricultural landscape and its vulnerability to climate change. There has historically been recognition of climate variability and its impact on agriculture, revealing the need for reliable information. Several factors, including the continent's susceptibility to the effects of climate change and the imperative to improve food security and resilience among smallholder farmers, have influenced the adoption of climate information services for agricultural decision-making (Speranza et al., 2017). Integrating climate information into agricultural practices is especially vital in areas prone to droughts, floods, and other extreme weather events, where timely and accurate weather forecasts can assist farmers in managing risks and adjusting their farming strategies. The formal integration of climate information services in the region has intensified as a response to the escalating challenges posed by climate change. Smallholder farmers, who represent a significant portion of the population in Africa, have historically relied on traditional knowledge systems to navigate climatic uncertainties (Tekle, 2017).

Climate information services involve providing weather forecasts, seasonal climate predictions, and agro-meteorological advisories to help farmers make informed decisions. In developing countries, notable advancements have been made in creating and disseminating these services through multiple channels, such as radio, mobile phones, and community networks (Fosu et al., 2018). Nevertheless, obstacles like restricted access to technology, insufficient infrastructure, and issues with the reliability of forecasts still hinder the effectiveness of these services (Ndlovu et al., 2020).

Ethiopia, with its diverse aggro-ecological zones, has a long-standing reliance on agriculture for livelihoods. Ethiopia's agricultural sector encounters distinctive challenges due to its topographical and climatic diversity. The irregularities in rainfall patterns and the increasing frequency of extreme weather events pose significant threats to crop yields and food security (Tekle, 2017). The historical utilization of climate information services in Ethiopia is intertwined with the country's rich agricultural heritage and the utilization of climate information services has gained momentum in recent years, supported by initiatives such as the Ethiopian Meteorological Institute (EMI) and research institutions collaborating to provide tailored weather forecasts and agro-advisories to farmers (Hansen et al., 2018). As climate-related challenges have intensified, there has been an increasing acknowledgment of the importance of obtaining accurate and timely climate information. Government efforts, along with partnerships with international organizations, have been vital in enhancing climate information services to meet the specific needs of farmers in Ethiopia (EMI, 2020).

The Sidama region, located in southern Ethiopia, has a diverse agro-ecological landscape where smallholder farmers primarily rely on rain-fed agriculture and livestock for their livelihoods. While this area is crucial for agriculture, it is also particularly vulnerable to the effects of climate change. Farmers in Sidama have encountered various climate-related issues, including changing rainfall patterns, greater temperature fluctuations, and extreme weather events, all of which have had a considerable impact on agricultural productivity and food security (Demissie and Legesse, 2013).

Currently, there is a lack of representation in the literature concerning the status and use of Climate Information Services (CIS) in the Sidama region. The availability of these services is limited, and there is inadequate emphasis on enhancing access to and utilization of climate information for smallholder farmers to help them manage climate risks and lessen vulnerabilities. It is crucial to understand the specific challenges faced by smallholder farmers in Sidama to develop targeted interventions that address their needs. Therefore, this study aimed to investigate the status of climate information services and the factors that affect their utilization among smallholder farmers in the Sidama region.

1.2. Statement of the Problem

The effects of climate change are felt globally, and developing countries are among the most vulnerable to its impacts (IPCC, 2014). The agricultural sector is especially vulnerable, given its strong reliance on weather conditions. Inaccurate and untimely climate information can lead to crop failures, food insecurity, and diminished livelihoods for farmers.The increasing frequency and intensity of extreme weather events have significantly affected agricultural productivity and food security in various regions, especially in developing nations (FAO, 2020). Consequently, there is an urgent demand for effective Climate Information Services (CIS) to help mitigate the negative impacts of climate change on agriculture (Speranza, et al., 2017). Conversely, utilizing Climate Information Services (CIS) offers a valuable opportunity to reduce the impacts of climate change on agriculture and enhance farmers' resilience (Jiri, 2020).

Africa is one of the regions most impacted by climate change, as the majority of Africans depend on agriculture for their livelihoods (UNEP, 2020). African countries are facing challenges such as unpredictable rainfall, rising temperatures, and new pests and diseases. Despite these challenges, the use of Climate Information Services (CIS) provides an opportunity for African farmers to adapt their farming practices to the changing climate conditions and improve agricultural productivity (ECA, 2019). The majority of smallholder farmers in sub-Saharan Africa live in communal regions and rely primarily on agriculture for their income. These farmers face numerous external challenges, with climate change emerging as a major threat in recent years (Fellman, 2012; World Bank, 2019).

In Africa, including Ethiopia, approximately ten countries have created detailed, high-resolution historical meteorological datasets that produce climate information products, which can be easily accessed through a web-based platform. This platform improves services by addressing issues of data quality, availability, and access, while also promoting stakeholder engagement and usage. The newly introduced data products enable the assessment of climate risks at a local level and provide significant opportunities for supporting research and practical applications (Dinku et al., 2017).

The provision of climate information services (CIS) in Ethiopia shows a significant gap interms of improving the livelihoods of farmers, promote sustainable agricultural practices, and contribute to the country's economic growth (Kifle and Woldeamlak, 2015).

The Sidama region, as part of country due to various factors also less benefited from climate information services (CIS) besides poor performance of management of agricultural practices. Like many areas in the country and across the continent, the Sidama region has a substantial population of smallholder farmers who depend on rain-fed agriculture; however, the practices and use of climate information services (CIS) are limited.

Several studies have evaluated the status of climate information. For instance, Mudombi and Nhamo (2014), Dinku et al (2014), Oyekale (2015), Adugna and Mekonnen (2019), Belay and Babulo (2020)Abate and Worku (2021), Abebe and Asfaw (2021), are some of them. Mudombi and Nhamo (2014) and Coulibaly et al (2017) studied using descriptive analysis to examine access to weather forecast in

Zimbabwe and Rwanda respectively, Oyekale (2015) utilized probit models to investigate the factors that account for access and utilization of extreme climate forecast in Sub-Saharan Africa. However, since the outcomes of the studies are specific to individual countries and due to the heterogeneous nature of the countries, the parameter estimates have limited significance in another country.

In Ethiopia, Dinku et al (2011) noted that, despite the presence of CIS, effective access and utilization are still limited. Some studies have focused on the technical aspects of CIS, such as system design and functionality (Asfaw et al., 2016), while others have investigated farmers' awareness and perceptions of these services (Nigus et al., 2020). Additionally,research by Seneshaw et al (2022) revealed that only 10% of districts and 18% of farmers have access to Climate Information Services (CIS), even though these services have been available for a considerable time. There is a need for further research to better understand the local status of CIS, especially regarding the relationship between providers and users, which remains insufficiently explored.

There is a critical need for further research on Climate Information Services (CIS) and the factors influencing their utilization among smallholder farmers in the Sidama region of Ethiopia, where existing literature on this topic is scarce. Additionally, while there is some information on access, determinants, and usage of CIS for agricultural activities in Ethiopia, significant methodological and empirical gaps remain.

First, there is need for studies that specifically explore the access, effectiveness, and determinants of CIS in the Sidama region. Also there is a need for more longitudinal research to evaluate the long-term impacts of Climate Information Services (CIS) on the livelihoods of smallholder farmers. Additionally, the application of mixed methods approaches is currently limited. While surveys, case studies, and experiments are frequently used to investigate farmers' access to and utilization of CIS, there is a call for more studies that incorporate mixed methods. Integrating various research approaches can provide a more thorough understanding of the issues involved.

Overall, the existing information regarding the status of Climate Information Services and their influencing factors of utilization among smallholder farmers in the Sidama region is inadequate. By addressing these gaps and challenges, it is possible to improve farmers' ability to adapt to climate change, reduce the adverse effects of climate-related risks, and foster the creation of more effective interventions aimed at increase productivity.

1.3. Objectives of the study

1.3.1. General Objective

➢ To assess the status of climate information service and factors affecting its utilization among smallholder farmers in Sidama region.

1.3.2. Specific objectives of the study

The specific objectives of the study were the followings:

- Asses smallholder farmers access and use of climate information services in study area;
- Analyze the effectiveness of climate information services in farm management decisions;
- Examine determinants of utilization of climate information services among smallholder farmers in study area.

1.4. Research questions

The research questions for this study were as follows:

1) What is the level of access to and utilization of climate information services among smallholder farmers in the study area?
2) How are climate information services applied in farm management decisions by smallholder farmers in the study area?
3) What factors influence the utilization of climate information services among smallholder farmers in the study area?

1.5. Significance of the study

Unpredictable climate variables expose smallholder farmers in Africa to various uncertainties that threaten food and water security, income, and health. This situation has impeded development efforts by redirecting resources originally planned for growth toward relief and recovery efforts. This study is significant for several reasons.

First, it provides insights into the current status of Climate Information Services (CIS) and their use among smallholder farmers in the Sidama region. Second, it identifies the factors that influence access to and utilization of these services, offering valuable information for policy interventions aimed at strengthening farmers' resilience to climate change. Third, it contributes to the existing literature on climate information services in Ethiopia. Additionally, the findings enhance the understanding of the determinants affecting the use of these services and their application in agricultural practices, serving as a reference for future research on this topic.

1.6. Scope of the study

This study focused thematically on assessing the status of Climate Information Services (CIS) and its determinants among smallholder farmers, utilizing both primary and secondary data. Geographically, the research was conducted in the Sidama regional state of Ethiopia, specifically within three agroecological woredas: *Dale (woinedega*/midland), *Lokabaya* (*kola*/lowland), and *Arbegona (dega*/highland). These areas were chosen to represent similar agroecological zones within the region. Including all woredas in the study would have made the research more complex, costly, and time-consuming. Therefore, the researcher conducted an in-depth investigation into the utilization of CIS by smallholder farmers in these representative area.

Additionally, the study was methodologically bounded. It employed a descriptive and explanatory research design, utilizing a mixed-methods approach. The researcher gathered both qualitative and quantitative data through various data collection tools , and also study was conducted from September, 2023G.C to October 2024G.C.

1.7. Limitation of the study

The study focused on the status of Climate Information Services (CIS) and the factors influencing their use among smallholder farmers in the Sidama region. However, capturing direct information from farmers was constrained by language translation issues during data collection, nevertheless questionnaires translated correctly and collected data accordingly. Financial limitations and time constraints restricted the research to three woredas, six kebeles, and smallholder farmers engaged in agricultural activities. Adverse weather conditions also complicated transportation during data collection; nevertheless, the researcher utilized alternative methods to gather relevant data effectively.

Gathering organized and up-to-date secondary data proved to be particularly difficult due to inadequate record-keeping practices. Another significant challenge was accessing smallholder farmers, especially those in remote regions. To facilitate access and promote participation, the researcher worked closely with local agricultural extension officers and community leaders, while also utilizing existing farmer networks and associations. Ensuring the quality and accuracy of self-reported data was problematic, as some respondents had difficulty recalling details accurately, which could introduce bias influenced by local conditions. To mitigate this, the researcher provided clear guidance, employed visual aids, and cross-checked responses against objective records.

Logistical challenges, such as transportation, accommodation, and coordination for researcher during data collection, also complicated fieldwork across the widely dispersed Sidama region. The researcher strategically planned field visits, relied on local contacts, and established efficient data collection protocols to overcome these obstacles. Engaging with key stakeholders, including government agencies and NGOs, to gain insights into the broader CIS landscape was sometimes hindered by scheduling conflicts and bureaucratic barriers. Nonetheless, the researcher persisted, conducting multiple outreach efforts and leveraging professional networks to secure the necessary cooperation. Despite these challenges, the researcher successfully gathered data and took deliberate steps to address the encountered limitations.

1.8. Organizations of the study

This study was organized into five chapters. Chapter one served as the introduction, outlining the background, problem statement, objectives, research questions, scope, limitations, and significance of the research. Chapter two featured a literature review that presents a conceptual overview, theoretical frameworks, empirical studies, and an analysis of factors affecting access to and utilization of climate information services among smallholder farmers, along with a conceptual framework. Chapter three explained the research methodology and describes the study area. Chapter four presents and discusses the study's findings. Finally, chapter five provided a summary of the research, drawn conclusions, and made recommendations.

CHAPTER TWO

2. REVIEW OF RELATED LITERATURES

2.1. Conceptual Literature Review

2.1.1. Definitions and Concepts of Climate Information Services.

Climate: In its most precise definition, climate is commonly referred to as the average weather, or more accurately, as a statistical representation of average values and variations of related factors over long periods, which can range from months to millions of years. The World Meteorological Organization (WMO) generally utilizes a 30-year time frame for averaging these variables (WMO, 2014). Key factors include surface measurements like temperature, precipitation, and wind. More broadly, climate encompasses the overall state of the climate system, including its statistical characteristics (IPCC, 2022).

Climate Change is referred to as alterations in the composition of the global atmosphere that may be ascribed directly or indirectly to human activities, and which is in addition to natural climate variability observed over extended time periods (IPCC, 2021).

Climate information: it encompasses data related to temperature, wind, humidity, precipitation, sunlight hours, and other related factors. It is essential to distinguish between climate, which refers to long-term weather patterns or "average weather," and weather, which pertains to conditions over a short duration. Climate information can be obtained through various methods, combining both traditional knowledge and scientific data. This information can be integrated with different services to help individuals effectively utilize it to enhance their livelihoods in sectors such as health, agriculture, energy, and water management. Climate data includes long-term projections spanning decades, multi-decadal, and centennial time frames, along with short-term forecasts, such as daily, monthly, and seasonal predictions (Wilkinson et al., 2015; Singh et al., 2016).

Climate services: climate services cover the transformation of climate-related data together with other relevant information into tailored products such as projections, forecasts, information, trends, economic analyses, assessments (including technology assessments), advice on the development of best practices and evaluation of solutions and any other services in relation to climate that can be used for society as a whole (street, et al 2015). They also noted that climate service providers must have access to climate data and information that supports decision-making processes. Effective communication between the provider and the recipient, along with reliable and timely access to information, is essential. Climate services involve delivering climate information in a way that is tailored to specific local livelihood systems, such as mixed crop and livestock farming (Oxfam, 2015).

Climate Information Services (CIS): refers to the organization and dissemination of climate data designed for specific users. These services are essential for Africa and Ethiopia in effectively tackling the challenges presented by climate change, particularly in vulnerable sectors like agriculture. By improving management strategies in response to weather variability, the agricultural sector can reduce risks associated with infrastructure, communication, and market access through the utilization of CIS (Tadesse et al., 2022). CIS includes the provision of various weather and climate products or advice that aid decision-making for individuals or organizations (Mills et al., 2016).

Access to climate information services for farmers refers to their capability to obtain and use weather and climate data through various channels. By supplying smallholder farmers with meteorological and climate information, CIS can enable them to make informed decisions regarding their agricultural practices, thereby enhancing their resilience and productivity (Mekonnen et al., 2018; Tesfaye et al., 2019).

2.1.2. Global perspective of Climate information services

Climate change is a global challenge that affects various sectors, especially agriculture. Smallholder farmers, who primarily rely on rain-fed agriculture, are particularly vulnerable to its impacts. Climate Information Services (CIS) are increasingly recognized as essential tools that give these farmers access to weather and climate data, allowing them to make informed decisions about their agricultural practices and improving their resilience and productivity (Gebrehiwot et al., 2017).

Climate Information Services (CIS) are acknowledged as crucial resources for improving farmers' resilience and productivity in the face of climate change. CIS includes the dissemination of meteorological and climate-related information to farmers through multiple channels, including radio, television, mobile devices, and community gatherings. Historical data, monitoring data, and forecast-based information can all be found in CIS. The provision of CIS is predicated on the idea that farmers possess information and are competent users of it when making decisions. Furthermore, according to WMO (2014), CIS can assist decision makers in anticipating and responding to the effects of climate change. By incorporating stakeholders, utilizing suitable access channels, and attending to user demands, CIS creates, translates, and distributes information for decision-makers that is pertinent to climate change and other issues (Brasseur and Gallardo, 2016; WMO, 2011). Thus, CISs have evolved into a thorough method for utilizing technical meteorological and climate data to lower risk and increase resilience (Carr and Onzere, 2017). Programs that increase the use of climate data have received significant funding from national governments, large donors, and scientific consortium including the World Bank, CGIAR(Consultative Group on International Agricultural Research), and the World Meteorological Organization (Vaughan and Dessai, 2014). Global spending on CIS exceeded US$24 billion in 2014 alone, almost matching the amount spent on meteorological services (Georgeson et al., 2017).

2.1.3. Climate information services in Africa.

In the African continent, climate change has serious negative effects that include flooding, irregular rainfall patterns, rising sea levels, droughts, soil erosion, and decreased crop productivity (Dube et al. 2016; Coulibaly et al. 2020). Millions of people's livelihoods are at risk throughout Africa as a result of these consequences, which worsen food insecurity and poverty (Atiah et al. 2022). This has made it necessary to look for ways to lessen climate change's consequences throughout Africa (Pachauri et al. 2014). Climate information services can help African farmers become more resilient to the increasing risks posed by climate change (Baffour et al. 2022).

African nations depend significantly on rain-fed agriculture, making them especially vulnerable to the impacts of climate change. Recent research has concentrated on climate information services, particularly in the Sahel region (Dayamba et al., 2018; Diouf et al., 2019). Numerous cowpea and sesame farmers in northern Burkina Faso are eager to invest in climate information services, which encompass long-term climate data, seasonal forecasts, daily updates, and agricultural consultations (Ouedraogo et al., 2018). In Mali and Senegal, a "participatory integrated climate services for agriculture" approach has empowered farmers to make informed strategic decisions before the planting season by improving their understanding of local climate conditions. Consequently, the role of CIS in mitigating the effects of climate change on agriculture is becoming increasingly important. Farmers use CIS to decide on the most suitable crops to plant, the best timing for planting, and when to apply irrigation. However, effectively utilizing CIS in farm management necessitates prior access to these services (Mekonnen et al., 2019).

Despite the abundance of available knowledge, many National Meteorological and Hydrological Services (NMHSs) in Sub-Saharan Africa function with outdated and ineffective telecommunications networks, resulting in infrequent and insufficient climate information services. This situation hampers the distribution of observations and products, especially in rural areas. Moreover, inadequate infrastructure restricts NMHSs from fully utilizing advancements in science and technology (Dorsouma, 2015; Harvey et al., 2019). As a result, although these services could support climate change adaptation, there is limited evidence of their integration into agricultural systems throughout Sub-Saharan Africa (Vaughan et al., 2016).

2.1.3.1 Climate information services in Ethiopia

According to the Federal Democratic Republic of Ethiopia (FDRE, 2017), Ethiopia is among the countries in Sub-Saharan Africa most vulnerable to the impacts of climate change and climate variability. Climate change represents a significant threat to livelihoods and food security in the country. The effectiveness of Climate Information Services (CIS) for smallholder farmers in Ethiopia is heavily dependent on their accessibility. Severe weather events and variations in precipitation adversely affect household welfare, agricultural GDP, and overall national economic output, particularly within the agricultural sector. The Notre Dame Global Adaptation Initiative (ND-GAIN, 2017) places Ethiopia among the top 10% of countries most at risk from climate impacts. Consequently, Weather and Climate Information Services are increasingly regarded as vital for enhancing resilience and adapting to the effects of climate change in agriculture and other climate-sensitive areas (Naab et al., 2019; Hansen et al., 2019).

