Addis Ababa University
College of Veterinary Medicine and Agriculture
Centre for Food Security

Households Food Security and Resilience to Drought and Conflict in South Wollo Zone, Ethiopia

By
Jemal Hassen Muhyie

Addis Ababa, Ethiopia
June 2025

Addis Ababa University
College of Veterinary Medicine and Agriculture
Centre for Food Security

Households Food Security and Resilience to Drought and Conflict in South Wollo Zone, Ethiopia

By
Jemal Hassen Muhyie

Advisers
Desalegn Yayeh Ayal (Ph. D.)
Temesgen Tilahun Teshome (Ph. D.)

A Dissertation Submitted to Centre for Food Security Studies, College of Veterinary Medicine and Agriculture, Addis Ababa University in Fulfilment of the Requirements for the Degree of Doctor of Philosophy in Food Security and Development

Addis Ababa, Ethiopia
June 2025

APPROVAL PAGE

Addis Ababa University

College of Veterinary Medicine and Agriculture

Centre for Food Security Studies

As supervisors/co-advisers of the dissertation, we certify that we have read and evaluated the dissertation prepared by **Jemal Hassen Muhyie** Entitled 'Households Food Security and Resilience to Drought and Conflict in South Wollo Zone, Ethiopia', and recommend for Open Defense as fulfilling the requirement for the degree of **Doctor of Philosophy in Food Security and Development.**

Dr. Desalegn Yayeh _____

Name, Major Advisor Signature, and Date

Dr. Temesgen Tilahun _____

Name, Co-advisor Signature, and Date

As members of the Examining Board of the dissertation Open Defense, we certify that we have read and evaluated the dissertation prepared by **Jemal Hassen Muhyie** Entitled 'Households Food Security and Resilience to Drought and Conflict in South Wollo Zone, Ethiopia' and recommend that it is acceptable as for the dissertation required for the degree of Doctor of Philosophy in Food Security and Development.

Dr. Messay Mulugeta _____

Name, Chairman Signature, and Date

Dr. Teferi Mekonen _____

Name, Internal Examiner Signature, and Date

Dr. Mekonen Hailu _____

Name, External Examiner Signature, and Date

Final approval and acceptance of this dissertation is contingent upon the candidate's submission of the final copy of the dissertation, incorporating all the comments by the Examining Board, to the Council of Graduate Studies (CGS) through the Centre Academic Committee (CAC) of the Centre.

_____

Chairperson of the Centre or Graduate Program Coordinator

DEDICATION

I would like to dedicate this dissertation to my beloved father, Mr. Hassen Muhyie, and mother, Mrs. Alemnesh Yimam, whose unwavering support, sacrifices, and unconditional love have been the foundation of all my achievements. They instilled the value of hard work, commitment, belief in knowledge, and perseverance, coupled with endless encouragement and trust, that carried me through the most challenging moments. Hence, this journey would not have been possible without you. Every step I have taken in my academic life reflects your strength, guidance, and love. As I fulfil the commitment to set the academic example for the family, we made the dream come true together! Congratulations!!

STATEMENT OF AUTHOR

I, **Jemal Hassen Muhyie**, do hereby declare to Addis Ababa University School of Graduate Studies that this dissertation is a product of my original research work, and it has not been submitted to any other university for any academic degree. Materials and information other than my own are duly acknowledged.

Jemal Hassen Muhyie

Signature:

Date of Submission: _____

This dissertation has been submitted for examination with our approval as a university adviser and supervisor.

Advisers	Signature
Dr. Desalegn Yayeh	_____
Dr. Temesgen Tilahun	_____

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATIONS AND ACRONYMS

ABS	Access to Basic Services
AC	Adaptive Capacity
AI	Aridity Index
AST	Asset
BoA	Bureau of Agriculture
CMB	Common Method Bias
CoBRA	Community-based Resilience Analysis
COVID-19	Corona Virus Disease - 19
CS	Coping Strategies
CSI	Coping Strategy Index
CWBAL	Climatic Water Balance
DFID	Department for International Development
DiD	Difference in Difference
EMI	Ethiopian Meteorological Institute
ESS	Ethiopian Statistical services
FAO	Food and Agriculture Organization
FCS	Food Consumption Score
FE	Fixed Effect
FEWS NET	Famine Early Warning Systems Network
FGD	Focus Group Discussion
FSIN	Resilience Measurement Framework of the Food Security Information Network
GDP	Gross Domestic Product
HDDS	Household Dietary Diversity Score
HFBM	Household food balance model
HFIAS	Household Food Insecurity Access Scale
HFSSM	Household Food Security Supplemental Module
HoA	Horn of Africa
ICESCR	International Covenant on Economic, Social and Cultural Rights