For centuries, many rural communities in Ethiopia's dry lands have depended on indigenous weather and climate forecasts to manage climatic challenges (Tilahun, 2020). However, the growing unpredictability of climate change is exposing these communities to extreme conditions, complicating their ability to respond effectively (ALP, 2017). The National Meteorological Institute (NMI) issued the first scientific climate forecast in Ethiopia in response to the El Nino phenomenon in 1997 (Wolde-Georgis et al., 2000). The NMI operates numerous weather stations, with approximately 1,300 ground stations and over 157 automatic weather stations across the country (NMI, 2017). It offers analyzed weather reports and forecasts across different time scales, including daily, monthly, decadal, and seasonal. The Federal Agro-meteorological Technical Task Force, formed in 2016 and comprising the Ministry of Agriculture and Natural Resources (MoANR), the National Meteorological Institute (NMI), the Ethiopian Institute of Agricultural Research (EIAR), and the Agricultural Transformation Agency (ATA), is tasked with transforming weather data into agro-meteorological advisories (Tesfaye et al., 2019).

Despite these initiatives, several challenges persist, including an uneven distribution of weather stations, issues with data quality, gaps in observations, and obstacles to data access and usage (Dinku et al., 2014). These issues have notably restricted the effective use of available climate data. Additionally, the placement of weather stations is often skewed, with most situated in urban areas along major roads, which leaves many lowland regions inadequately served (Dinku et al., 2011). This situation has created significant barriers to the availability, accessibility, and utilization of Climate Information Services (CIS) in disadvantaged rural communities.

2.1.3.2 Sources of climate information services

According to World Bank (2016) report states that the private sector provides 27% of climate information services, with government agencies providing 21%, non-governmental organizations (NGOs) and community-based organizations (CBOs) were providing 21%, research institutions and academia providing 17%, and international organizations providing 14%.

Several regional sources of Climate Information Services in Africa include the National Meteorological and Hydrological Services (NMHS), the African Centre for Meteorological Application and Development (ACMAD), the Global Framework for Climate Services (GFCS), and the Intergovernmental Authority on Development(IGAD) Climate Prediction and Application Centre (Muema et al., 2018). The Global Framework for Climate Services(GFCS), led by the World

Meteorological Organization (WMO) and the United Nations High-Level Task Force, aims to provide climate information, interpretation, and advisory services to assist in climate risk management. Based in Niger, ACMAD delivers short-term climate forecasts and information about extreme weather events across the continent. The IGAD (intergovernmental authority on Development) Climate Prediction and Application Centre (ICPAC) focuses on early warning forecasts and climate monitoring for countries in the Great Horn of Africa. In collaboration with National Meteorological Institutes (NMIs) and the Consultative Group on International Agricultural Research (CGIAR), Global Framework for Climate Services(GFCS) and Climate Change Agriculture and Food Security program (CCAFS) offer climate services that enhance food security, disaster preparedness, and overall health in countries like Malawi and Tanzania (Kadi et al., 2011; Singh et al., 2016).

The Ethiopian NMI is dedicated to providing accurate meteorological services and information, including daily, monthly, and seasonal weather forecasts and climate bulletins for users nationwide. It also produces agrometeorological bulletins that contain weather data, rainfall intensity maps, weather outlooks, and assessments of vegetation conditions and their agricultural impacts. Climate data is gathered through a network of weather stations across Ethiopia, which are gradually increasing in number, though their distribution is still uneven (Dinku et al., 2011). Despite the available records, many suffer from data gaps, quality issues, and accessibility challenges. The NMI regularly distributes reports to NGOs throughout the country, containing information on precipitation distribution and weather forecasts (Cochrane and Singh, 2017).

While indigenous climate forecasts are the primary source of agricultural information for many smallholder farmers in Sub-Saharan Africa, accessing this information presents several challenges. Issues include the loss of traditional indicators, such as specific bird species and trees due to deforestation, the passing of older generations, and a lack of systematic documentation (Changa et al., 2010). Additionally, because of significant climate variability over time, local populations have increasingly lost trust in indigenous forecasts and have begun relying on scientific seasonal forecasts to adapt to climate change (Tall et al., 2018). Both indigenous and scientific climate projections have their own strengths and weaknesses. Therefore, to enhance farmer adaptation to climate change, it is recommended to combine both types of information (Kirui et al., 2014; Russo et al., 2013).

2.1.4. The role of CIS in smallholder farming communities

Climate Information Services (CIS) have become essential for making informed adaptation decisions. In practice, CIS are designed to enhance agricultural livelihoods by addressing climatic risks (Singh et al., 2016). Vaughan and Dessai (2014) note that the primary goal of CIS is to provide timely and customized climate forecasts to help manage climate-related risks, thereby safeguarding the livelihoods and assets of farmers.

Climate Information Services (CIS) provide crucial data that includes weather forecasts, early warnings, and seasonal predictions. This information helps users better understand weather and climate patterns, leading to more informed decision-making and economic benefits. These advantages can take the form of direct financial gains, such as higher agricultural yields or reduced losses, as well as non-economic benefits, like fewer injuries or positive environmental effects, including lower greenhouse gas emissions. Both types of benefits can be measured to evaluate the overall socioeconomic impact of CIS. Investing in weather and climate services (WandCS) enhances the quality of information, resulting in improved forecasts, early warnings, and seasonal predictions for users. As a result, users gain economic advantages as this information influences their decisions and actions positively (WMO, 2015).

Climate services encompass the gathering, organizing, processing, and dissemination of weather and climate data, including variables like wind speed, temperature, and precipitation. These services function as decision support tools that convert climate data into actionable advisory services, assisting individuals and organizations in their decision-making processes (Tall et al., 2018). Smallholder farmers can utilize this information to make educated choices regarding crop selection, planting times, harvesting schedules, and marketing strategies. Numerous studies have highlighted the importance of CIS as a fundamental strategy for enhancing agricultural productivity and increasing farmers' adaptive capacity (Muema et al., 2018; Djido et al., 2021; Seneshaw et al., 2022). By giving smallholder farmers access to weather and climate data so they may make educated decisions about their agricultural practices, climate information services (CIS) have gained attention as a possible tool to boost their resilience and production (Gebrehiwot et al., 2017). Services, such as when to sow, plant, apply fertilizer, water, harvest, and spray pesticides and herbicides; can assist farmers in making better cropping decisions and maximizing many aspects of their production systems (Balaji and Craufurd, 2011). All of these factors contribute to better resilience and adaptation planning by lowering production costs, reducing losses, and maintaining or increasing production (Vaughan et al., 2019; Nidumolu et al., 2020).

Significant progress has been achieved in developing nations in the creation and distribution of climate information services via a variety of media, such as community networks, mobile phones, and radio (Fosu et al., 2018). However, problems like inadequate infrastructure, restricted access to technology, and anticipated reliability still have an impact on how effective these services are (Ndlovu et al., 2020). The adoption and implementation of climate information is also significantly influenced by the socioeconomic environment, cultural norms, and institutional support (Nguyen et al., 2021).

2.2. Theoretical Literature Review

Climate Information Services (CIS) encompass the generation, interpretation, dissemination, and application of climate knowledge and data in decision-making across various societal levels (Vaughan and Dessai, 2014). As climate change continues to pose significant challenges, CIS have gained essential importance, especially for farmers and agricultural decision-makers. Several theories have been developed to understand and analyze the elements influencing farmers' access to and use of Climate Information Services (CIS).

2.2.1. Climate Services Value Chain Theory

The climate services value chain theory, developed by Vaughan and Dessai (2014), posits that climate information services (CIS) involves a sequence of activities, including data collection, processing, product development, delivery, and use. This theory emphasizes the importance of aligning CIS with the specific decision-making contexts and information needs of smallholder farmers, as well as the need for continuous feedback and co-production mechanisms to ensure the relevance and effectiveness of the services (Hewitt et al., 2017).

The climate services value chain theory suggests that the effectiveness of CIS is dependent on the integration of various components, including data collection, processing, translation, and dissemination, as well as the engagement and feedback from end-users (Vaughan and Dessai, 2014). The theory emphasizes the need for a user-centered approach in the development and delivery of CIS, ensuring that the information and products are relevant, understandable, and actionable for smallholder farmers.

According to this theory, smallholder farmers are seen as key end-users of CIS, as they often face significant climate-related risks and can benefit from tailored climate information to inform their farming decisions (Vaughan and Dessai, 2014). The theory suggest that the need for co-production of CIS with smallholder farmers to ensure relevance and usability.

In the realm of Climate Information Services (CIS), the climate services value chain theory offers valuable insights for researchers and practitioners to comprehend the specific needs and decision-making situations of smallholder farmers, enabling the design of tailored CIS (Tall et al., 2014). This theory can facilitate the development of collaborative and participatory approaches for CIS, actively involving smallholder farmers in the design, implementation, and evaluation of these services.

The climate services value chain theory has been widely applied to examine CIS for smallholder farmers. Studies show that effective CIS can help these farmers manage climate-related risks, increase agricultural productivity, and strengthen their resilience to climate change (Hansen et al., 2019; Tall et al., 2014).

However, one limitation of the climate services value chain theory is its focus on the supply side of CIS, which may overlook broader social, institutional, and environmental factors that influence smallholder farmers' demand for and utilization of climate information. Additionally, the theory might not adequately address the challenges related to scaling up and sustaining CIS initiatives over the long term. While researcher find the climate services value chain theory useful for understanding how to convert climate information into practical services for smallholder farmers, enhancing it with a focus on the wider factors affecting demand and use, as well as the sustainability of these interventions, could provide a more comprehensive framework.

2.2.2. Social-Ecological Systems Theory

The social-ecological systems (SES) theory, introduced by Elinor Ostrom in 2009, offers a framework for analyzing the intricate and dynamic relationships between social and ecological systems. This theory is particularly relevant to Climate Information Services (CIS) as it emphasizes the importance of various social, institutional, and environmental factors that affect the accessibility, utilization, and effectiveness of CIS. Key elements to consider include governance structures, resource availability, stakeholder interactions, and the institutional frameworks that influence the provision and adoption of CIS (Meadow et al., 2015).

According to SES theory, the effectiveness of CIS is influenced by the interactions among different levels of social and ecological systems, including individual users such as smallholder farmers, community organizations, and broader policy frameworks (Ostrom, 2009). It underscores the necessity of assessing the governance and management of CIS within a wider social-ecological context, taking into account factors like resource availability and stakeholder dynamics. This approach assists researcher and practitioners in identifying the barriers and facilitators that impact smallholder farmers' access to and use of climate information, including social and institutional aspects that affect the credibility and relevance of CIS, as well as environmental conditions that influence the availability of climate data (Jost et al., 2016).

In the context of CIS, SES theory suggests that smallholder farmers function within a larger social-ecological framework, where their decisions regarding climate information are influenced by factors such as access to resources, institutional support, and cultural norms (Ostrom, 2009). Research indicates that effective CIS initiatives must consider the broader social-ecological landscape and address the diverse needs and challenges faced by smallholder farmers (Carr and Onzere, 2018; Tall et al., 2014).

The theory also underscores how social and institutional dynamics contribute to the trust and credibility of CIS (Ostrom, 2009). If farmers perceive CIS information as unreliable, incompatible with their traditional knowledge, or misaligned with their local context, they may be hesitant to trust it. Furthermore, the institutional and policy environment plays a crucial role in facilitating or obstructing effective CIS delivery and utilization. Barriers such as insufficient institutional support, lack of funding, or inadequate policy frameworks can hinder smallholder farmers' access to CIS.

Additionally, SES theory highlights the impact of sociocultural and gender-related factors on CIS use (Ostrom, 2009). Smallholder farmers, especially women, may encounter obstacles in accessing and utilizing CIS due to cultural norms, power imbalances, or social inequalities.

One of the advantages of the SES theory is its ability to capture the complexity and interrelationships among the factors that affect the effectiveness of Climate Information Services (CIS). However, a potential drawback is its lack of clear guidance on how to design and implement CIS interventions. Additionally, the theory may not sufficiently consider the specific challenges faced by marginalized groups, including women and disadvantaged smallholder farmers. In summary, while the SES theory provides a strong basis for understanding the broader context of CIS, it could be improved by more explicitly addressing issues related to equity, power dynamics, and the unique needs of vulnerable populations such as smallholder farmers.

2.2.3. Adaptive Capacity Theory

Adaptive capacity theory, formulated by Neil, 2006 examines how individuals, communities, and systems can adjust to changing environmental conditions, particularly climate change. This theory is significant in the context of Climate Information Services (CIS) as it underscores the necessity for smallholder farmers to enhance their ability to use climate information in their decision-making and adaptation efforts. Key elements of these capacities include access to resources, knowledge, skills, social networks, and autonomy in decision-making (Haile et al., 2019).

According to this theory, the adaptability of smallholder farmers to climate change is shaped by various factors, such as resource availability, knowledge and skills, social connections, and institutional support (Adger, 2006). It emphasizes the importance of empowering farmers to understand, apply, and act on climate information to bolster their resilience and adaptive capacity. CIS can significantly enhance this capacity by equipping farmers with the information and tools necessary for informed decision-making. Research shows that CIS improves farmers' comprehension of climate risks, enabling them to devise and execute suitable adaptation strategies, thus increasing their resilience to climate change (Nyasimi et al., 2017; Roudier et al., 2014).

In relation to CIS, adaptive capacity theory helps researchers and practitioners identify the specific skills and resources smallholder farmers require to effectively leverage climate information, such as technical expertise and access to resources (Tall et al., 2014). This understanding can guide the design and implementation of CIS to better support farmers in adapting to climate challenges.

One strength of adaptive capacity theory is its emphasis on empowering end-users, like smallholder farmers, to actively engage with climate information. However, a potential limitation is its focus on individual capacities, which may neglect the broader institutional and systemic challenges that can impede effective CIS utilization.

Overall, adaptive capacity theory offers valuable insights into the needs and limitations of smallholder farmers regarding CIS, but it could benefit from a more thorough exploration of the interactions between individual, community, and institutional factors that influence adaptive capacity.

2.2.4. Technology Acceptance Model

The Technology Acceptance Model (TAM) is frequently used to examine how farmers adopt and apply climate information services (CIS) in their agricultural practices. TAM posits that two key factors influencing the adoption of technology are its perceived usefulness and ease of use. In the context of CIS, perceived usefulness refers to farmers' beliefs about the service's ability to enhance their farming techniques, while perceived ease of use pertains to how user-friendly the service is. Research conducted worldwide has confirmed the applicability of TAM in understanding farmers' adoption of CIS (Adhikari et al., 2018; Mekonnen et al., 2019).

2.2.5. Theory of social capital

Social capital theory (SCT) provides a valuable framework for examining the ways in which social networks and relationships influence farmers' access to Climate Information Services (CIS). According to SCT, involvement in social groups, such as associations and cooperatives, improves farmers' access to important information and resources. Trust and reciprocity play significant roles in both accessing and utilizing CIS, particularly when relying on informal information sources like other farmers or local officials (Urgessa et al., 2019). Many studies have utilized social capital theory to explore how farmers obtain access to climate information services.

2.2.6. Diffusion of innovation theory

The study examined how farmers adopt and disseminate Climate Information Services (CIS) through the framework of the Diffusion of Innovation Theory (DOI). According to DOI, the characteristics of the innovation, the traits of the adopters, and the communication channels employed to disseminate the innovation all influence its adoption. The quality and relevance of the provided information are viewed as the attributes of the innovation, while the characteristics of the adopters encompass factors such as income, education level, and access to resources. CIS utilizes both formal and informal communication pathways, including weather stations, extension agencies, community leaders, and fellow farmers, to facilitate its dissemination (Mekonnen et al., 2019).

2.2.7. Systematic innovation model

The Systematic Innovation Model (SIM) was used to understand the development and diffusion of CIS. SIM suggests that innovation is a systemic process that involves several stages, including need identification, idea generation, prototype development, testing and evaluation, and diffusion and adoption. In the CIS context, SIM suggests that the development and dissemination of CIS should be a collaborative process involving various stakeholders, including farmers, researchers and decision makers. Additionally, SIM recommends that the adoption and distribution of CIS be customized to the requirements and preferences of various user groups, including farmers (Speranza et al., 2010).

Although there are shortcomings, theoretical frameworks aid in understanding farmers' perspectives on CIS. Since most studies have been carried out without a theoretical framework, more research is required to examine the variables impacting access and usage, cultural elements forming attitudes, and the influence on productivity and livelihoods in the Sidama area of Ethiopia. This study closes these gaps and establishes a theoretical basis for them.

2.3. Empirical Literature

Numerous global researches have been carried out to investigate the effects of CIS on agriculture. For instance, Adhikari et al. (2018) looked into the variables that affect farmers' access to CIS in Nepal and discovered that radio broadcasting and mobile phone availability were positively correlated with farmers' access to CIS. However, a number of factors, including infrastructure, routes for distribution, literacy level, and socioeconomic characteristics, affect access to Climate Information Service (Mekonnen et al., 2018).

2.3.1. Access to and Use of Climate Information Services in Africa and Ethiopia

The Global Framework for Climate Services was established in 2009 and has been operational since 2012 with a mission to facilitate timely access to climate services (Antwi et al., 2021). Access to CIS reduces the impacts of climate change and increase farmers' ability to cope with climate change and unpredictability (ECA, 2021). Access to weather forecasts can help farmers undertake farming activities effectively (Guido et al., 2020; Djido et al., 2021). Furthermore, Access to effective climate information services is expected to support climate-sensitive sectors cope better while improving resilience and livelihoods in Africa (Serra and Mckune, 2016). CIS is more available in East and Southern Africa than in Central and West Africa (Anni, 2019). However, the availability of data may not necessarily lead to access (Dinku et al., 2011).

Access to climate data and early warning systems is essential for achieving sustainable agricultural practices in the context of climate change (Mudombi and Nhamo, 2014). This information empowers farmers to make well-informed decisions, improving their efficiency and facilitating the adoption of effective adaptation strategies. Timely and accurate climate forecasts strengthen farmers' ability to cope with the adverse effects of climate change and contribute to increased agricultural productivity and food security (Hammer et al., 2001; Hansen, 2002).

According Speranza et al. (2010), Climate information Services interventions helped farmers in sub-Saharan Africa become more knowledgeable and conscious of climate change. In a similar vein, CIS treatments helped farmers make better decisions and were less vulnerable to climate change (Urgessa et al.2019). In Ghana, due to infrastructure and technology limitations, smallholder farmers have restricted access to climatic information. The attempts to enhance farmers' access to timely weather predictions and notifications using mobile phone-based services had showed promise (Fosu et al., 2018). The study conducted in Kenya, different regions have different levels of access to climate information services, and with some having better coverage thanks to community outreach initiatives and radio broadcasts (Kiplagat et al. 2019).

A few scholarly works have documented the benefits and utility of CIS in enhancing smallholder farmers' ability to adapt. For instance, Mubiru et al.'s (2019) study conducted in Uganda discovered that farmers' crop decisions were positively impacted by timely access to climatic information, resulting in higher yields and revenues. Comparably, a study conducted in Kenya, demonstrated the important effect that CIS plays in improving farmers' readiness for risks and variability connected to climate change, which in turn boosts agricultural productivity (Ouma et al.,2018).

This study employed a survey method to gather data from 200 farmers in northern Ethiopia to gain insights into their views on climate change and coping strategies. The results indicated that access to climate information services played a significant role in the farmers' adoption of adaptive measures. Although the study did not concentrate specifically on climate information services, it provides important insights into the agricultural practices within the region (Van and Gebrehiwot, 2013).

The use of CIS was examined in the study through focus groups and questionnaires, and it was discovered that CIS is positively correlated with farmers' adoption of water and soil conservation techniques. Researcher looked the connection between CIS and the Oromia region of Ethiopia's adoption of soil and water conservation measures in a different study (Urgessa et al., 2019).

The local intermediary institutions, such as community organizations and agricultural services are very important in assisting with the local interpretation and dissemination of climate data. It was discovered that these intermediary structures were crucial in bridging the gap between end users and CIS providers, which in turn affected Ethiopia's degree of access to and utilization of climatic information services (Tefera et al. 2020). According to Abebe and Asfaw's (2021) localizing and designing climate information with users in mind makes it more relevant and easily accessible, which improves its usefulness for agricultural decision-making and adaptive methods. the availability of dependable, up-to-date CIS facilitates its efficient application in shaping Ethiopia's adaptation plans and climatic variability and change decision-making procedures (Lemmy et al,. 2020).

Farmers use CIS in farm decisions making to reduce the impact of climate change on agricultural production (Patt et al., 2017). High-quality data and good access may not ensure the effective use of climate information (Dinku et al., 2011). Despite growing access to CIS in Africa, the use for adaptation is remaining very low (CIASA, 2015). Therefore, enhancing user awareness is essential. Limited accesses to CIS, lack of trust between producers and users, and poor capacity to interpret and apply information to agricultural needs are the prime factors influencing the use of CIS in Africa (Muema et al., 2018). Further, socio-economic factors, including land availability, high illiteracy levels, access to credit, and market-constrained African farmers being the CIS user in decision-making (Klopper et al., 2006; Coulibaly et al., 2017).

2.3.2. Channels for Disseminating Climate Information

The methods used to deliver climate information services (CIS) are crucial for effective communication regarding these services. According to the World Bank (2016), these channels must be easily accessible and user-friendly, providing accurate, timely, affordable, and reliable information in languages that are suitable for users. The manner in which climate information is shared can greatly influence farmers' access to and use of CIS. The key modes of CIS distribution include newspapers, bulletins, radio, television, trained intermediaries, short message service (SMS), internet, mobile phone applications, digital platforms, farmer organizations, and agricultural extension agents are widely used at the global level (WB, 2016). Radio is the most preferred dissemination channel among farmers and pastorals in developing countries (Muema et al., 2018; Seneshaw et al., 2022; Hampson et al., 2014).

Recent studies revealed that smallholder farmers are interestingly using mobile phone services such as SMS, calls, voicemail, or the Internet to receive weather information (Rosaine and Janvier, 2021). In Ethiopia, different platforms such as ‘’Lersha’’ and ‘’Digital Green’’ are also providing climate information and agro-advisory services to farmers using extension agents in a digitized way (CGIAR, 2021). This is very challenging and rarely acceptable in rural Ethiopia due to the low literacy rate and mobile access (Seneshaw et al., 2022). Moreover, farmers in rural areas prefer indigenous information to scientifically generated information (Muema et al., 2018).

2.3.3. Applying Climate Information Services in Agriculture in Africa and Ethiopia.

According to Funk et al. (2015) reported the use of Climate Hazards Group Infrared Precipitation with Stations (CHIRPS), a novel environmental record for tracking extreme weather events in Africa, in the application of climate information services for agricultural activities in the continent. CHIRPS is a data-set that offers high-resolution data on rainfall patterns in Africa by integrating satellite and ground-based rainfall observations. The study demonstrates how agricultural planning and decision-making may be supported by using this data collection to identify areas at danger of flooding or drought.

Sub-Saharan Africa, which is particularly vulnerable to climate change, has seen the launch of various climate information service (CIS) initiatives. Research by Levy et al. (2015) in Malawi found that the use of CIS resulted in increased investments in climate-resilient farming methods. This led to improved crop yields, higher household incomes, and reduced vulnerability to severe weather events.

Farmers who accessed climate information services were more inclined to adopt climate-smart practices such as crop diversification and conservation agriculture (Diop et al., 2019). The study also indicated a positive correlation between access to CIS, increased crop yields, and decreased crop losses due to extreme weather.

Kihupi et al. (2018) demonstrated that access to climate information services is positively associated with the adoption of climate-smart agricultural techniques, including conservation agriculture and rainwater harvesting. Additionally, this study showed that using climate information services significantly lowered farmers' risk of crop failure and bolstered their resilience to climate variability.

Climate information services are essential for enhancing farmers' understanding of climate change and variability, as well as supporting their decision-making processes. Farmers utilizing CIS were more likely to embrace climate-smart practices, such as crop diversification and soil and water conservation (Adugna and Mekonnen, 2019).

According to Haile et al. (2017), having access to Climate Information Services (CIS) was linked to better food security and higher household income. The study also discovered that CIS significantly decreased farmers' susceptibility to crop failures and increased their resistance to climate unpredictability.

2.3.4. Determinants of access and use Climate Information Service in Africa and Ethiopia.

Numerous studies have been conducted to investigate the factors influencing farmers' access to and use of climate information services across Africa. Kamga et al. (2019) noted that the availability of CIS for rural populations in Cameroon is significantly affected by reliable telecommunications infrastructure, including internet access and mobile networks. Additionally, research in Burkina-Faso revealed that socioeconomic factors such as education and income levels can either facilitate or hinder the use of climate information services (Ouedraogo et al., 2020).

In South Africa's Limpopo River basin, Oyekale (2012) evaluated the factors that impact access to climate forecast sources. The study found that ownership of a television, car, or radio, having land, prior experience with hailstorms and floods, and higher education levels were associated with a greater likelihood of accessing climate forecasts. Conversely, factors such as farming experience, larger household size, extensive farm size, and access to fertile land were linked to a decreased likelihood of accessing these forecasts (Oyekale, 2012). In Baringo County, Kenya, the uptake of seasonal forecasts was hampered by issues such as conflict and insecurity, cultural factors, lack of information, and diversified income sources (Ochieng et al., 2017).

Mekonnen et al. (2019) found that access to CIS in Ethiopia was significantly influenced by factors like income, education, and proximity to meteorological stations. Similarly, Tesfaye and Assefa (2019) identified that access to CIS in Ethiopia was notably affected by age, education, land ownership, and the availability of extension services. These findings underscore the importance of considering socioeconomic factors to improve access to climate information services (CIS) and demonstrate that these variables play a significant role in the effective utilization of CIS.

2.3.5. Challenges of Practices of Climate Information Services

2.3.5.1 Accessibility and Availability

A significant challenge in implementing climate information services is the limited accessibility and availability of these services, particularly for smallholder farmers in remote and under-resourced areas. Factors such as poor infrastructure, low literacy rates, and restricted access to communication technologies can severely reduce the effectiveness of CIS (Tall et al., 2014; Dinku et al., 2018). In many developing regions, the distribution of weather stations and other meteorological infrastructure is often inadequate, leading to incomplete and unreliable data, which hampers the generation of accurate and localized climate information (Dinku et al., 2014). Moreover, the absence of affordable and user-friendly communication methods, such as mobile apps or community-based platforms for information sharing, can hinder smallholder farmers from effectively accessing and utilizing CIS (Jost et al., 2016; Abebe et al., 2018). It is essential to tackle these issues of accessibility and availability to ensure that CIS reach the most vulnerable and marginalized communities, who typically have the highest demand for such services.

2.3.5.2. Mismatch between Information and Users' Needs

Another significant challenge in CIS practices is the mismatch between the information provided and the specific needs and decision-making contexts of smallholder farmers. CIS often fail to address the unique circumstances and priorities of these farmers, leading to a disconnect between the services offered and the farmers' requirements (Lemos et al., 2012; Vaughan and Dessai, 2014). Smallholder farmers may require tailored information on crop-specific climate risks, timing of planting and harvesting, and practical adaptation strategies that align with their local agricultural practices and resources. CIS providers often find it challenging to grasp the complexities of smallholder farming systems and the decision-making processes of these farmers. This can lead to the creation of generic or one-size-fits-all information that fails to meet their specific needs (Jost et al., 2016; Nigussie et al., 2017). To bridge the gap between the supply and demand for climate information, it is crucial to engage more closely with smallholder farmers, incorporating their insights and knowledge into the development and delivery of climate information services (CIS).

2.3.5.3. Institutional and Policy Challenges

Beyond the challenges at the user level, CIS practices also face significant institutional and policy-related barriers. Weak coordination among the various stakeholders involved in the CIS ecosystem, such as meteorological agencies, extension services, and research institutions, can undermine the coherence and effectiveness of these services. Inadequate funding and the lack of clear policy frameworks to support the development, dissemination, and long-term sustainability of CIS can also hinder their scalability and impact. In many developing countries, the institutional and policy environment for CIS may be fragmented, with unclear roles and responsibilities, limited cross-sectoral collaboration, and a lack of dedicated resources for capacity building and service delivery. Addressing these institutional and policy challenges requires a comprehensive approach that fosters stronger coordination, secured funding streams, and the development of enabling policy frameworks to support the effective and sustainable provision of CIS (Dinku et al., 2014; Dorward et al., 2015).

2.4. Conceptual framework

According to Katani (2014), a conceptual framework integrates information and provides direction for gathering relevant data. This study has created a conceptual framework to illustrate the relationship between dependent and independent variables, based on a review of related literature and insights obtained during the research. The framework highlights the factors that influence the use of climate information services (CIS) among smallholder farmers in the study area. Farmers who successfully navigate challenges tend to utilize CIS more effectively, with various studies indicating its positive effects on agricultural productivity.

Key factors affecting access to and use of CIS among smallholder farmers in various regions include economic, demographic, institutional, and individual characteristics, as well as farm-related traits (Ngigi and Muange, 2022; Muema et al., 2018). Timely, accurate, and reliable access to CIS is essential for improving decision-making in agriculture and enhancing adaptation to climate change.

The study is organized around a conceptual framework that clarifies the relationship between independent and dependent variables. The dependent variable is the utilization of CIS by smallholder farmers, while the independent variables encompass education levels, access to credit, participation in social protection initiatives, awareness of available services, communication infrastructure, availability of extension services, gender, age, membership in farmer organizations, infrastructure, dissemination channels, literacy levels, frequency of climate information use, and various socioeconomic factors.

After reviewing the relevant conceptual, theoretical, and empirical literature, the researcher developed the following framework. The accompanying diagram illustrates that the use of climate information services among smallholder farmers is influenced by multiple factors. Anticipated outcomes from effective use of CIS include increased resilience to climate change, improved crop yields, higher income, and enhanced food and water security.

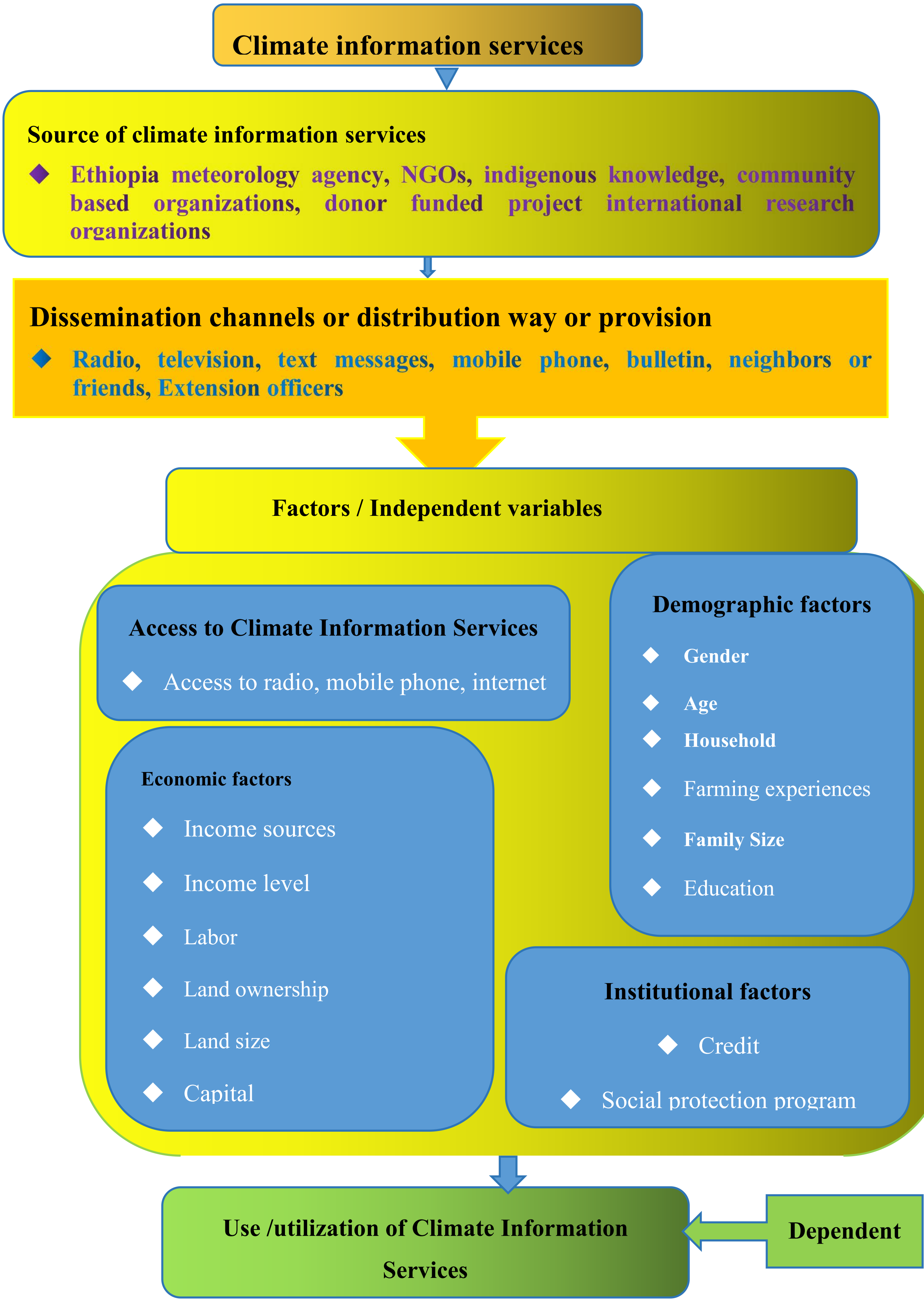

Figure 2.1. Conceptual Framework (Source: Muema et al. 2018, modified by Researcher's, 2024)

CHAPTER THREE

3. RESEARCH METHODOLOGY

This chapter presented the research methodology utilized in this study and provides a comprehensive framework for the research. It includes a thorough description of the study area, as well as the research design, target population, sample size, and sampling techniques. Additionally, it addresses the data collection instruments, the piloting process of these tools, and their validity and reliability. The chapter also outlines the procedures for data collection, the methods employed for data analysis, and the ethical considerations that were taken into account during the research.

3.1. Description of the Study Area

3.1.1 Physical settings

3.1.1.1 Location

The Sidama Region, also known as *Sidamu Qoqqowo*, is a newly formed regional state in southern Ethiopia, having separated from the Southern Nations, Nationalities, and Peoples' Region (SNNPR). Geographically, it lies between 6°12' and 7°17' N latitude and 38°01' to 39°08' E longitude. In terms of its location, Sidama is bordered to the south by the Oromia Region (with a brief stretch sharing a border with the Gedeo zone of the SNNPR), to the west by the Bilate River, which separates it from the Wolayita Zone, and to the north and east by Oromia. The capital of the region is Hawassa, situated 273 km from Addis Ababa, the capital of Ethiopia (SRAO, 2023).

The study was conducted in three specifically selected woredas within the Sidama Region: *Dale* (*woinedega*/midland), *Lokabaya* (*kola*/lowland), and *Arbegona* (*dega*/highland), chosen based on their agroecological characteristics.

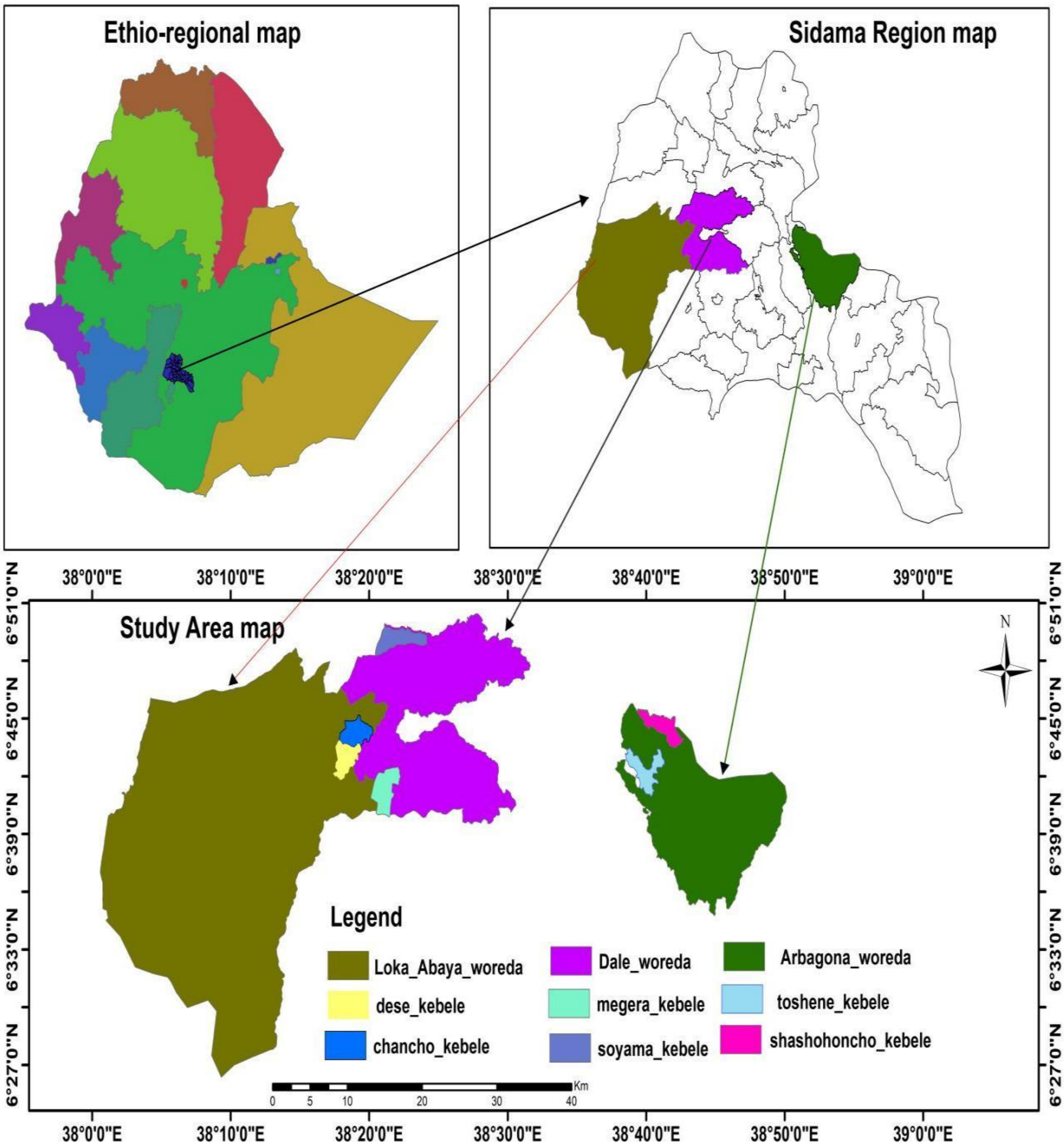

Figure 3.1 Map of the study area (Source: Ethio GIS, 2024).

3.1.1.2. Topography

The Sidama region is characterized by high land, mid and lowland areas. Region encompasses a diverse landscape including mountain ranges, forests, and rivers, ranging from fertile flat lands (with warm to hot temperatures) to highlands (with warm to cool climates). Its total area with 97.71% being land and 2.29% covered by water (Ethiopian Wildlife Conservation Authority, 2010).The elevation of Sidama ranges from 1001 m.a.s.l over the northwestern part of the region to > 3336 m.a.s.l, towards southeastern and the peak at Mt Garamba (Markos, et al. 2023).

3.1.1.3. Climate Conditions of Study Area

The Sidama region has a tropical climate, featuring two rainy seasons: one from March to May and another from September to November. It also experiences two dry seasons, occurring from December to February and June to August. The area is marked by significant rainfall variability and frequent droughts, which impact agricultural productivity. Climatic conditions vary widely across the region, ranging from hot and dry in the lowlands of Loka Abaya to cold and humid in the alpine regions of Hula, Teticha, Bursa, Arbegona, Burra, Daeela, and Aroressa (Elbakidze et al., 2018).