IDMP	Integrated Drought Management Programme
IDP	Internally Displaced Person
IPCC	Intergovernmental Panel on Climate Change.
KII	Key Informant Interview
MIMIC	Multiple Indicators, Multiple Causes
MoH	Ministry of Health
NDVI	Landsat Normalized Difference Vegetation Index
OCHA	Office for the Coordination of Humanitarian Affairs.
PET	Potential Evapotranspiration
PSNP	Productive Safety Net Programme
RCI	Resilience Capacity Index
RE	Random Effect
RIMA	Resilience Index Measurement and Analysis
RIMA	Resilience Index Measurement and Analysis
RSM	Resilience Structure Matrix
SDG	Sustainable Development Goal
SPEI	Standardize Evapotranspiration Index
SPI	Standardized Precipitation Index
SSN	Social Safety Net
TCA	Total Calorie Availability
TCL	Total Calorie Loss
TLU	Total Livestock Unit
UN	United Nations
UNSC	United Nations Security Council
USAID	United States Agency for International Development.
USDA	United States Department of Agriculture
VIF	Variance Inflation Factor
WFP	World Food Programme

ACKNOWLEDGMENTS

I thank my advisors, Dr. Desalegn Yayeh and Dr. Temesgen Tilahun, for the tremendous support, professional guidance, and mentorship throughout my research work. It is made possible only because of the great support and encouragement. I recognize and appreciate the support from Ethiopian Meteorological Institute for providing me with longitudinal precipitation and temperature data that is used for the study. I would also like to thank Mohammed Tilahun, Hussien Gizaw, Solomon Zewdu, Yimer Abebe and Meseret Demelash for the priceless support during my PhD journey and for the guidance, ideas, motivation, and for the great support during data collection in such complex security context. I am thankful to all research participants who have made the research possible by providing local and contextual information. It was an excellent opportunity to share their life experiences during the study. I am very grateful to my wife, Zumra, who has spent sleepless nights encouraging and motivating me to finalize the project. She has been instrumental in the process and gave me comfort and energy when I spent long hours reading and working on my dissertation. Indeed, my research has become a success at the cost of the time I would rather give to my beloved children, and I am indebted to them.

Jemal Hassen

June 2025

ABSTRACT

Armed conflicts cause food insecurity and famine by triggering the disruption and destruction of food systems. The conflict that erupted in northern Ethiopia lasted from 2020 to 2022 and affected millions of people. This resulted in severe damage to the food security, livelihoods and social dynamics of communities in the Amhara region of Ethiopia. Besides, due to climate change, drought conditions are increasing from time to time, threatening the food security of communities reliant on rainfed agriculture. Drought has become protracted and has resulted in a widespread food insecurity crisis. South Wollo Zone, already vulnerable to climate shocks, suffered severe destruction and loss of life during the northern Ethiopia conflict.

The study analyzed household food security and resilience of conflict and drought-affected households by synthesizing the impact, analyzing drought trends, identifying food security determinant factors, and coping strategies deployed by households during adversities through the use of longitudinal meteorological data from 1981 to 2022, and establishing a pre-post conflict food security and resilience assessment.

Descriptive and quasi-experimental designs were employed for pre-post retrospective data gathered from 422 randomly selected households, while literature reviews, key informant interviews, and focus group discussions were analyzed using the thematic analysis method. Standardized Precipitation and Evapotranspiration Index helped to analyze the direction and magnitude of drought trends. Besides, Resilience Index Measurement and Analysis, and the Household Food Balance Model were used for the food security and resilience component. A recall bias analysis was conducted for retrospective data using the Flashbulb memory test method as a complementary approach to the study to determine statistical reliability of recall data in food security and resilience study.