The average annual rainfall ranges from 800 to 1,800 mm, and the mean annual temperature ranges from 16°C to 21°C (Central Statistical Agency, 2013). The region has different agro-ecology which could be grouped into four as Kola, Woinadega, Dega and Wurch on the basis of traditional agroecological categories of Ethiopia. Woinadega Argo-ecology covers larger geographic area of the region followed by Dega and Kola Argo-ecology of the region is confined to the rift valley around the periphery of the region and wurch only limited to smaller around mount Garamba in the eastern part of the region.

3.1.2. Demographic and socioeconomic characteristics

3.1.2.1 Population

As the estimated 2019, the population of the Sidama region was 5,977,000, with an annual growth rate of 2.5% (CSA, 2023). The region has a diverse ethnic composition, with the Sidama people being the majority. Other ethnic groups include the Amhara, Oromo, wolayta and Gurage. The region also has a youthful population, with 60% of the population under the age of 25 (United Nations Development Programme, 2019).The region has fast growing and young denominated population where greater proportion of the region is dwelling in rural part.

3.1.2.2. Socio-Economic Activities

The Sidama region is predominantly rural, with subsistence agriculture serving as the main source of economic activity and livelihood for its residents, despite the presence of some manufacturing industries limited to urban areas. Smallholder farmers make up a significant portion of the population, engaging in both crop cultivation and animal husbandry, with coffee being the primary cash crop. However, climate variability has adversely impacted agricultural productivity, contributing to the region's vulnerability to climate-related shocks (Seyoum, 2015; Fich, 2022). Additionally, the region faces major challenges such as inadequate access to education and healthcare, insufficient infrastructure, and elevated poverty levels (UNDP, 2019).

3.2. Methodology of the study

3.2.1. Research Design and Research Approach

The research design employed in this study was both descriptive and explanatory. The descriptive design was selected to portray the current situation regarding various aspects such as CIS practices, farmers' education levels, communication infrastructure, availability of extension services, perceptions of effectiveness in enhancing agricultural outcomes, gender, age, frequency of climate information usage, socioeconomic factors, and elements affecting the utilization of CIS. Conversely, the explanatory design was chosen to clarify causal relationships between independent and dependent variables, enabling the researcher to demonstrate how these variables interact.

A mixed-methods approach, incorporating both quantitative and qualitative research, was utilized in this study. The quantitative approach was deemed appropriate for converting data into numerical form, allowing for statistical analysis and drawing conclusions. Meanwhile, the qualitative approach facilitated an analysis of the qualitative data collected through various instruments and contributed to generating quantitative insights on the issues being examined. Combining these methods allows for addressing the limitations of each approach by leveraging the strengths of the other.

3.2.2. Type and Sources of Data

This study utilized both qualitative and quantitative data. Quantitative data was gathered through questionnaires administered to sample respondents, while qualitative data was collected through focus group discussions (FGDs) and interviews with key informants from Woreda and Kebele administrations. Relying solely on quantitative data would not provide a comprehensive understanding of the trends and nature of Climate Information Services (CIS). To address this limitation, FGDs and interviews were conducted. Key informant interviews focused on discussing factors influencing access to CIS, its usefulness, and its effective application in agricultural practices within the Sidama region, involving Woreda administration authorities and Development Agent officials.

Data for the study was sourced from both primary and secondary sources. Primary data included responses from sample respondents, key informants, and participants in focus group discussions. Secondary data was collected from various published and unpublished materials, such as books, journal articles, research reports, magazines, official statistics, and reports from the Central Statistical Agency (CSA), Woreda administration offices, and the internet, all deemed relevant to the study. This secondary data encompassed information on general concepts of climate information services, factors influencing the utilization of CIS, and the effectiveness of CIS in farm management decision-making, providing supplementary insights to compare and contrast with the primary data findings.

3.2.3. Instruments of Data Collection

Data represent measurable aspects of reality at a specific time. In this study, data were collected using a cross-sectional approach, allowing for the gathering of survey data at one point in time, which can then be generalized to a larger population. However, generalizations about a broad population can be misleading if the data collection instruments are not consistent and effective. The researcher carefully considered the data collection tools due to the complex and multifaceted factors influencing the utilization, accessibility, usefulness, effectiveness, and successful application of Climate Information Services (CIS) in agricultural practices. As a result, the primary data collection methods employed in this study included household surveys, key informant interviews, focus group discussions, and direct observations.

3.2.3.1. Household survey

The questionnaire was pre-tested beforehand using a few local farmers prior to the main data collection. As the primary tool for gathering data, questionnaires were utilized to collect information from household respondents, using structured questions delivered via the Kobo Toolbox/Kobo Collect platform. The study purposefully selected three woredas, each representing different agroecological zones, and within each woreda, two kebeles were chosen. A total of 384 household heads participated in the questionnaire administration across the six kebeles in the three woredas. This method was selected for its effectiveness in gathering detailed information about household characteristics and its efficiency in collecting data in a short time frame. The closed-ended questions provided respondents with specific answer options, while the open-ended questions allowed for a more in-depth expression of respondents' views, ideas, and opinions.

3.2.3.2. Focus Group Discussions (FGDs)

Focus group discussions are essential for gathering insights on group dynamics, as they allow participants to focus on key aspects of the research topic under the guidance of a skilled moderator. In this study, six focus group discussions were conducted across six kebeles: *Chancho, Dase, Megera, Soyama, Shashohoncho, and Toshine,* with eight individuals participated from each kebele. Three discussions were held with women and three with men, ensuring a balanced representation of gender and social groups, including kebele chairpersons, farmers, elders, youth, and local community leaders, none of whom were involved in the quantitative data collection. The discussion checklist comprised semi-structured, open-ended questions designed to facilitate the exchange of ideas among participants. These focus group discussions proved valuable in obtaining detailed information on specific topics relevant to the study.

3.2.3.3. In-depth Interviews from Key Informants

In-depth interviews were conducted with key informants to collect relevant information on all aspects of the study. Qualitative methods are generally more effective than quantitative methods for understanding the social and institutional contexts of individuals' lives. In order to gather qualitative data, informants were chosen for Both of Men and Women interviews. In this study key informants were included, such as Kebele chairperson, DA, woreda agriculture experts and community local leaders. It was carried out using a face-to-face interview method with 15 informants. In this study, the investigator was used semi-structured interview because of its flexibility and to make clear any time when there is ambiguity. Therefore, this method was applicable for all objectives of this study due to the fact that all important supplementary information was asked.

3.2.3.4. Field Observation

Field observation was one of the data collection methods used in this study. This approach was systematically planned and documented to ensure its validity and reliability. Through direct observation, the investigator gathered information about the study context and phenomena without directly asking respondents. To gain insights into the issues being investigated, the researcher personally observed farmers' fields. This observation was conducted throughout the research process to verify the accuracy of the information collected. Primary data from the kebeles were gathered through these observations, allowing the researcher to assess both the physical and socioeconomic activities within the sample kebeles. This helped to understand the various economic activities in which the residents were engaged and provided a comprehensive view of the conditions faced by smallholder farmers.

3.2.4. Target Population, Sampling Techniques and Sample Size

3.2.4.1. Target Population of the Study

The target population is the group to which a researcher aims to generalize the findings of the study. In this research, the target population consists of smallholder farmers in selected woredas within the Sidama region. As reported by the Woredas Administration (2024), there are approximately 134,100 households in the three woredas. Consequently, the study's target population includes all 134,100 households, from which the researcher selected 384 households to participate as respondents in the survey.

3.2.4.2. Sampling Techniques of the Study

The study employed a cross-sectional survey to evaluate the status of Climate Information Services (CIS) and the factors influencing their use among smallholder farmers in the Sidama region. A multi-stage sampling method was applied to select a representative sample for the research. In the first stage, three woredas (*Dale, Arbegona and Loka abaya)* woreda was selected by purposively sampling technique based on agro-ecological characteristics. Secondly, kebeles was selected by simple randomly sampling technique, by concerning their similarity agro-ecological conditions based consultation of woreda experts, so six kebeles were selected that means two kebeles from each woredas(three woredas).

Ultimately, households from the selected kebeles were chosen using a systematic random sampling technique. This method was utilized because it ensures that every household has an equal chance of being selected without influencing the previously chosen households.

3.2.4.3 Sample Size Determination of the Study

There are various methods for determining sample size. These methods include conducting a census for small populations (i.e., using the entire population as the sample), referencing sample sizes from similar studies, utilizing published tables, and applying specific formulas to calculate the required sample size. For this study used formula to calculate the sample size was provided by Cochran's (1963:75) sampling technique. This formula is significant or preferable to determine sample size or to yield representative sample for proportions of heterogeneous population and large population. According to data from the Woredas Administration Bureau (2024), there are a total of 134,100 households in the selected woredas. The sample size for this study was calculated using the Cochran sample size determination formula. Following Cochran's approach, the required sample size was determined at a 95% confidence level, with a maximum variability of 0.5 and a 5% margin of error.

$$n_0 = \frac{z^2pq}{e^2}$$

Whereas,

n_0 is the sample size

N Population size = 134,100

Z Z-score = 1.96 (for a 95% confidence level)

E Margin of error = 0.05 (margin of error of 5%)

P Sample proportion = 0.5 (assuming maximum variability) estimated proportion of the population that has particular characteristics

q = 1-p or (1-0.5) = 0.5

So, plug the value into the Cochran formula,

$$\mathbf{n_0} = \frac{1.96^2(0.5)(0.5)}{(0.5)^2}$$

$$\mathbf{n_0} = 384.16$$

$$\text{So, } \mathbf{n_0} \approx 384$$

Therefore, the calculated sample size using Cochran formula with the population size included is with 384 for population 134100.

A total of 384 household heads were selected for the questionnaire survey across the three woredas. The researcher determined the sample size of each kebele purposively according to their population size so, from *Chancho* kebele 84 Household, from *Dase* kebele 80 Household, from *Magra* kebele 66 Household, from *Soyama* kebele 64 Household, from *Toshine* kebele 50 Household, and from *Shashohoncho* kebele 40 Household were selected for survey.

n= 84+80+66+64+50+40 n = 384

Respondents for the survey were chosen from the selected kebeles using a systematic random sampling technique. The first household number in each kebele was randomly selected, and subsequent households were sampled by adding an interval of five.

Table 3.1. Total sampled household's proportion to the total population size from sampled woredas' of which sampled kebeles.

No	Sampled woredas	Total number of household	Sampled households from woredas'	Sampled kebeles	Sampled households (n)	Percentage
1	Lokabaya	57530	164	Chancho	84	42.7
				Dase	80	
2	Dale	45271	130	Megera	66	33.9
				Soyama	64	
3	Arbegona	31299	90	Toshine	50	23.4
				Shashohoncho	40	
Total	3	134,100	384	6	384	100

Source : Household survey 2024.

3.2.5 Data collection procedures

Before starting data collection, the researcher secured essential documents, including an introduction letter from the university. The questionnaire was initially created in English and then translated into *Sidaamu Afoo* to facilitate understanding for the respondents. Household survey questionnaires were administered to either the head of the household or an available adult in the selected households to collect both quantitative and qualitative data regarding perceptions of Climate Information Services (CIS).

To ensure the successful completion of the study, the researcher first reached out to officials from the selected kebeles and woredas. Subsequently, kebele leaders, Development Agency (DA) employees, relevant stakeholders, and government representatives were informed in detail about the study's purpose and provided clarification on any questions raised by the respondents. The researcher encouraged respondents to share all necessary information and express their feelings. Once all data had been collected, the researcher proceeded to analyze it accordingly.

3.2.6. Methods of Data Analysis and Presentation

After completing data collection, both quantitative and qualitative analytical methods were employed for analysis. To meet the study's objectives, descriptive and econometric analysis techniques were utilized, with data processed using the Statistical Package for Social Sciences (SPSS) version 27 and STATA version 17.

Quantitative data included both discrete and continuous variables, categorized as nominal, ordinal, interval, and ratio. This data was analyzed using descriptive statistics, such as frequencies, percentages, means, standard deviations, and cross-tabulation.

Qualitative data collected from focus group discussions (FGDs) and key informant interviews were presented to clarify issues that were not fully addressed in the survey data and to complement the quantitative findings. Qualitative data consisted of attribute variables, including binomial and categorical types. FGD participants were expected to share their real-life experiences. The information gathered from key informant interviews and FGDs was analyzed to verify the status of Climate Information Services (CIS) and the situation regarding their utilization in the study area.

3.2.6.1. Descriptive analysis

Descriptive analysis played a significant role in examining the distribution of variables and offering brief profiles of the respondents. It was employed to assess the socioeconomic, demographic, and institutional characteristics, as well as access to Climate Information Services (CIS), sources of climate information, the usefulness of CIS in farm management decisions, and to identify whether smallholder farmers were utilizing CIS. Analytical tools such as means, standard deviations, frequencies, percentages, and tables were utilized to present the necessary findings. Additionally, various tables and charts were included to enhance the analysis.

3.2.6.2. Inferential data analysis

Inferential statistics, including regression, chi-square tests, and t-tests, were employed to examine the relationships between variables. Additionally, Cronbach's alpha was used to assess the reliability of the data. A binary logistic regression model was applied to explore the connection between the dependent variable (the use of Climate Information Services) and a range of independent variables, such as age, sex, income, access to extension services, training programs, education, farming experience, access to credit, access to CIS, market distance, and household farm size. The objective of the model was to estimate the probability of the dependent variable based on the independent variables.

3.2. 6.3. Econometrics Model

Econometric models are statistical tools used to analyze relationships between dependent (use of climate information service) and independent variables (age, sex, income, access to extension service, training program, communication infrastructure, education, farming experience, access to credit, farm size of household). These models aid in understanding how different factors influence a specific outcome. In this study, the researcher focused on analyzing the factors that affect the utilization of Climate Information Services (CIS) among smallholder farmers in the Sidama region. Researcher used a binary logistic regression model. These model commonly used in econometrics when the dependent variable is binary (e.g. yes/no, success/failure) and the independent variables are continuous or categorical.

Model Specification: Models with a dependent variable that has two possible outcomes, such as "yes" or "no," are referred to as dichotomous. The binary logit model, also known as logistic regression, is a specific type of regression analysis used when the dependent variable is binary, meaning it can only take on two values, usually coded as 0 or 1 (representing yes or no). These models establish mathematical relationships between the explanatory variables and the dependent variable, which is always qualitative. The model estimates the probability of the dependent variable being 1 (indicating the occurrence of the event of interest or the utilization of CIS) based on the values of the independent variables.

The general equation for the binary logistic regression model is:

$$\log(p/(1-p)) = \beta_0 + \beta_1X_1 + \beta_2X_2 + ... + \beta_nX_n$$

Where:

p is the probability of the event of interest (the probability of utilizing climate information services)

β_0 is the intercept term

$\beta_1, \beta_2, ..., \beta_n$ are the regression coefficients associated with the independent variables $X_1, X_2, ..., X_n$

Equation for the Binary Logistic Regression Model with the Specified Variables: $\log(p/(1-p)) = \beta_0 + \beta_1(\text{Age}) + \beta_2(\text{Sex}) + \beta_3(\text{Education Level}) + \beta_4(\text{Income}) + \beta_5(\text{Access to CIS}) + \beta_6(\text{Access to Credit}) + \beta_7(\text{Access to Agricultural Extension Services}) + \beta_8(\text{Access to Training}) + \beta_9(\text{Market Distances})$ and etc.

By employing the binary logit model and focusing on the specific objective and variables mentioned earlier, the researcher effectively analyzed the factors affecting the use of Climate Information Services (CIS) among smallholder farmers in the Sidama region.

The researcher chose the binary logistic regression model for several reasons: the study aimed to identify the determinants influencing the use of CIS in the area. This indicated that the dependent variable was binary, specifically whether a farmer utilized CIS or not. Binary logistic regression is suitable for situations where the dependent variable has only two possible outcomes (e.g., using or not using CIS).

The goal was to uncover significant factors (independent variables) that impact the likelihood of smallholder farmers using CIS. Logistic regression enables modeling the relationship between multiple independent variables and a binary dependent variable. Unlike linear regression, logistic regression does not require assumptions of normality, linearity, or homoscedasticity, making it more appropriate for analyzing relationships between a categorical dependent variable and both categorical and continuous independent variables.

Additionally, the binary logistic regression model provides estimates of odds ratios, which facilitate the interpretation of the strength and direction of the relationships between independent variables and the likelihood of using CIS.

In summary, the binary logistic regression model is well-suited for the study's objective and the nature of the dependent variable (use or non-use of Climate Information Services).

3.2. 6.4. Model diagnostic tests

Before estimating the specified model, it is essential to conduct various tests to determine whether the underlying assumptions of the model are satisfied.

3.2.6.4.1 Multicollinearity Test

Before running the logit model, a multicollinearity test was conducted to assess whether there is a strong correlation between the explanatory variables. If multicollinearity is found to be significant, the combined presence of these variables could amplify their individual effects.

To identify multicollinearity issues among continuous variables, the variance inflation factor (VIF) technique was utilized (O'Brien, 2017). VIF is specifically used to assess multicollinearity among the explanatory variables. Each continuous explanatory variable was regressed against all other continuous variables, and the coefficient of determination (R^2) was calculated for each regression. If a significant linear relationship exists among the explanatory variables, it will be indicated by a high R^2 value in at least one of the regression tests.

A popular measure of Multicollinearity associated with the Variance inflation factor is defined as VIF (xi) $\frac{1}{1-Ri^2}$, Where Ri2 represents the squared multiple correlation coefficients between the variable and other xi variables. A higher VIF value indicates a greater potential for multicollinearity issues. If a variable's VIF exceeds 10, it is considered to have a high degree of linear relationship with other variables.

In this study, the multicollinearity test was conducted using the variance inflation factor (VIF). The calculated VIF values were all relatively low, with none exceeding 10. Specifically, the computed VIF was 1.43.

3.2.6.4.2. The goodness of fit test

The likelihood ratio test was employed to evaluate the goodness of fit, assessing the significant differences between the observed values of a particular event and the expected values. The p-value obtained was 0.5753, which is greater than 0.05.

3.2.7. Variables of Study

Variables in model are dependent and independent variables.

Dependent variables: the utilization of Climate Information Services (CIS) by smallholder farmers.

Independent variables: are those factors affecting dependent variables:- Education levels or educational status of farmers, age of farmers, size of household, farming land size, income of household in ETB, farming experience, access to credit services, access to advisory service, received training on extension service, getting any social protection program support in cash or kind, access to Climate information services and distance from market.

1. **Age of Household:** The age of the household, measured in years, is a continuous variable. It is assumed that as the age of the household increases, the likelihood of adopting new technologies or scientific weather forecasts decreases. According to Oyekale (2012), older farmers often rely on established methods for managing climate-related risks, preferring traditional practices over scientifically supported approaches. Consequently, younger farmers are more inclined to utilize Climate Information Services (CIS) than their older counterparts, who may be less likely to do so (Mdemu et al., 2017; Nhemachena et al., 2014). Therefore, it is hypothesized that the age of the household may have either a positive or negative impact on the use of CIS. This variable is expected to exhibit an inverse relationship with both the availability and utilization of CIS.

2. **Educational level**: is a way of defining whether the household is literate or illiterate. It is assumed that literate households have better trends in accepting and implementing new technologies which have positive effects to be utilized climate information services. Households with educated family members are more likely to access additional climate information and, consequently, utilize Climate Information Services. The higher education levels are positively associated with the utilization of climate information services among smallholder farmers (Adekunle et al., 2019; Deressa et al., 2011). So, it is hypothesizes that the education level of the households have either positive effect on the use to climate information service.