The study revealed that conflict and drought significantly undermine household food security. Both the short-term and long-term drought conditions have increased between 2000 and 2015. The significant downward trend in SPEI highlights increasing drought

severity and frequency. The average per capita calorie availability drops from 1,789 kcal pre-conflict to 1,420 kcal at post-conflict, below the Ministry of Health recommendation of 2,300 kcal. In contrast, the coping strategy index increased for the same period. It was found that livestock ownership, agricultural index, work ratio, and age of the household head were positively associated with food security. In contrast, larger family size, exposure to drought, and exposure to conflict and aid were negatively associated. While the resilience capacity index was reduced from 45.1 to 38.8 after the conflict, assets contributed 60.55% to resilience capacity, but access to basic services was not relevant in determining resilience post-conflict. Households with high conflict exposure experienced a 7.85-point greater decline in resilience capacity compared to a 3.32-point decline for low-exposure at p-value <0.01. Whereas, a statistically significant decline in RCI by approximately 6.43-point for low drought-exposed households but no statistically significant differential impact of drought between groups.

The study offers policy recommendations to build productive livelihoods through asset building, livelihood diversification, recovery programs integrating conflict-sensitive and peace-building initiatives to enhance food security and foster self-reliance, acknowledging the compounding nature of conflict and drought. It also recommends the integration of complementary statistical approach such as the Flashbulb memory test to examine recall bias in retrospective food security and resilience study to enhance reliability of data for statistical inference.

Keywords: Coping strategies, Drought trend, Food security, Household resilience, Social dynamics, SPEI, Violent conflict, Vulnerability

CHAPTER 1: GENERAL INTRODUCTION

This chapter provides a detailed introduction to the research theme. It covers key topics related to the rationale, objectives, problem statement, scope, and limitations of the study regarding the food security and resilience of communities affected by recurrent drought and violent conflict in the South Wollo zone, Amhara region, Ethiopia.

1.1. Background

Food security is one of the most important global agendas in the Sustainable Development Goals (SDGs). Food security is a multidimensional concept and a multicausal phenomenon that covers people's ability to make food available, accessible, and utilize it to support the normal functioning of the body required for physical and mental development. It also encompasses the stability of the three dimensions of availability, accessibility, and utilization over a longer period (Birara et al., 2015; Motbainor et al., 2016). Drought, political instability, conflict, poor governance, population growth, and outbreaks of disease like COVID-19 are among the most common drivers of food insecurity in developing nations (Dorward & Kydd, 2004; Mangaliso & Dlamini, 2018).

Impacts of climate change are major threats to food security in Africa, where the community is mainly dependent on rain-fed agriculture that is vulnerable to climate change consequences (Parry et al., 2004; Parry et al., 2007; Aklilu & Alebachew, 2009; Lemma et al., 2013). Population growth and land degradation also exacerbate chronic food insecurity and expose people to vulnerabilities. These further contributed to widespread poverty characterized by continuous out-migration, illiteracy, hunger, conflict for scarce resources, incapability to use improved inputs and technologies, and poor asset base (Arega, 2015). Besides, the continent is severely affected by various kinds of conflict ranging from election disputes to control over resources, civil unrest, religious intolerance, ethnic motivated violence, and boundary conflicts (Allen & Okeke-Uzodike, 2010; Alozieuwa, 2010; Amungwa, 2011; Bere, 2011; Christakis, 2013; Pate, 2014).

Conflict also drives food insecurity and destabilizes communities. Conflict displaces people, leaving them to abandon their farmlands, homes, and jobs. This could lead to a shortage of food production and a lack of income to buy food and other basic services. The destruction of private and public infrastructure, including market networks, roads, bridges, health and water facilities, schools, and research institutions, leads to poor food security and nutrition outcomes (OCHA, 2018).

In 2021, Ethiopia faced its worst crisis since 2016, with an exceptionally high need for humanitarian assistance. An estimated number of 5.5 million people are facing acute food insecurity in northern Ethiopia. The country is facing multiple hazards, including conflict, civil unrest, floods, and drought, which are further exacerbated by desert locust infestations and the COVID-19 pandemic, resulting in a devastating food insecurity situation. Since the conflict in northern Ethiopia expanded into neighboring regions of Amhara and Afar, it was reported that more than half a million people have been displaced, resulting in the disruption of livelihood activities, including farming, in areas affected by the war (FEWS NET, 2021).