3. **Household size**: This is anticipated to demonstrate a positive correlation, as an increase in the number of household members typically raises interest and demand for Climate Information Services (Young, 2014). Conversely, additional productive household members may pursue off-farm employment rather than relying solely on

farm income, which could limit access to and use of Climate Information Services, consequently reducing the likelihood of increased utilization (Oyekale, 2012). Smaller household sizes are expected to be positively associated with the use of Climate Information Services, while larger household sizes may exhibit a negative association, as indicated by studies conducted by Tesfaye et al. (2016) and Tadesse et al. (2018). Therefore, household size is likely to have either a positive or negative impact on the use of Climate Information Services.

4. Farm Land size: Farmers with larger land holdings are believed to have better access to various livelihood options, which can enhance the overall income of their households. Since land plays a crucial role in coping with and adapting to climate change, households with larger farms are likely to have a greater chance of accessing and utilizing Climate Information Services. This is because farmers with extensive farms can engage in crop and livestock diversification, thereby mitigating climate-related risks (Young, 2014; Belay et al., 2017).

5. Farming experiences: More farming experience is positively correlated with the use of climate information services (Kassie et al., 2015; Bekele et al. (2017). so farming experiences have positive relation to utilization of climate information services.

6. Income level of household: Higher household incomes in Birr will be positively associated with the utilization of climate information services. According to Deressa et al. (2011) and Adimassu et al. (2018), Higher household incomes are positively associated with the utilization of climate information services.

7. Credit access: This is a dummy variable indicating a household's access to credit for various purposes. It is assumed that households with access to credit have a greater opportunity to invest in different communication infrastructures. Those household heads with credit access are expected to have higher levels of access to and utilization of Climate Information Services than those without. Access to credit can empower farmers to invest in and adopt new technologies, including Climate Information Services (Nhemachena and Hassan, 2007; Fosu-Mensah et al., 2012). Therefore, it is hypothesized that access to credit has a positive relationship with the dependent variable.

8. Access to Climate information services: Farmers with access to Climate Information Services are more inclined to use them. Numerous studies in this area have shown that access to these services increases the likelihood of their utilization among farmers.

9. Getting any social protection program service: Farmers who receive support from social protection programs, whether in cash or in-kind, are more likely to utilize Climate Information Services than those who do not benefit from such support. Therefore, it is hypothesized that receiving any form of social protection program service has a positive relationship with the dependent variable.

10. Access to Advisory services: Access to advisory services is expected to have a positive correlation with the utilization of Climate Information Services. Research indicates that there is a positive relationship between access to advisory services and the use of Climate Information Services (Ngigi et al., 2013; Mungai et al., 2019).

11. Training: increases households' awareness and knowledge about the use to climate information services, which in turn enable households to be utilizes the climate information service. So, it is hypothesized that training improves the contributions of use to climate information services.

12. Distance to Market: This is a continuous variable measured in minutes, representing the time required to reach the nearest market. Households located near market centers are more likely to access Climate Information Services. It is anticipated that this variable will show a positive relationship, indicating that those closer to the market are more likely to utilize CIS.

3.2.8. Validity and Reliability Test

Validity Test: This refers to how well the results obtained from data analysis accurately reflect the phenomenon under investigation. Validity evaluates whether the research instruments meet their intended objectives. In this study, the researcher crafted questions aimed at encouraging respondents to express their views on the state of Climate Information Services and their influencing factors. An advisor reviewed the questionnaire, providing feedback that was incorporated during the pilot study.

Reliability Test: This assesses the consistency of research instruments in yielding similar results over repeated trials. Any issues identified were addressed in the instruments, which the researcher manually scored to ensure consistent outcomes. The internal consistency of the reliability estimate was determined using Cronbach's Alpha, a widely used metric in psychometrics for assessing the reliability of scales or questionnaires. Cronbach's Alpha values range from 0 to 1, with higher values indicating better internal consistency. Generally, a value of 0.7 or higher is considered acceptable for research, though the specific threshold may depend on the context.

3.2.9. Ethical Considerations

The researcher prioritized participants' respect by recognizing their role in the study and informing them about its purpose, including their right to choose freely whether to take part and their ability to withdraw at any point. Participants received an overview of the research objectives, and their consent was secured. Prior to the commencement of data collection, enumerators underwent training to clarify the study's aims and to guarantee the confidentiality of participants' personal details. They were also instructed to request participants' willingness to provide information through various methods, such as questionnaires, interviews, and discussions. All individuals involved in the study participated voluntarily and with informed consent.

Throughout the data collection phase, careful consideration was given to the social, cultural, economic, and political contexts of the respondents to protect the well-being, health, values, and dignity of the community and its members. Participants were assured that their anonymity would be maintained and that the information they shared would be kept confidential. The investigator took measures to safeguard each participant's privacy, ensuring that all identities remained undisclosed. Consequently, the data gathered was exclusively used for educational research purposes, without compromising the anonymity of informants at any point during the study.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

This chapter presents the key findings and discussions of the research. The findings are structured and analyzed under the following themes: The first subsection details the demographic and socioeconomic profiles of the sampled households. The second subsection discusses smallholder farmers' engagement with Climate Information Services. The third subsection examines the accessibility and utilization of CIS for these farmers. The fourth subsection indicated the role of CIS in decision-making for farm management, while the final subsection explores the factors that impact the use of Climate Information Services among smallholder farmers.

4.1. Background Information of Respondents

This section provides an analysis of the survey data along with the interpretation of the findings. It outlines the characteristics of the sample households, including age, family size, gender, marital status, education levels, access to market, availability of credit, primary income sources, landholding size, and household income results.

4.1.1. Demographic characteristics of the sample household

Table 4.1 presents the demographic characteristics of the households surveyed in the study area. Out of the 384 households, 94.8% were married, 4.2% were widowed, and 0.5% were single(men) and also 0.5 were divorced (men). Regarding the gender of the household heads, 95.8% were male, while 4.2% were female. The research posited that male-headed households are more inclined to use Climate Information Services (CIS) compared to female-headed ones, as cultural norms and limited labor resources often push female-headed households toward sharecropping. The Chi-square test indicated a significant relationship between the use of climate information services and the gender of the household head.

The age distribution among the respondents was as follows: 16.4% were aged 18-30, 34.9% were between 30-40, 28.6% were 40-50, and 20.1% were over 50 years old. The youngest respondent was 20, while the oldest was 90, with ages spanning from 18 to over 50. The average age was 42.8 years, with a standard deviation of 12.362. A notable association was identified between the age of the household head and the use of CIS.

Table 4.1. Demographic Characteristics of the sample households

Description		Number of respondents	Percent (%)
Sex	Male	368	95.8
	Female	16	4.2
	Total	384	100
Marital Status	Married	364	94.8
	Single(men)	2	.5
	Divorced(men)	2	.5
	Widowed	16	4.2
	Total	384	100
Education Level	Cannot read and write	152	39.6
	Primary (1–8)	149	38.8
	Secondary (9-12)	6	17.5
	Diploma	10	2.6
	Degree and Above	6	1.6
	Total	384	100
Age of the household head in years.	18- 30	63	16.4
	30-40	134	34.9
	40-50	110	28.6
	Above 50	77	20.1
	Total	384	100

Source: Household survey, 2024.

In terms of the educational background of the sampled households, the data revealed that 39.6% of respondents were illiterate. In contrast, 38.8% had attended primary school (grades 1-8), and 17.5% had completed secondary education (grades 9-12). Additionally, 2.6% had earned a diploma, while 1.6% possessed a bachelor's degree or higher. The results of the Chi-square test (P = 0.000) indicated a significant positive correlation between the education level of the household head and the overall usage of Climate Information Services by the family.

4.1.1.1. Education Level, Age, Gender of Respondents, and the Utilization of Climate Information in the Study Area

As presented in Table 4.2, there was a correlation between respondents' education levels and their use of Climate Information Services (CIS). Among the 254 individuals who do not use these services, 145 are illiterate. In contrast, a notable portion of users 62 out of 130 have completed primary education (grades 1-8). The data indicates that higher education levels correlate with an increased likelihood of utilizing Climate Information Services. Specifically, 48 respondents have completed secondary education (grades 9-12), 8 hold diplomas, and 5 possess degrees or higher. This suggests that more educated household heads are more likely to adopt new practices and technologies that enhance productivity, facilitating the use of CIS. The Chi-square test results show a significant positive relationship between education level and the use of these services (p-value = 0.000).

In terms of age, Table 4.2 indicates that the majority of non-users (77 out of 254) are over 50 years old, while the largest group of users (60 out of 130) is between 30 and 40 years old. Younger respondents (aged 18-30) tend to utilize Climate Information Services more than older respondents. The Chi-square test shows a significant association between age and the use of these services (p-value = 0.028).

Table 4.2 also shows the relationship between the gender of respondents and their utilization of Climate Information Services, with the Chi-square test yielding a p-value of 0.003. This indicates a statistically significant relationship, revealing that a greater percentage of male respondents use these services compared to females.

Focus group discussions and key informant interviews indicated that the gender of the household head plays a crucial role in the use of Climate Information Services. The findings suggest that female-headed households are less likely to engage with CIS than male-headed households. This aligns with research by Aryal et al. (2022), which found that increased domestic responsibilities for women significantly reduce their ability to adopt climate change adaptation measures. Such gender-based divisions of labor can limit women's participation in climate adaptation strategies, including the use of CIS. Additionally, a study by Zeray and Demie (2015) noted that male-headed households are more likely to implement climate adaptation techniques. This raises questions about whether climate adaptation strategies and the use of CIS are inherently more labor-intensive or require better access to information, posing challenges for female-headed households.

The gender disparities in the use of CIS reveals the need to consider the unique circumstances and challenges faced by women, especially in female-headed households, when developing and implementing climate information services. Strategies aimed at enhancing women's access to CIS and addressing gender-related obstacles could include targeted outreach, capacity building, and the incorporation of gender-sensitive approaches within climate information systems.

In conclusion, the Chi-square analysis reveals statistically significant relationships between the education level, age, and gender of respondents, and their use of Climate Information Services. These findings provide valuable insights into the factors influencing the utilization of these services within the population studied.

Table 4.2. Respondents educational level, Age of respondents and sex of respondents *use of climate information service cross tabulation

Items	category	Use of climate information services			Chi-Square Tests/ Chi2 0r x2(Asymptotic Significance (2-sided)
		No	Yes	total	
Education level of respondents	Cannot read and write	145	7	152	P = 0.000
	Primary (1–8)	87	62	149	
	Secondary (9-12)	19	48	67	
	Diploma	2	8	10	
	Degree and Above	1	5	6	
	Total	254	130	384	
Age of respondents	18-30	30	33	63	P = 0.028
	30-40	74	60	134	
	40-50	77	33	110	
	> 50	73	4	77	
	Total	254	130	384	
Sex of respondents	Male	238	130	368	P = 0.003
	female	16	0	16	
	Total	254	130	384	

Source: Own computation, based on household survey data, 2024.

4.1.1.2 household family size in study area

Concerning family size in the study area, Figure 4.1 indicates that the average household consists of approximately 5.49 individuals, or roughly 6, with a standard deviation of 1.868. The smallest household recorded had only 1 member, while the largest included 13. This implies that the average adult equivalent family size in the rural households of the study area is greater than both the regional average of 4.99 and the national average of 4.6 (EDHS, 2024).

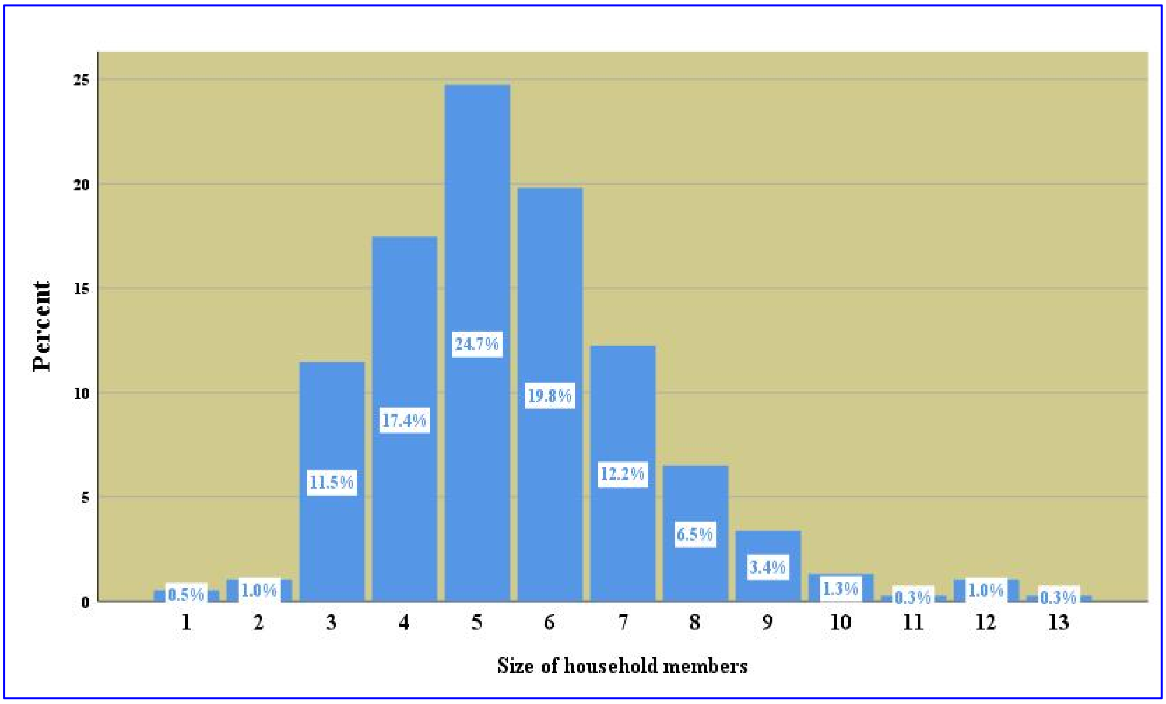

Figure 4.1. Size of household members *(Source*: *based on field survey data, 2024)*

As indicated in Figure 4.1, The graph presents the distribution of household sizes in the study area. The most common household size is 6 members, with 24.7% of households falling into this category. The second most prevalent household size is 8 members, accounting for 19.1% of the total.

As the household size increases, the percentage of households tends to decrease. Larger households with 9 or more members make up a smaller proportion of the overall population. On the other end of the spectrum, smaller households with 5 or fewer members also have lower percentages, with 1-member households being the least common at just 0.5%.

The data suggests that the typical household in the study area tends to be medium-sized, with 5 to 8 members being the most prevalent range, making up over 60% of the total. The average household size calculated from the data is around 6 members, which is higher than both the regional and national averages.

In generally, the graph depicts a skewed distribution of household sizes, with the majority of households falling within the medium-sized range, and larger and smaller households being less prevalent in the study area.

4.1.2 Socioeconomic Condition of sample households and climate information services

4.1.2.1. Household Income source

As indicated in Figure 4.2, the economy of the community in the study area is predominantly based on agricultural activities. However, the income sources for the sampled households encompass both agricultural (crop production and livestock farming) and non-agricultural (small-scale trading and daily wage work) endeavors. Agricultural income is derived from the sale of livestock, livestock-related products, and crops. Non-agricultural income is primarily generated through small-scale trading and daily labor. Most households earn their livelihoods by combining crop and livestock production, while others rely solely on crop farming, daily wage work, or small-scale trading.

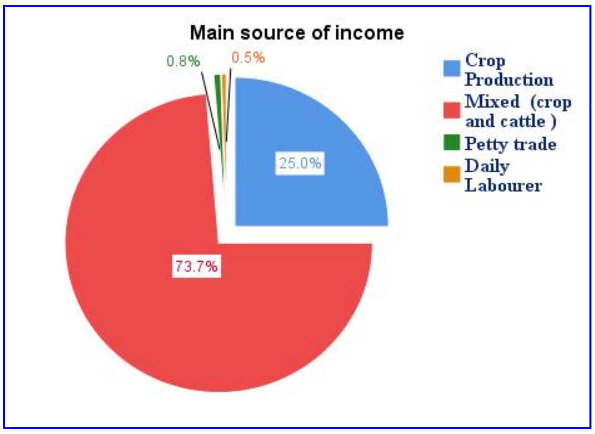

Figure 4.2. Sources of Household Income ***(Source****: Household survey, 2024)*

As shown in Figure 4.2, 73.7% of respondents derived their income from mixed farming, which includes both crop and livestock production. Mixed farming is the primary livelihood activity in the study area. Crop production serves as the second source of income, accounting for 25.0%. The remaining income sources, including petty trade and daily labor, contribute 0.8% and 0.5%, respectively. A significant portion of the population in the study area has been impacted by climate change, particularly through unreliable rainfall. Additionally, poor households have limited access to off-farm employment opportunities that would provide income in cash or kind.

4.1.2.1.1 Annual household income (in ETB) and climate information services

As shown in Figure 4.3, the annual household income levels of survey respondents were categorized into six brackets in Ethiopian Birr (ETB): up to 5000 ETB, 5001-15000 ETB, 15001-25000 ETB, 25001-40000 ETB, 41001-50000 ETB, and above 50,000 ETB. As shown in Figure 4.3 that 32.81% of respondents indicated an annual income ranging from 5001 to 15000 ETB, equating to a monthly income of around 1250 ETB. Additionally, 21.88% and 23.96% of respondents fell into the income ranges of 15001-25000 ETB and 25001-40000 ETB, respectively. About 7.29% of households had incomes up to 5000 ETB, translating to a monthly income of around 416.61 ETB. The remaining 7.03% reported incomes between 41001 and 50000 ETB, or above 50,000 ETB, indicating a monthly income of at least 4166 ETB. The data indicates a notable relationship between household income levels and both access to and utilization of Climate Information Services. Farmers with greater incomes in ETB are more inclined to embrace new technologies.

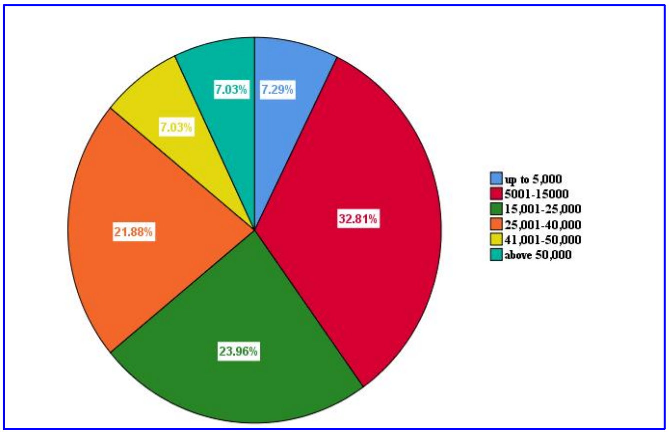

Figure 4.3. Household annual income in ETB *(source: Author's survey 2024).*

4.1.2.2. Size of land holding and climate information services

Table 4.3 presents important information regarding landholding sizes of households in the study area, which has notable implications for the use of climate information services. The data includes responses from 384 participants, showing that farming land sizes vary from a minimum of 0.20 hectares to a maximum of 4.5 hectares, with an average landholding of 1.08 hectares and a standard deviation of 0.71. This distribution indicates that the majority of households own small to medium-sized farms, suggesting that their agricultural practices are likely to be significantly affected by climate variability.

The lower average compared to the maximum underscores a prevalence of smaller landholdings, which may restrict these households' ability to effectively manage climate-related risks. Conversely, households with larger landholdings may be better positioned to adopt adaptive measures and leverage climate information services to counteract the negative impacts of climate events. In contrast, those with smaller plots may face challenges in implementing such strategies due to limited resources, rendering them more susceptible to the effects of climate change.

Table 4.3. Landholding Size in the Study Area

landholding size					
Item	Number of respondents	Minimum	Maximum	Mean	Std. Deviation
Farming land size in hectares	384	.20	4.50	1.0850	.711

Source: Household survey (2024).