Climate change exacerbates existing vulnerabilities and inequalities, further undermining the Sustainable Development Goals (SDGs), particularly in areas where these vulnerabilities and inequalities already exist. This impact can potentially reduce the adaptive and transformative capacities of the poor by limiting their choices and opportunities. Floods, droughts, and storms are climate change-induced disasters that have resulted in mortality, exacerbated poverty, forced migration, increased inequality, reduced access to basic services, and weakened governance capacities among communities and governments. All these are interlinked problems where one affects the other and vice versa. The IPCC (2022) report indicated that mortality related to floods, droughts, and other storms in vulnerable countries, such as Ethiopia, is 15% higher than in countries with low vulnerability.

Climate-induced crises not just aggravate further vulnerabilities and inequalities but also undermine the achievement of SDGs, particularly the goals related to no poverty (SDG1),

zero hunger (SDG2), gender equality (SDG5), and reducing inequality (SDG10). At the same time, it has both direct and indirect negative impacts on several other United Nations Sustainable Development Goals (Birkmann et al., 2022). Climate change impacts the erosion of livelihoods, which is important for resilience. Besides, displacement, forced migration, and violent conflict are also included in the list. It affects people disproportionately depending on differences in adaptation capacities and the level of existing vulnerabilities. However, women, youth, the elderly, ethnic and religious minorities, and refugees are the most impacted. Most importantly, households and communities with climate-sensitive livelihoods, such as agriculture and livestock, are highly impacted segments of the community (Birkmann et al., 2022).

The FAO indicated that drought and other climate change-induced factors affect all four pillars of food security. Drought and climate impacts have long-term consequences on food security and longer-term development. According to Dorward and Kydd (2004), drought reduces the productivity of the rural economy by reducing the return on agricultural investment, pushing investment from income-maximizing activities towards risk-reduction activities, and discouraging investment in agriculture, which leads to long-term stagnation of development and increased rural poverty.

In communities where multiple shocks exist, an in-depth understanding of livelihoods, gender dynamics, the social context, and local and national institutions is required to address the critical constraints to the problem at the household level and understand the underlying causes of the crisis. A food security assessment at the household level provides logical evidence that reflects national food availability and nutritional security at both the household and individual levels (Pérez-Escamilla & Segall-Corrêa, 2008). Besides, such assessments provide information on the prevalence of food insecurity at a particular location or community. Other research has indicated that building resilience capacity, attributed to improved food security, can be measured by various indicators (Ansah et al., 2019). Although defining resilience is so challenging, as it means different things to different people and institutions, so is measuring resilience.

Agriculture is Ethiopia's primary source of GDP, which is characterized by erratic rainfall, and the economy is recurrently affected by drought. Regardless of its agricultural production potential, the Amhara region, particularly the South Wollo zone, is the most disaster-prone zone in the country with a significant level of food insecurity. South Wollo zone is one of the zones in the Amhara region of Ethiopia that is periodically affected by drought (Regassa et al., 2007). Recently, the conflict in Northern Ethiopia imposed devastating impacts on the food security situation of the community.

In addition to the recent conflict that affected communities in South Wollo zone, previous records showed that drought episodes in the last four decades were observed in 1984, 1987/1988, 1992/1993, 1999, 2003/2004, 2007/2008, 2009, and 2012, which were among the worst drought years in the history of Ethiopia. 1984 was the most drastic and extreme drought in South Wollo and other parts of Ethiopia (Masih et al., 2014; Mohammed et al., 2018). Such extreme weather events threaten crop production, exacerbate food insecurity issues, and ultimately impact the socio-economic conditions of smallholder farmers (Suryabhagavan, 2017).