4.1.2.3 Access to credit and climate information services

Credit is essential for offering financial assistance to low-income farmers, enabling them to purchase necessary inputs and adopt innovative technologies. However, access to credit is inconsistent, with some farmers facing challenges in securing it due to limited options within the community. Figure 4.4 illustrates that only 20.31% of the surveyed households had access to credit, while a substantial 79.69% did not. The chi-square analysis (P = 0.024) indicated a significant correlation between access to credit and the use of Climate Information Services among smallholder farmers.

Households that used credit were often seen as having a greater ability to purchase various agricultural inputs, adopt new technologies, and access climate information dissemination of communication infrastructures. Consequently, these households could enhance and diversify their income and increase their assets. It is expected that credit users would have better access to Climate Information Services compared to non-users.

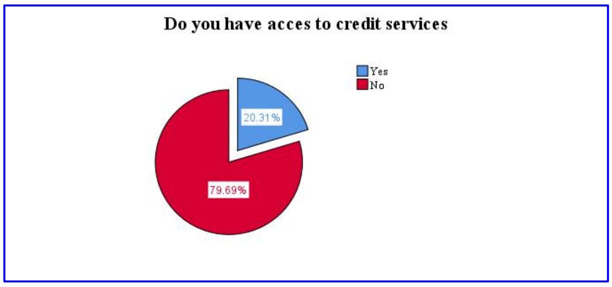

Figure 4.4. Access to Credit Among Households (Source: Author's Survey, 2024).

4.1.2.4. Distance from Respondents' Residence to Market

The distance to the market significantly affects both access to and the use of Climate Information Services among smallholder farmers. When markets are located far away, it consumes considerable time, making it difficult for farmers to fulfill their needs and, consequently, limiting their access to vital information.

Table 4.4 presents data on the travel time from the homes of 384 surveyed households to the nearest market. On average, this distance is 58 minutes, suggesting that, overall, households are relatively far from market access. The distances range from a minimum of 5 minutes to a maximum of 240 minutes, indicating considerable variation in market accessibility among households. This variability means that while some households can reach markets quickly, many face substantial travel times, which may impede their economic activities.

The standard deviation of 42.09 minutes highlights the diversity in market distances, suggesting that many households are further away from the market than the average indicates. Greater distances can adversely affect access to crucial resources, including Climate Information Services (CIS), as longer travel times may discourage farmers from pursuing essential information and inputs. As a result, this situation can intensify inequalities in agricultural productivity and restrict smallholder farmers' ability to adapt to climate change effectively.

Statistically, this variable is significant at the 1% level (p-value = 0.000), demonstrating that increased distance from markets negatively influences the utilization of Climate Information Services.

Table 4.4. Distance from household residence to market

Distance from market					
Item	N	Minimum	Maximum	Mean	Std. Deviation
Distance to the nearby market (in minutes)	384	5.00	240.00	58.2135	42.09012

Source: Household survey, (2024).

4.2. Smallholder Farmers' Engagement with Climate Information Services.

The National Meteorological Institute of Ethiopia is crucial in delivering climate information services to smallholder farmers. This agency gathers data from weather stations and satellites to produce weather forecasts, rainfall predictions, and other climate-related insights specifically designed for the needs of farmers in the area. Reliable and timely climate information is crucial for smallholder farmers, as it enables them to make well-informed choices regarding their agricultural practices and improves their overall livelihoods. According to Tilahun et al. (2020), there is increasing interest among smallholder farmers in the Sidama region to access climate information services to improve their farming techniques.

Table 4.5 indicates that 51% of respondents have heard about weather forecasts, while 49% have not. The sources of this information include media, formal and informal education, extension workers, and other channels. The study reveals that climate information services in the Sidama region have made strides in delivering relevant information to smallholder farmers. However, challenges persist regarding accessibility and the need for capacity-building initiatives to help farmers effectively utilize this information in their practices.

Table 4.5. weather forecasts and the weather information source.

Question	Response	Number of respondents	Percent(%)
Have you heard about weather forecasts?	Yes	196	51
	No	188	49
	Total	384	100.0

Source: Household survey, 2024.

Results from the focus group discussions revealed that many farmers were unaware of the availability of Climate Information Services (CIS), including weather forecasts and advisory services, leading to relatively low levels of access and utilization. Farmers in mid-temperate and highland regions reported greater awareness of weather forecasts and agricultural advisory services compared to those in lowland areas. The findings from the Focus Group Discussions (FGD) and Key Informant Interviews (KII) suggest that variations in awareness among farmers in the Sidama region stem from differences in access to information, educational programs, cultural attitudes, and infrastructure. Addressing these gaps is crucial for enhancing the overall use of CIS and bolstering agricultural resilience across all woredas.

As FGD from mid temperate explained*," we hear about climate forecasts on the radio, but the information is not always accurate or relevant to our local conditions." in contrast participants from lowland woreda stated,"I'm not sure what climate information services are available to us, as we don't receive much support from the extension services."*

Additionally, findings from the focus group discussions and interviews indicate that the availability of Climate Information Services (CIS) in the Sidama region is limited. Smallholder farmers encounter difficulties in obtaining timely and relevant climate information due to insufficient infrastructure and communication channels. This lack of access hampers their capacity to make informed decisions about their agricultural practices, presenting a mixed picture of the current state of CIS in the region.

4.3. Access and Use of Climate Information Services for Smallholder Farmers

4.3.1. Vulnerability to Climate-Related Shocks

According to figure 4.5, revealed that the study area is already feeling the effects of climate change. In recent years, there has been a noticeable decline in rainfall, contributing to reduced agricultural production. Moreover, the region has seen an increase in the frequency and severity of droughts and floods, which has adversely affected food security and heightened malnutrition levels. According to the Ethiopian Ministry of Environment, Forest, and Climate Change (EMEFCC, 2016), Sidama is particularly vulnerable to climate-related shocks, facing high rates of poverty, food insecurity, and malnutrition, as well as susceptibility to droughts, floods, and landslides. These environmental challenges have a severe impact on the livelihoods of the local population.

Furthermore, a recent study by the International Food Policy Research Institute (IFPRI, 2017) identified Sidama as one of the most susceptible regions to climate change in Ethiopia, predicting that residents will experience more frequent and intense droughts, floods, and landslides in the future. Smallholder farmers in the area are particularly vulnerable to these climate shocks. All respondents acknowledged the presence of climate change, citing alterations in temperature, rainfall patterns, and extreme weather events, which have negatively affected their agricultural productivity. For instance, survey findings indicate that unreliable rainfall, droughts, and severe flooding have led to crop failures, decreased yields, loss of assets, reduced incomes, food insecurity, rising market prices, and increased anxiety, ultimately harming their crops and livestock.

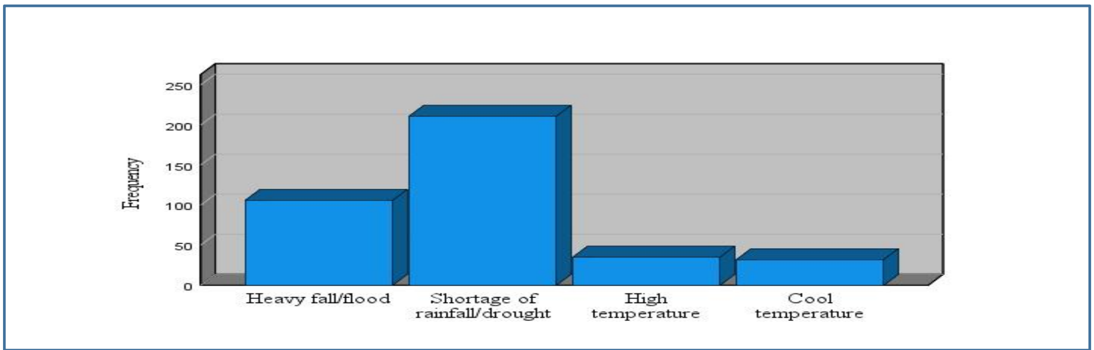

Figure 4.5. Extreme weather events in Study Area (Source: Household Survey Data, 2024).

4.3.1.1 Extreme weather events by woreda and Argo-ecological zones

The results presented in Table 4.6 indicate the prevalence and types of extreme weather events across different agro-ecological zones within the specified woredas. The data captures responses concerning common extreme weather events, categorized into heavy rainfall/flood, drought, high temperature, and cool temperature. This analysis aims to interpret these findings and discuss their implications on the local environment and agricultural practices.

From the table, it is evident that the most frequently reported extreme weather event is a shortage of rainfall or drought, particularly prominent in the Kolla zone, where 132 individuals reported experiencing this issue. This suggests a significant vulnerability to drought in this agro-ecological region, which could have dire consequences for local agriculture, food security, and water supply. In contrast, the Dega zone, primarily reported heavy rainfall and flooding, with a notable 70 responses indicating this as a common event. This discrepancy between the zones underscores the necessity for targeted climate adaptation strategies tailored to the specific challenges faced in each agro-ecological area. In total, the survey captured 384 responses, indicating a robust engagement from the community. The significant number of reports on drought and heavy rainfall reveals the critical need for comprehensive disaster risk management and climate resilience planning. Policymakers and agricultural stakeholders must consider these findings to implement effective strategies that address the specific needs of each agro-ecological zone. This could include investing in irrigation systems in drought-prone areas and developing flood management techniques in regions susceptible to heavy rainfall.

Overall, the results of this survey not only reflect the diverse climatic challenges faced by different agro-ecological zones but also emphasize the importance of local knowledge in understanding and addressing the impacts of extreme weather. As climate change continues to escalate, ongoing monitoring and adaptive management will be essential to safeguard livelihoods and promote sustainable agricultural practices in these vulnerable regions.

Table 4.6. Extreme weather events by woreda and Agro-ecologies

Question	responses	Argo-ecological zones			Total
		Kolla	Woinadega	Dega	
		Loka Abaya	Dale	Arbegona	
What type of extreme weather events are common in your area?	Heavy fall/flood	12	24	70	106
	Shortage of rainfall/drought	132	79	0	211
	High temperature	20	15	0	35
	Cool temperature	0	12	20	32
Total		164	130	90	384

Source: Household survey, 2024.

4.3.2. Access to Climate Information Services in the Study Area and Their Sources

The availability and use of climate information services are vital for helping smallholder farmers make informed decisions and improve their resilience to the impacts of climate change. In the Sidama region, there is increasing interest among smallholder farmers in accessing these services to enhance their agricultural practices (Tilahun et al., 2020). To effectively implement climate change adaptation strategies, it is essential to ensure that climate information is accessible to these farmers.

Table 4.7 shows the access to climate information services among smallholder farmers in the study area. Of the 384 households surveyed, 50.8% reported having access to climate information services, while 49.2% did not. The study also indicates that many smallholder farmers in the Sidama region struggle to obtain reliable climate information. According to FGD, they noted a lack of access to essential resources such as weather forecasts, climate projections, and information on climate-smart agricultural practices. For those without access to climate information services, adapting to climate change becomes increasingly challenging. Simply having access to climate information services does not guarantee that farmers will utilize them effectively.

Table 4.7. Access to climate information services in study area and its source

Item	response	Number of respondents	Percent
Do you Access to climate information services?	Yes	195	50.8
	No	189	49.2
	Total	384	100.0
source of accessed CIS	TV	41	10.7
	Cell phone	18	4.7
	Radio	57	14.8
	Extension workers/agricultural experts	68	17.7
	Village Leaders/Representative	5	1.3
	Peer farmers	6	1.6
	Total of accessed to CIS	195	50.8
	Not accessed	189	49.2
	Total	384	100.0

Source: Household survey data, 2024.

Smallholder farmers who participated in the household survey and focus group discussions indicated that they utilize multiple channels to access climate information (Table 4.7). Among those who accessed Climate Information Services (CIS), 35% primarily relied on agricultural extension services provided by experts or extension workers. This was followed by information accessed via radio (29.4%) and television (21%). Additional sources included mobile phones (9%), peer farmers (3%), and village leaders (2.6%). The services offered by agricultural experts and radio emerged as the most effective and cost-efficient channels for disseminating CIS, preferred by the majority of respondents. Similarly, Oyekale (2015) found that radio is widely used to communicate information to local farmers due to its extensive reach,While most respondents were aware of agricultural extension services, less than half actually accessed CIS through these providers (extension agents). This observation aligns with earlier studies conducted by Muema et al. (2018) and Ochieng et al. (2017).

Findings from focus group discussions and key informant interviews indicate that, despite farmers having access to climate information services, only a small proportion of smallholder farmers in the study area actually utilize this information to guide their farming decisions. This gap suggests that, although climate information is viewed as a valuable and reliable resource, many smallholder farmers still do not have sufficient access to effective agricultural extension services.

Focus group discussions and key informant interviews confirmed that the impacts of climate change on the environment are evident. The qualitative data revealed that significant indicators of climate change and variability have severely affected livestock and crop production. Smallholder farmers in the region struggle to obtain accurate and localized climate information tailored to their specific farming practices. They noted that information from national agencies is often too general, failing to account for the distinct micro-climates and crop varieties prevalent in the Sidama region.

Participants in the focus group discussions emphasized the need to improve access to relevant climate services to enhance decision-making and resilience among smallholder farmers. The study concludes that while farmers in the Sidama region are aware of climate change and its effects on their agricultural activities, they lack access to reliable climate information services that could assist them in adapting to these changes. Additionally, the findings suggest that smallholder farmers are willing to adopt climate-smart agricultural practices if they receive the necessary training and support.

4.3.2.1. Access to climate information service by woreda and Agro-ecologies

Table 4.8, provides insights into the access to climate information services across different agro-ecological zones—Kolla, Woinadega, and Dega—within the woredas of Loka Abaya, Dale, and Arbegona. Out of a total of 384 respondents, a significant proportion,189 individuals, reported not having access to climate information services, while 195 affirmed their access.

The data reveals a notable disparity in access across the zones. The Kolla zone shows a relatively balanced situation, with 85 respondents indicating access compared to 79 without. Conversely, Woinadega also demonstrates a higher level of access (76) but has a significant number of individuals (54) lacking access. The Dega zone, however, is strikingly different, with the lowest total of affirmative responses (34) regarding access to climate information services. This suggests that individuals in Dega zone particularly disadvantaged in obtaining critical climate-related information, which is essential for making informed agricultural decisions and enhancing resilience to climate variability.

The overall lack of access in all zones reveals a potential gap in the dissemination of climate information that could be detrimental to agricultural communities, especially in the context of increasing climate unpredictability. The fact that nearly half of the respondents do not have access to such services raises concerns about their ability to adapt to extreme weather events, which were indicated in the previous table. Therefore, enhancing access to climate information services should be a priority for policymakers and agricultural extension services to empower farmers with the knowledge needed to cope with changing climatic conditions effectively. This could lead to improved agricultural practices and better preparedness for extreme weather events, ultimately contributing to food security and community resilience.

Table 4.8. Access of climate information service by woreda and Argo-ecological zones

		Argo-ecological zones				
		Kolla	**Woinadega**	**Dega**		
Question	**response**	Loka Abaya	Dale	Arbegona	**Total**	**Percent**
Do you access to climate information service?	No	79	54	56	189	49.2
	Yes	85	76	34	195	50.8
Total		164	130	90	384	100

Source: Household survey, 2024.

4.3.3. Utilization of Climate Information Services in the Study Area

Table 4.9 provides important insights from a household survey conducted in 2024 on the use of climate information services. Among the 384 respondents, only 33.9% (130 individuals) indicated that they utilized these services, whereas a substantial 66.1% (254 individuals) reported that they did not. This notable disparity reveals a significant gap in engagement with climate information services, which may have serious consequences for community preparedness and resilience to climate change. These findings warrant further investigation into the factors contributing to this low utilization rate, particularly given the growing importance of climate information in decision-making processes.

Table 4.9. Utilization of climate information service

Item	Response	Frequency	Percent
Do you use climate information service?	No	254	66.1
	Yes	130	33.9
	Total	384	100.0

Source: household survey, 2024.

Key informant interviews (KII) and focus group discussions (FGD) conducted alongside the survey offered important insights into the challenges encountered by non-users. Many participants revealed a considerable lack of awareness about the existence of climate information services. Accordingly, despite the existence of these services, they are often not communicated effectively to the communities that need them most. Some key informants noted that local governments and organizations have not invested enough in outreach initiatives, which has led to a disconnect between available services and potential users. This lack of visibility translates directly into the high percentage of non-usage, as many individuals simply do not know these services exist.

Additionally, issues related to accessibility emerged as a prominent theme in both KIIs and FGDs. Many respondents reported difficulties accessing climate information due to inadequate digital infrastructure, particularly in rural areas. Participants noted that unreliable internet connectivity and limited access to smartphones or computers hinder their ability to obtain timely climate updates. These findings indicate a pressing need for investments in infrastructure that can facilitate greater access to climate information. Community leaders emphasized that local radio broadcasts and SMS alerts could serve as effective alternatives for disseminating climate information in areas where internet access is lacking.

Moreover, the discussions revealed that those who are aware of climate information services often find them difficult to interpret or irrelevant to their specific needs. Focus group participants expressed frustration over the complexity of information presented in technical formats, which may not resonate with local contexts. Many respondents indicated that they would prefer more simplified, actionable data that directly relates to their daily activities, such as agriculture or disaster preparedness. The KII findings echoed this sentiment, as several key informants recommended that information be tailored to local languages and cultural contexts to enhance understanding and applicability.

Further exploration of demographic factors through the KII and FGD sessions illuminated differences in engagement with climate information services. Younger participants, particularly those with higher educational levels, were more likely to utilize digital platforms and engage with online climate information. In contrast, older community members and those with lower educational backgrounds expressed a need for more traditional, face-to-face communication methods. This demographic divide indicates that outreach strategies should be multi-faceted, employing a combination of digital tools and community-based approaches to cater to diverse groups effectively.

4.3.3.1. **Utilization of Climate Information Services Across Various Agro-Ecological Zones in Woredas**

The utilization of climate information services (CIS) across different agro-ecological zones indicates a significant discrepancy in adoption rates among rural households. As shown in Table 4.10, the overall percentage of households utilizing climate information services is relatively low, with only 33.9% affirming their use, while a substantial 66.1% reported not using these services.

In the Kola agro-ecological zone, only 39.63% of households reported using CIS but 60.37 not, which is the highest among the zones but still reflects a concerning gap in utilization. The Woinadega zone demonstrated a slightly lower usage rate at 36.9%, while the Dega zone had the least engagement, with only 18.9% of households utilizing climate information. These results suggest that specific socio-economic and environmental factors in each zone may influence the effectiveness and accessibility of climate information services.

During focus group discussions, participants indicated that the lack of timely and localized weather forecasts significantly impacted their agricultural decisions. As one farmer stated, “We often receive information too late to prepare for the rains or droughts, and by then, it’s often too late to change our planting strategies.” This sentiment echoes the findings of Hain et al. (2018), who noted that timely access to climate data is crucial for effective agricultural planning and resilience.

Key informants indicated additional barriers to the utilization of CIS, including low literacy rates and a lack of awareness about the available services. One informant remarked, “Many farmers are not aware of the climate information services provided by the government, and even if they are, they may not understand how to interpret the data.” This observation is consistent with the conclusions of Kanyanga et al. (2019), who argue that improving literacy and training on climate information interpretation is essential for enhancing its utilization among rural communities.

Moreover, the differences in CIS utilization among the agro-ecological zones may be attributed to varying levels of infrastructure and access to technology. Kola , for example, showed slightly higher utilization rates compared to Woinadega zones and Dega, suggesting that localized interventions may be necessary to address specific barriers in each zone. Tailoring information dissemination methods to local contexts and enhancing community awareness could significantly increase the utilization of these vital services. As noted in previous studies, building local capacity to interpret and utilize climate data is fundamental for fostering resilience among smallholder farmers (Sova et al., 2017).