In the South Wollo zone, communities exposed to multiple shocks require mechanisms that build inherent or learned resilience. A research study by Kasie et al. (2017) in the Amhara region showed that communities exposed to shocks gained better ex-ante risk management choices. Resilience is a prerequisite for achieving the global sustainable development agenda, which is regarded as a thread that links the development, human rights, peace, and security pillars. Evidence-based research that understands resilience from a food security perspective is crucial and can help focus on building upon existing best practices. This research, therefore, provides empirical evidence on the impact of drought and conflict on resilience to food insecurity from a sustainable food systems perspective for households in the South Wollo zone of the Amhara region, Ethiopia.

1.2. Statement of the Problem

The South Wollo zone is affected by recurrent drought, and the area is often considered the heart of Ethiopia's ‘famine belt’. The zone was severely affected by the drought-induced

famines in 1971-74 and 1983-84 (Mesfin, 1984; Rahmato, 1986). Drought, conflict, high population, fragmentation of farmland, steep slopes often prone to flooding, frost-affected areas, severe impact of pests and other calamities made the South Wollo zone the most food insecure and famine-prone area (Little, 1992; Little et al., 2006; Tesfaye et al., 2023; Seid et al., 2024).

Conflict affects the quality and quantity of food that people require for nourishment through its multifaceted impact, constraining the means of production, distribution, accessibility, and purchasing power of affected communities (FAO & WFP, 2018). Conflict results in the huge destruction of private and public infrastructure, including the loss of lives and livelihoods. Agricultural activities are disrupted, means of food distribution are affected, market infrastructures are damaged, public institutions are destroyed, and all these leads to a deteriorated food security situation. In return, food insecurity can also lead to conflict in fragile contexts, weakening local and government institutions (Gatdet, 2021).

Though the conflict affected both urban and rural households in the South Wollo zone, the worsening food insecurity situation poses a higher risk to vulnerable communities like pregnant and lactating mothers, old persons, and children under the age of five years. The risk of malnutrition is increasing to the level that exposes these vulnerable groups to opportunistic diseases like cholera, typhoid, and COVID-19 (IFRC & ICRC, 2021). Many farmers who used to rely on the Productive Safety-Net Programs (PSNP) to access food have been affected, and the distribution mechanism of PSNP was interrupted because of security concerns and looting of PSNP food from the warehouses in various parts of the region. Even after the cessation of the active conflict, thousands of people in South Wollo continue to struggle to meet their basic food and other needs. During the recent Northern Ethiopia conflict, livestock, agricultural tools, and grain stores were reportedly looted, which are key for household food security and resilience (GEOGLAM, 2022).

The conflict in the Amhara region erupted during the harvest time, which affected all the resources such as human, financial, physical, natural, and social capitals that are relevant assets for household food security and resilience, and were degraded (Justino, 2011; FAO,

2021). The war forced communities in the war-torn areas to flee their home, abandoning mature crops almost at the harvesting stage. Rainfed agriculture is predominant in the study area, so these farmers would take some time to start recovering from the crisis and build household resilience.

Previous studies in Ethiopia (Negatu, 2004; Agidew & Singh, 2018; Mohammed et al., 2021) focused on identifying the food security situation at macro, meso, and micro levels. Small-scale pocket studies also identified determinant factors for food insecurity related to the drought disaster situation. However, there is no evidence-based research that has identified resilience mechanisms to conflict and drought and how these contributed to attaining food security among the multiple shock- and stress-affected communities in the South Wollo zone.

Rural households in the South Wollo zone of Ethiopia face a compounding crisis of food insecurity driven by recurrent drought and violent conflict. While drought has historically defined the region's vulnerability, which places it at the heart of Ethiopia's so-called "famine belt", the recent Northern Ethiopia conflict has introduced severe additional shocks that devastated agricultural systems, eroded household assets, and disrupted critical food assistance programs such as the Productive Safety Net Program (PSNP). These crises have depleted essential resources, including livestock, grain stores, agricultural tools, and social support systems, while forcing large segments of the population to flee their homes. Vulnerable groups like pregnant and lactating women, children, and the elderly face the highest risk of food insecurity, malnutrition, and disease in the aftermath of these compounded disruptions as a result of drought and conflict.