Table 4.10 utilization of climate information services among different Argo-ecological zones

Question	response	Argo-Ecological zones				
		Kolla	Woinadega	Dega		
		Loka Abaya	Dale	Arbegona	Total	percent
Do you use climate information service?	No	99	82	73	254	66.1
	Yes	65	48	17	130	33.9
Total		164	130	90	384	100

Source: household survey, 2024.

4.4. Effectiveness of Climate Information Services in Farm Management Decisions

Farmers' perceptions regarding the usefulness of climate information services for making farming decisions in the face of climate risks were assessed using a three-point Likert scale. The response categories included: 1 = I don't receive the information, 2 = Yes, it is useful, and 3 = No, it is not useful. Since these responses were ordinal and the intervals could not be assumed to be equal, mean and standard deviation calculations were not applicable. Instead, frequencies were utilized to identify the most valuable climate information services for farm decision-making, with the results presented in a table.

Table 4.11, the findings of this study reveal that climate information services (CIS) are highly beneficial for assisting smallholder farmers in their farm management decision-making. A significant majority of participating farmers (79.2%) reported that the CIS provided through the project was useful or very useful for their agricultural activities.

According to FGD, Farmers identified several ways in which CIS enhanced their management decisions:

Timing of Agricultural Activities: Access to seasonal climate forecasts and real-time weather data allowed farmers to better schedule planting, harvesting, and other field operations in alignment with expected rainfall patterns and extreme weather conditions. This proactive approach helped them avoid losses from poorly timed farming activities(FGD, 2024).

Crop and Variety Selection: The climate information enabled farmers to choose crop varieties and planting times that were more suited to the anticipated seasonal conditions, resulting in higher yields and reduced climate-related risks (FGD.2024).

A previous study also indicated that access to weather and climate information services increased maize and wheat productivity by 27% and 17%, respectively (Seneshaw et al., 2023).

According to FGD, Farmers utilized climate information services (CIS) to enhance various aspects of water and irrigation management. By leveraging rainfall data and forecasts, they optimized their irrigation schedules and water usage, leading to improved efficiency and productivity of water resources. Additionally, timely information on weather conditions and climate trends allowed farmers to anticipate and prepare for potential pest and disease outbreaks, enabling them to implement preventive measures and minimize crop losses. Some farmers also reported using CIS to guide their decisions on livelihood diversification, such as pursuing off-farm income opportunities or adjusting their crop-livestock combinations to better manage climate-related risks. These findings align with previous research highlighting the value of CIS in enhancing smallholder farmers' agricultural decision-making and resilience to climate variability (Tall et al., 2018; Haile et al., 2019).

However, the perceived usefulness of CIS varied among farmers; approximately 21.8% of participants indicated that the services were only somewhat useful or not useful at all for their management practices. Factors such as access to complementary resources (e.g., credit and agricultural inputs), education levels, and existing adaptive capacities influenced how effectively farmers could interpret and apply climate information in their decision-making. This underscores the necessity for CIS to be integrated into a broader framework of support and capacity-building initiatives, ensuring equitable access and utilization among smallholder farmers (Tall et al., 2014; Meadow et al., 2015). Overall, the study demonstrates the significant potential of CIS to improve the resilience and productivity of smallholder farming systems when these services are tailored to the specific needs and constraints of users. Continued investment and innovation in climate information products, communication strategies, and farmer engagement will be essential for maximizing the benefits of CIS for smallholder agricultural development.

Focus group discussions (FGDs) and key informant interviews (KIIs) conducted during the study provide deeper insights into the perceived effectiveness of CIS. Participants in the FGDs emphasized the practical benefits of weather forecasts, stating, *"Knowing when to plant or harvest based on weather predictions has saved us from crop losses"* (FGD, 2024).

Key informants, including agricultural extension officers, echoed this perspective, stated that "farmers who utilize climate information are better prepared to face adverse weather conditions," which is crucial for maintaining food security in the face of climate change (KII, 2024).

In furthermore, the effectiveness of Climate Information Services in farm management decisions is evident from both quantitative survey results and qualitative insights from FGDs and KIIs. While the majority of farmers find CIS useful, improving access to timely information and integrating local knowledge are essential steps to enhance the effectiveness of these services. Continued efforts to address these challenges will be vital for supporting farmers in adapting to climate change and improving agricultural resilience.

Table 4.11. The usefulness of weather forecast information for livelihood activities

Item	Responses	Frequency	Percent (%)
Are the weather forecast information useful for livelihood activities?	I do not get the information	78	20.3
	Yes useful	304	79.2
	No, it is not useful	2	.5
	Total	384	100.0

Source: household survey, 2024.

4.5. Determinants of utilization of climate information service among smallholder farmers.

The binary logistic regression model was used to assess the impact of the hypothesized independent variables on the utilization of climate information services by smallholder farmers. The factors influencing the use of CIS among these farmers are interpreted through the marginal effects of the parameters presented in the results. An examination for multicollinearity indicated that the independent variables are not correlated, allowing all variables to be included in the model estimation.

4.5.1. Econometric Results and Analysis

The econometric model employed in this study was binary logistic regression, chosen for its suitability in analyzing the factors influencing the utilization of climate information services among smallholder farmers. This method is typically applied when the dependent variable is dichotomous, with independent variables that can be either categorical or continuous.

While climate information services are multidimensional and encompass a broader scope, this study focused specifically on the status of these services and the factors influencing their use among smallholder farmers, categorizing them as either users or non-users. Before estimating the parameters of the binary logistic model, tests for multicollinearity were conducted using the variance inflation factor, along with the Hosmer-Lemeshow chi-square test to assess the model's adequacy and goodness-of-fit for validation purposes.

4.5.1.1. Tests for multicollinearity

The Variance Inflation Factor (VIF) was calculated to assess the extent of correlation among the explanatory variables. The VIF values obtained were relatively low, all being below 10. With a VIF value of 1.43, there were no significant multicollinearity issues among the explanatory variables, allowing all of them to be retained in the logistic regression model for analysis (Appendix-1).

4.5.1.2. Goodness of Fit of the Model

The goodness of fit, or calibration, of a model indicates how effectively it describes the data. Evaluating this involves examining how closely the values predicted by the model align with the observed values. The results of the Hosmer-Lemeshow test, presented in Appendix-2, show a chi-square value of 6.65 with a p-value of 0.5753, indicating no significant difference between the observed and predicted values, thus confirming that the model adequately fits the data.

To identify the best predictors of the dependent variable, explanatory variables were included in the model to estimate their parameters using binary logistic regression analysis. The selection of these variables was guided by theoretical expectations and prior empirical studies. Consequently, the explanatory variables used to assess the utilization of climate information services were entered into STATA (version 17) and SPSS (version 27), where a binary logistic regression model was fitted. This analysis aimed to determine whether the variables were statistically significant within the model and whether a significant statistical difference existed between those who utilized climate information services and those who did not. The model treated the use of CIS as a dichotomous dependent variable, assigning a value of 1 for households that utilized the services and 0 otherwise.

Since the logit model employed is not linear, the marginal effect of each explanatory variable on the dependent variable varies depending on the values of the explanatory variables. Thus, marginal effects provide a summary of how changes in a response are related to changes in a covariate. For categorical variables, the effects of discrete changes are computed, i.e., the marginal effects for categorical variables show how $P(Y=1)$ is predicted to change as X_k changes from 0 and 1 holding all other X_{nk} equal. In contrast, for continuous explanatory variables, the marginal effect quantifies the instantaneous rate of change.

4.5.2. Results of Model Analysis

A binary logistic regression model was employed to identify the factors influencing the use of climate information services (CIS). The marginal effects of the parameters, as shown in the results appendix 3 and (Table 4.12), help interpret the factors affecting CIS usage among smallholder farmers. The findings from the logistic regression model offer valuable insights into the factors related to the utilization of climate information services among the study participants.

Table 4.12. Determinants of utilization of climate information services

variables	dy/dx	Std.Err.	Z	P>z	sig
Age	-0.043	0.020	-2.190	0.028	**
Educational	0.073	0.017	4.310	0.000	***
Size_of_household	0.001	0.010	0.130	0.894	
land_size_hectares	0.058	0.024	2.380	0.017	**
How_long_you_been_farming	0.002	0.002	1.110	0.268	
advisory_services	0.089	0.029	3.030	0.002	***
received_training	0.097	0.031	3.170	0.002	***
Distance_Market	-0.002	0.000	-4.550	0.000	***
access_credit	0.084	0.037	2.250	0.024	**
getting_social-support	0.079	0.031	2.580	0.010**	**
access_to_climate	0.262	0.038	6.860	0.000	***
Constant	3.892	1.912	2.04	.042	**

** ** p<.01, ** p<.05, * p<.1 significant at 1%, 5% and 10% degree of precision respectively*

Mean dependent var	0.339	SD dependent var	0.474
Pseudo r-squared	0.688	Number of obs	384
Chi-square	338.202	Prob > chi2	0.000
Akaike crit. (AIC)	181.366	Bayesian crit. (BIC)	236.675

Source: own computation based on household survey data, 2024

The marginal effects from the logistic regression analysis regarding the use of climate information services (CIS) among smallholder farmers reveal that several factors significantly decrease or increase the likelihood of utilizing these services. Specifically, the age of the household head, total farmland area, education level, training received, access to credit, availability of climate information services, social support, distance to the market, and the advisory services available to the household head all played a role.

The results of the logistic regression model shed light on the factors influencing the use of climate information services among the participants in the study. Below is an analysis of the key findings:

Age of household:

The age of the household head significantly impacts the utilization of climate information services (CIS), with a p-value of 0.028 indicating a negative relationship with service usage in the study area. The model shows that, the marginal effect (Coefficient (dy/dx)) of age is -0.043, meaning that for each additional year in age, the probability of using CIS decreases by 4.3 percentage points, while keeping other variables constant. This suggests that older individuals are less likely to use CIS, possibly due to a lower level of technological familiarity or willingness to adopt new information sources. The variable is statistically significant at the 5% level (p-value = 0.028), indicating that age is a significant determinant of CIS usage.

Consequently, younger households are more inclined to use CIS in their farm decision-making compared to older ones. This trend may be attributed to younger farmers being more innovative and adaptable, making them more likely to embrace new practices and technologies that can improve their resilience to climate-related challenges. This finding aligns with previous research by Muema et al. (2018) and Onyeneke et al. (2023), which also indicated that as the age of the household head increases, the likelihood of utilizing CIS decreases.

Education level of household:

The results show that the educational level has a positive marginal effect of 0.073. For each unit increase in the education level of the household head, the probability of using climate information services (CIS) rises by 7.3 percentage points, while keeping other variables constant. This finding underscores the significance of education in facilitating the adoption of CIS, likely because a higher education level enables a better understanding of the benefits and improves the ability to utilize the available information effectively. The variable is statistically significant at the 1% level (p-value = 0.000), suggesting that education is a strong positive predictor of CIS usage.

These studies indicate that educated farmers are more inclined to incorporate climate information into their farming decisions, including adjusting planting dates, choosing suitable crop varieties, and implementing soil conservation practices. Higher education levels enable farmers to integrate climate information into their adaptive strategies, leading to improved resilience to climate variability, and farmers with lower levels of education may struggle to comprehend and implement climate information effectively, resulting in sub-optimal responses to changing weather patterns and environmental conditions. Limited education can impede farmers' ability to capitalize on climate information services for sustainable agricultural practices.

Land size:

The model indicates that the marginal effect of land size (measured in hectares) is 0.058. This means that for each additional hectare of land, the probability of utilizing climate information services (CIS) increases by 5.8 percentage points, assuming other variables remain constant. This suggests that farmers with larger landholdings are more likely to employ CIS, possibly to enhance the management of their agricultural operations. They may have a greater need for climate information to effectively oversee their larger farms. The variable is statistically significant at the 5% level (p-value = 0.017), indicating that larger land size is a positive predictor of CIS usage. These results align with findings from Tsiyon (2023) and Gebru (2014), who noted that an increase in farm size by one unit enhances the likelihood of farmers adopting climate adaptation strategies. However, this contradicts the results of Mwinkom et al. (2021), who found that for each unit increase in farm size, the probability of using CIS decreases by 21.1%.

Access to advisory services:

The results indicate that access to advisory services is positively correlated with the use of climate information services (CIS). The marginal effect (dy/dx) is 0.089, meaning that if a household has access to advisory services, the probability of utilizing CIS increases by 8.9 percentage points, assuming other variables remain constant. In other words, for each unit increase in access to advisory services, the likelihood of using CIS rises by 8.9%. This variable is statistically significant at the 1% level (p-value = 0.002), indicate that access to advisory services is a strong positive predictor of CIS utilization.

Training services:

The results indicate that access to or participation in training services is positively related to the use of climate information services (CIS). The marginal effect (dy/dx) is 0.097, meaning that if a household has received training, the likelihood of utilizing CIS increases by 9.7 percentage points, assuming other variables remain constant. This variable is statistically significant at the 1% level (p-value = 0.002), suggesting that receiving training is a strong positive predictor of CIS usage.

Distance to market:

The model indicates that distance to market has a negative marginal effect (dy/dx) of -0.002, implying that individuals located further from markets are less likely to utilize climate information services (CIS). Specifically, for each unit increase in distance to the market, the probability of using CIS declines by 0.2 percentage points, while keeping other variables constant. This variable is statistically significant at the 1% level (p-value = 0.000), suggesting that increased distance to markets negatively impacts the usage of CIS.

Access to credit:

The results demonstrate that access to credit is positively related to the utilization of climate information services (CIS). The marginal effect (dy/dx) is 0.084, meaning that if a household has access to credit, the probability of using CIS increases by 8.4 percentage points, assuming other variables remain constant. In other words, for each unit increase in access to credit, the likelihood of utilizing CIS rises by 8.4%. This variable is statistically significant at the 5% level (p-value = 0.024), indicating that access to credit serves as a positive predictor of CIS usage.

Getting any social protection program support:

Receiving social support has a positive marginal effect (dy/dx) of 0.079, indicating that individuals who benefit from social protection programs are more likely to utilize climate information services (CIS). Specifically, for each unit increase in social support, the probability of using CIS rises by 7.9%. This variable is statistically significant at the 5% level (p-value = 0.010), suggesting that increased social protection support positively influences CIS usage.

Access to climate information:

The model reveals that access to climate information has the highest positive marginal effect at 0.262, indicating that individuals with access to such information are significantly more likely to use climate information services (CIS). Specifically, for each unit increase in access to climate information, the probability of utilizing CIS increases by 26.2%. This finding highlights the critical need to improve farmers' access to climate information to promote the use of CIS. This variable demonstrates the most considerable impact and is highly statistically significant at the 1% level (p-value = 0.000), reinforcing that access to climate information is a key positive predictor of CIS utilization.

Overall, the analysis indicates that factors such as education, land size, access to advisory services, training, credit, and availability of climate information services are significant positive determinants of CIS usage, while distance to market and age serve as negative determinants. These findings suggest that enhancing access to these resources and services could increase the utilization of climate information services among households. The model has a pseudo R-squared value of 0.688, indicating that the included variables account for a considerable portion of the variation in CIS usage. Additionally, the Chi-square value of 338.202 and the p-value of 0.000 indicate that the model is statistically significant. The logistic regression model offers a thorough understanding of the factors influencing CIS usage among the study area. These insights can guide the development of targeted interventions and policies aimed at promoting the adoption of CIS by addressing the identified barriers and capitalizing on the enabling factors.

CHAPTER FIVE

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. Summary

The study investigated the status of climate information services (CIS) and their determinants among smallholder farmers in the Sidama region of Ethiopia. The aims were to evaluate the level of access to CIS, assess its usefulness in farm management decisions, and analyze the factors influencing the utilization of CIS among smallholder farmers.

The study found a moderate overall status of CIS availability (50.8% access), but significantly lower utilization (33.9% actively utilized). This suggests a gap between access and effective application of the information received. The main sources of CIS included agricultural extension workers, radio, television, peer farmers, village leaders, and community meetings. However, farmers frequently perceived the content and timeliness of the information provided as inadequate. Access to and utilization of climate information services with Agroecological zones were different; In the Kolla agroecological zone, access to climate information services is relatively balanced, with approximately 51% of farmers reporting access, yet only 39.6% actively utilize these services for decision-making, indicating a disconnect between availability and practical use. Conversely, the Dega zone faces significant challenges, as only 18.9% of households engage with CIS despite the fact that 37.78% have reported access, highlighting a critical gap in both access and effective utilization of essential climate data. Meanwhile, the Woinadega zone demonstrates a slightly higher access rate 58.46 but utilization rate of 36.9%, revealing that while farmers have some utilization of climate information, many still struggle to leverage this data effectively for adapting their agricultural practices to climate variability.

The study found that climate information services (CIS) are highly beneficial for smallholder farmers' decision-making, with 79.2% reporting usefulness in farm management. Qualitative data from focus groups revealed improved timing of agricultural activities, better crop selection, and enhanced water management as key benefits of CIS utilization.

The binary logistic regression analysis identified several key determinants influencing CIS utilization. These included: education level, farm size, age of the household head, distance to market access to credit, access to extension services, availability of climate information services, and support from social protection programs. Positive and statistically significant influences were found from education level, farm size, access to extension services, access to credit, availability of climate information services, and support from social protection programs. Conversely, age of the household head and distance to market were identified as negative determinants with statistical significance regarding CIS utilization. Additionally, barriers such as limited awareness, low relevance, and poor dissemination channels were revealed as significant obstacles to effective CIS utilization.

The study summarized that while some access to CIS exists, utilization remains low. Improving the availability, accessibility, reliability, and ultimately the utilization of CIS is crucial for enhancing agricultural productivity and resilience to climate change in the Sidama region. Overall, the study offers valuable insights into the current status and factors influencing CIS use among smallholder farmers in the Sidama region, contributing to a better understanding of the challenges and opportunities for enhancing climate resilience in smallholder farming communities in Ethiopia.

5.2. Conclusion

This study assessed the climate information services and its determinants among smallholder farmers in Ethiopia's Sidama region, revealing a significant gap between availability and effective use. While approximately half of the surveyed farmers reported access to CIS, a substantial portion remained disengaged. Key sources identified included agricultural extension agents, broadcast media (radio and television), mobile technologies, and community forums. However, feedback consistently revealed deficiencies in information timeliness and relevance, directly impacting practical application. Furthermore, the fragmented nature of CIS delivery, characterized by poor inter-agency coordination, hampered overall effectiveness.

The disparities in access to and utilization of climate information services across the agroecological zones underscore the complexities of effectively supporting farmers in their decision-making processes. While some zones show relatively balanced access, the actual use of these services remains limited, pointing to a significant gap between availability and practical application. This situation reveals the need for targeted interventions that not only improve access to climate information but also enhance farmers' capacity to utilize it effectively in adapting their agricultural practices to changing climatic conditions.

The study identified several factors influencing CIS usage among smallholder farmers. Positive and statistically significant effects were associated with education level, farm size, access to extension services, access to credit, and social capital. These findings suggest that enhancing farmers' access to complementary resources, such as education,social support programs, and credit, could improve CIS utilization. Conversely, barriers such as limited awareness, low relevance of the information, and ineffective dissemination channels were identified as significant obstacles to effective CIS usage.

The study emphasized the importance of social capital, revealing that farmers with stronger social networks were more likely to access and use climate information services. The low utilization of CIS among smallholder farmers in the Sidama region is concerning, especially given their vulnerability to climate variability and change. Without timely and relevant climate information, these farmers struggle to make informed decisions and adapt their agricultural practices to changing conditions.

The study's findings enhance understanding of the current status and determinants of CIS usage in the Sidama region, offering valuable insights for policymakers and stakeholders involved in the provision and promotion of climate information services. It underscores the need for a comprehensive and coordinated strategy to improve access, relevance, and utilization of CIS among smallholder farmers.

5.3. Recommendations.

Based on this study’s findings on the status of climate information services (CIS) and its determinants among smallholder farmers in the Sidama region of Ethiopia, several recommendations for different stakeholders can be made. Service providers, policymakers, the regional agricultural offices and local administrators are some of the stakeholders for whom these recommendations will be of relevance.

General Recommendations:

- Strengthen the technical and organizational capacity of the relevant climatic service delivery agencies such as the meteorological institutions and agricultural extension services to enable the quality and distribution of climate information to improve.
- Create market oriented CIS that corresponds to the farming activities and decision-making process of smallholder farmers. Farmers must participate in the development of these services to make them useful.
- Diversify Dissemination Channels: Including mobile apps and SMS, among other channels witness climate information to be central in engaging people.
- Increase Awareness and Adoption: Specific awareness and training of farmers on CIS and its associated and enhancing farmers' knowledge of the use of related services, such as credit or agricultural inputs must be conducted.

Policy makers Recommendations:

- It is necessary to draw up a specific plan that details how the CIS would be developed and disseminated as part of the agricultural policies and programs.
- It is necessary to put enough resources into national meteorological agencies and research institutions for the purpose of collecting, analyzing, and forecasting climate data.
- Develop policies that ensure that climate information is made available in a timely manner, as well as provided in an accessible manner to the smallholder farmers and other intended users.

Regional and Local Administration Recommendations:

- Integrate with relevant institute or agency and set up regional climate information centers that provide relevant data and advice that are helpful to the farmers.
- Provide packages of training that will train the extension agents on climate information use and its communication to the farmers effectively.
- Create Feedback Mechanisms: Build systems that will enable farmers to be met regularly and their views concerning provision of CIS taken into account.

- Enterprise Developments and Networking: Promoting opportunities for the advancement of ideas within the farming community and enabling farmers to learn from one another.

Community Engagement Recommendations:

- Smallholder farmers should be engaged actively in the identification of their climate information requirements.
- Farmers should engage in various communication methods including language and visual means to widen their reach.
- Farmers should have consistent training programs focused on teaching them to understand and use climate information, specifically targeting the more disadvantaged members of society such as women and youth.

These consolidated recommendations are aimed at enhancing the operationalization of the climate information services framework so that smallholder farmers can adapt to the climate change impacts.

5.4. Future works

In this study, the focus was on evaluating the status of climate information services and its determinants among smallholder farmers in the Sidama region of Southern Ethiopia. But, still some areas exist which need to be solved through further studies. Some of those are for future work include:

- Assessing the role of climate information services on the livelihood systems and resilience of smallholder farming communities.
- Determining the efficacy and sustainability of various climate information dissemination channels and mechanisms against each other.
- Assessing impact of institutional and policy frameworks in enhancing the supply and use of climate information services.

Further research in these areas could assist in better comprehension of the relationships between various elements and uncertainties regarding climate information services leading to formulation and provision of appropriate modalities geared towards smallholder farmers and climate variability.

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APPENDICES

Appendix 1. Tests for multicollinearity

Variance inflation factor (Mean VIF 1.43)

Variables	VIF	1/VIF
Age	1.85	0.541502
access_to_climate info-	1.79	0.560027
Educational	1.66	0.601174
received_training	1.49	0.671189
How_long_y~g	1.45	0.691177
Size_of_household	1.44	0.693678
access_credit	1.41	0.708935
advisory_services	1.36	0.737040
land_size_hh	1.36	0.737897
income_Birr	1.35	0.740574
getting_social protection	1.24	0.804457
Distance_Market	1.13	0.886657
Sex	1.11	0.900501
Mean VIF	1.43	

Source: own computation, 2024 .

Appendix 2. Test of goodness-of-fit for binary logistic regression model

Logistic model for Use_CIS, goodness-of-fit test

(Table collapsed on quantiles of estimated probabilities)

Group	Prob	Obs_1	Exp_1	Obs_0	Exp_0	Total
1	0.0004	0	0.0	39	39.0	39
2	0.0013	0	0.0	38	38.0	38
3	0.0030	0	0.1	39	38.9	39
4	0.0095	1	0.2	37	37.8	38
5	0.0646	2	1.3	36	36.7	38
6	0.3078	7	6.3	32	32.7	39
7	0.6348	13	17.5	25	20.5	38
8	0.9143	33	30.9	6	8.1	39
9	0.9757	36	36.0	2	2.0	38
10	0.9999	38	37.8	0	0.2	38

Source: own computation, 2024

Dependent variable = UCIS

Number of observations = 384

Number of groups = 10

Hosmer-Lemishow chi2 (8) = 6.65

Prob > chi2 = 0.5753

Appendix 3. Logistic regression

Use_CIS	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Age	-.663	.314	-2.12	.028	-1.278	-.049	**
Educational	1.113	.286	3.89	0	.552	1.673	***
Size_of_household	.021	.154	0.13	.894	-.281	.322	

land_size_hectares	.893	.386	2.32	.017	.137	1.65	**
income_Birr	0	0	0.52	.605	0	0	
How_long_you_been_~g	.031	.028	1.09	.274	-.025	.086	
advisory_services	1.365	.482	2.83	.002	2.31	.42	***
received_training	1.493	.508	2.94	.002	2.489	.498	***
Distance_Market	-.03	.008	-3.98	.0	-.045	-.015	***
access_credit	1.287	.591	2.18	.03	2.445	.128	**
getting_social-PPS	1.205	.488	2.47	.014	2.162	.248	**
access_to_climate	4.014	.743	5.40	.0	2.557	5.47	***
Constant	3.892	1.912	2.04	.042	.145	7.639	**

Mean dependent var	0.353	SD dependent var	0.479
Pseudo r-squared	0.675	Number of obs	368
Chi-square	322.748	Prob > chi2	0.000
Akaike crit. (AIC)	181.242	Bayesian crit. (BIC)	232.047

*** *p<.01*, ** *p<.05*, * *p<.1*

Source: researcher own computation, 2024 .

Appendix 4. Marginal effect for Logistic regression result through analyzing utilization of CIS

Average marginal effects Number of obs = 384

Model VCE : OIM

Expression : Pr(Use_CIS), predict()

dy/dx w.r.t. : Sex Age Educational Size_of_household land_size_hectares income_Birr

How_long_you_been_farming advisory_services received_training Distance_Market access_credit getting_social access_to_climate

	Delta-method					
	dy/dx	Std.Err.	Z	P>z	[95%Conf.	Interval]
Sex		0		(omitted)		
Age	-0.043	0.020	-2.190	0.028	-0.082	-0.005
Educational	0.073	0.017	4.310	0.000	0.040	0.106
Size_of_household	0.001	0.010	0.130	0.894	-0.018	0.021
land_size_hectares	0.058	0.024	2.380	0.017	0.010	0.106
income_Birr	0.000	0.000	0.520	0.604	-0.000	0.000
How_long_you_been_farming	0.002	0.002	1.110	0.268	-0.002	0.006
advisory_services	0.089	0.029	3.030	0.002	0.147	0.031
received_training	0.097	0.031	3.170	0.002	0.158	0.037
Distance_Market	-0.002	0.000	-4.550	0.000	-0.003	-0.001
access_credit	0.084	0.037	2.250	0.024	0.157	0.011
getting_social-SP	0.079	0.031	2.580	0.010	0.138	0.019
access_to_climate	0.262	0.038	6.860	0.000	0.187	0.337

Source: researcher own computation, 2024 .

Appendix.5. Questionnaires

SCHOOL OF GRADUATE STUDIES

COLLEGE OF SOCIAL SCIENCE AND HUMANITIES

MASTERS OF POPULATION AND DEVELOPMENT PLANNING

QUESTIONNAIRES

Baseline Survey on the Status of Climate Information Services and Factors Influencing Their Use Among Smallholder Farmers in the Sidama Region

Dear Respondents,

My name is Kereyu Kebede, and I am a postgraduate student at Hawassa University in Ethiopia. I am conducting a study titled "Climate Information Services and Their Determinants Among Smallholder Farmers in the Sidama Region of Southern Ethiopia." The purpose of this questionnaire is to gather relevant information about the status of climate information services and the factors that affect their use among smallholder farmers. The information you provide will be used for academic purposes only. The success of this study relies on your honest and thoughtful responses to each question. Rest assured, your answers will be treated with respect and kept confidential.

Thank you for your cooperation.

1. Background Information

No_	Basic characteristics of respondents	Answers
1.1.	Name of the Zone	
1.2.	Name of the Woreda	
1.3.	Name of the Kebele	
1.4.	Sex of household head	1) Male 2) Female
1.5.	Age of household head	---------
1.6.	Educational Level of household head	1) Cannot read and write 2) Primary (1–8) 3) Secondary (9-12) 4) Certificate 5) Diploma 6) Degree and Above
1.7.	Marital Status of household	1) Married 2) Single 3) Widowed 4) Divorced
1.8.	Job Status of household	1) Farmer 2) Government employee 3) Merchant 4) Unemployed
1.9.	Size of household (HH) members including husband and wife	-------------
1.10.	Do you have your own land?	1) Yes **2)** No

No_	Basic characteristics of respondents	Answers
1.11.	Farming land size in hectare	------------
1.12.	Main sources of income house hold	1) Crop production 2) Cattle rearing 3) Mixed 4) petty trade 5) Weaving 6) Daily laborer 7) No income
1.13.	Annual income of HH in Br	------------------
1.14.	What type of agriculture do you practice?	1. Rain-fed 2. Irrigated 3. Mixed
1.15.	How long have you been farming?	------------------
1.16.	What power do you use for farming?	1) Labor 2) Animal traction 3) Tractor
1.17.	In which of the classification of land fertility your cultivated land is categorized?	1) Infertile, 2) Medium, 3) Fertile
1.18.	What is the slope of your cultivated land?	1) Higher slope 2) Medium slope 3) Lower slope
1.19.	How do you perceive the productivity of your farm land?	1) Improving 2) Constant 3) Declining 4) Not sure
	If the yield from your farm land is	1) Absence of

No_	Basic characteristics of respondents	Answers
1.20.	decreasing, what could be the reason behind? (Rank if more than one answer)	fallowing 2) Poor access to chemical fertilizers 3) Unreliable rainfall 4) Erosion/runoff 5) Over cultivation 6) Pests 7) Moisture stress
1.21.	Do you get advisory services from agricultural extension agents?	1) Yes 2) No
1.22.	Have you ever received training on extension services?	1) Yes 2) No
1.23.	Do you have market access which nearby?	1) Yes 2) No
1.24.	Do you have access to credit services?	1) Yes 2) No
1.25.	Land ownership certificate	1) I do not have land 2) I do not have land certificate 3) Yes in my name 4) Together with my husband/wife
1.26.	Are you getting any social protection program support in cash or kind?	1. Yes 2. No

2. Climate services

SN	Questions	Answers
2.1.	Have you heard about weather forecasts?	1. Yes 2. No

2.2.	Do you believe it is useful to agricultural activities?	1. Yes 2. No
2.3.	If Yes, who introduced you for the first time?	1. Media 2. From formal/informal education 3. Extension workers 4. Family/friends etc
2.4.	Do you have access to climate information services	1. Yes 2. No
2.5.	If yes what is the source of access	1.TV 2.Cell phone 3. Radio 4.extension workers/agricultural experts 5.Village leaders/ Representative 6. Peer farmers
2.6.	If you receiving weather advisory, how is its frequency?	1. every day 2. every other day 3. weekly 4. every two weeks 5. seasonally
2.7.	Which weather element is you receive?	1)Rainfall 2)Temperature 3)Both
2.8.	Are you receiving seasonal forecast?	1)Yes 2)No
2.9.	If yes, when?	1)Onset 2)cessation 3)Both 4)Un usual weather event happened

2.10.	Have you ever received advisory during un seasonal rainfall?	1)Yes 2)No
2.11.	What types of extreme weather events are common in your area?	1)Heavy fall/flood 2)Shortage of rainfall/drought 3)High temperature 4)Cool temperature
2.12.	Are the weather forecast information useful for your livelihood activities?	1)I do not get the information 2)Yes useful 3)No, it is not useful
2.13.	Are you practicing Indigenous/ knowledge to forecast climate?	1)Yes 2)No
2.14.	If yes, how it is frequent?	1)Frequently 2)Sometimes
2.15.	From which source you receive the Indigenous knowledge to forecast?	1)Self-experience 2)From elders/families 3)Religion leaders 4)From all
2.16.	Are you applying/using the weather for cast information in your livelihood activities?	1)I do not get the information 2)Yes I am applying them 3)No I am not applying them
2.17.	If you are applying the weather information, Are they useful	1)Yes 2)No

APPENDIX 6. Interview Guideline for key informants

Interview for key informants

Dear Interviewee,

My name is Kereyu Kebede, and I am a postgraduate student at Hawassa University, pursuing a Master of Arts (MA) degree with a specialization in "Population and Development Planning." I am conducting research on the topic of "Climate Information Services and Their Determinants Among Smallholder Farmers in the Sidama Region."

Your cooperation in providing reliable information during our discussion is crucial for the success of this study. Therefore, I kindly ask you to share your thoughts openly and honestly. I truly appreciate your time and effort in participating in this interview. Please be assured that all information will be kept confidential and used solely for the purposes of this study.

Interview Guideline for key informants

Interview: for **Woreda Agriculture Rural Development Office,Development Agents (DA), kebele administrators.**

Good morning/afternoon, thank you for taking the time to speak with us today. Could you please introduce yourself and briefly describe your role in supporting agricultural development in your community?

I. Informants' background and research site identification

1.1. Name of interviewer(optional) ____________________

1.2. Name of interviewee _____________ Sex___age___

1.3. Name of interviewee kebele ____________________

1.4. Role in community_________________________

1.5. Place of interview_________________________

1.6. Date of Interview ______________________

1.7. Time of Interview____________________

Interview Questions for Development Agents on the Status of Climate Information Services and Factors Affecting its Use among Smallholder Farmers:

1. Can you share your observations on the current access of smallholder farmers to climate information services in your area of operation?
2. In your experience, how have smallholder farmers utilized climate information services in making farm management decisions?
3. What factors do you believe play a significant role in determining smallholder farmers' access to climate information services?
4. Have you noticed any successful examples of smallholder farmers applying climate information services for their agricultural activities?
5. How do you think we can further enhance the adoption and effectiveness of climate information services among smallholder farmers in our community?

Interview Questions for Woreda Agriculture Rural Development Office Expert:

1. Can you provide insights on the current access of smallholder farmers to climate information services in your woreda?
2. How do you perceive the usefulness of climate information services in assisting smallholder farmers with their farm management decisions?
3. What factors do you believe are significant in determining smallholder farmers' access to climate information services in your woreda?
4. Have you observed any successful cases of smallholder farmers effectively applying climate information services for their agricultural activities?
5. How do you think we can improve the utilization of climate information services among smallholder farmers in your woreda?

Interview Questions for Kebele Administrators on the Status of Climate Information Services and Factors Affecting its Use among Smallholder Farmers:
1. Can you provide insights on the current availability and accessibility of climate information services for smallholder farmers in our kebele?
2. From your perspective, how have smallholder farmers benefited from using climate information services in making farm management decisions?

3. What do you believe are the main factors that influence smallholder farmers' access to climate information services in our kebele?

4. Have you observed any successful examples of smallholder farmers applying climate information services for their agricultural activities? If so, could you share some details?

5. How do you think we can enhance the utilization of climate information services among smallholder farmers in your kebele and address any barriers to access?

interview Questions for Local Elders on the Status of Climate Information Services and Factors Affecting its Use Among Smallholder Farmers:

1. Can you share your observations on the current access of smallholder farmers to climate information services in your community?

2. In your experience, how have smallholder farmers benefited from using climate information services in making farm management decisions?

3. What do you believe are the main factors that influence smallholder farmers' access to climate information services in your area?

4. Have you seen any examples of smallholder farmers successfully applying climate information services for their agricultural activities? If so, could you provide some details?

5. How do you think we can further support and improve the utilization of climate information services among smallholder farmers in your community?

Thank you for sharing your insights with us today. Your perspective is valuable for our study on enhancing climate information services for agricultural development.

APPENDIX.7. Guideline for FGD (Focus Group Discussions)

Focus Group Discussion

Dear Participants,

My name is Kereyu Kebede, and I am a postgraduate student at Hawassa University, working towards a Master of Arts (MA) degree in "Population and Development Planning." I am conducting research on "Climate Information Services and Their Determinants Among Smallholder Farmers in the Sidama Region of Southern Ethiopia."

Your cooperation in providing accurate information during our discussion is essential for the success of this study. I kindly ask you to share your thoughts candidly and without hesitation. Thank you for taking the time and effort to participate in this interview. Please rest assured that all information will be kept confidential and used solely for this research.

Guideline for FGD (Focus Group Discussions)

1. What types of crops are growing in the area? When is the growing season? Why you adopt the varieties you preferred?

3. How do you currently access climate information services?

How do you judge the climate services in your area? Where are the sources? Are you getting the information as you need?

4. Are you believed the prediction is important? Explain its reliability from your past experiences?

5. In what ways have climate information services been useful in your decision-making process for farm management?

6. Explain the support of DA and agricultural offices in getting climate information?

7. How much you used the indigenous knowledge of climate information in practicing/applying farming activities?

8. Do you use climate information services? What factors do you think influence the farmer's use to climate information services?

9. Can you describe any specific examples of how you have applied climate information services to your agricultural activities?

10. Do you have access to climate information dissemination sources?

11. Do you remember the worst time of drought or flood and similar hazard in your area? Explain the damage you faced? Is there time you applied climate knowledge to intervene the challenge?

12. How much are you ready to receive recent predictions in using agricultural activities? Which media/channel you prefer to receive the information? (Like radio, Mobile…)

13. Are there social protection programs and do you getting support from local governments And NGOs in promoting climate information services?

14. Is there any language barrier to receive the information? Which language you prefer to receive the information?

15. What do you recommend for best climate services and from which organization you expect?

Image 1.women Focus Group Discussion from samples Kebeles.

Image 2.Men Focus Group Discussion from samples Kebeles

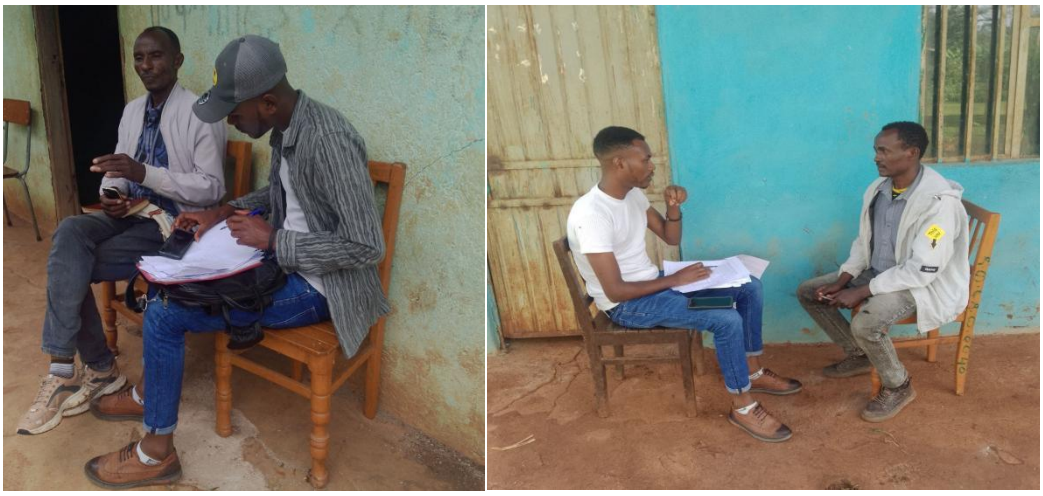

Image 3.Woreda and Kebele Key Informants