Despite the severity of these overlapping shocks, there is limited empirical research that systematically investigates how drought and conflict jointly affect household food security and resilience, particularly at the local level. Existing studies in Ethiopia have typically examined food insecurity from either a climatic or socio-political lens, often neglecting the interactive and amplifying effects of multiple shocks on household capacities to absorb, adapt, and recover. Furthermore, little attention has been given to the actual coping mechanisms employed by disaster-affected households or to how these responses shape long-

term resilience and food access. This research fills that gap by conducting an integrated analysis of drought trends, conflict impacts, and household resilience capacities using localized data and a systems perspective on food security.

In addition, most studies that rely on retrospective data on food security and resilience do not adequately account for recall bias, especially in crisis-affected settings where traumatic events may distort memory. To address this, the study incorporates a flashbulb memory test method as a complementary approach to assess the reliability of household recall, thereby contributing to methodological refinement in post-crisis research.

By combining meteorological analysis, household surveys, resilience metrics, and memory validation, this study not only deepens understanding of vulnerability in South Wollo but also offers practical insights for building household resilience in regions facing climate and conflict-induced food insecurity.

1.3. Objectives

The general objective of this research is to analyze the impact of drought and conflict on household resilience to food insecurity in the South Wollo zone of the Amhara region, Ethiopia.

The specific objectives of the research are to:

- examine the trend and variability of drought conditions in the South Wollo zone
- analyze the status of household food security and its determinant factors among rural households in the South Wollo zone
- explore the impact of drought and the Northern Ethiopia conflict on food security and livelihoods of households in the South Wollo zone
- identify the adaptation and coping responses of disaster-affected households to the food insecurity situation in the South Wollo zone
- determine the resilience capacity of households affected by conflict and drought to the food insecurity situation in the South Wollo zone

1.4. Research Questions

- What is the pattern of drought in the South Wollo zone and its impact on the household food security situation?
- How did drought and conflict affect household resilience to food insecurity situations?

1.5. Literature Review

1.5.1. Theoretical and conceptual framework

The complex interactions between political, economic, social, and environmental factors have resulted in a protracted and vicious cycle of crisis in the Horn of Africa (HoA). In recent years, climate-induced crises, exacerbated by conflict and deep-rooted poverty, have significantly impacted the lives and livelihoods of millions of people in developing nations (Headey & Kennedy, 2012). The vulnerability of households to shocks relies on their capacity to absorb or withstand the impacts of these shocks. This capacity is also determined by the household's asset endowment and structural factors (FAO, 2008).

Resilience is built when households or affected people or communities are supported to cope with change, the ability to adapt livelihoods to the changing circumstances, and improvement in the structures, systems, and the entire ecosystem where people are able to avoid or minimize the impact of future crises (Pasteur, 2011).

Livelihoods comprise the set of assets and activities necessary to maintain a means of living. A livelihood is sustainable if it can cope with and recover from shocks and stresses by maintaining the asset base of the household without compromising a means of living now and in the future (Chambers & Conway, 1992). These assets determine the livelihoods of a community or a household. These assets – human, physical, social, natural, and financial – that an individual, household, or society owns as a group use as resources to enable the achievement of food security and nutrition outcomes. These assets individually should not be analyzed in isolation. However, the social and political make-up of the community that governs access to natural resources, regulates the market systems, and factors that determine social relations and power dynamics should be analyzed together for a better understanding of livelihood systems (Maxwell et al., 2017).

The role of livelihood assets in the face of environmental crises like drought is to help build the resilience of communities as the key resource to respond to the shock. However, these assets, particularly the physical and financial assets, will automatically become liabilities during violent conflict as they are often deliberately targeted for looting or attack. This will increase the vulnerability of affected households or communities quickly and make them more vulnerable to secondary shocks (Lautze & Raven-Roberts, 2006). During violent conflict, membership in a certain ethnic group or cast could expose households to attacks in different ways.

The scope of this research is linked to the resilience of households to food insecurity in the context of drought and conflict from a food system perspective. Therefore, the author developed the following conceptual framework (Figure 1.1) by adapting the framework (TANGO, 2012) that integrates the livelihoods framework (DFID, 1999; CARE, 2002; TANGO, 2007), disaster risk reduction framework (DFID, 2011) and climate change approaches to address the underlying causes of vulnerability to food insecurity and interplay of the different components of the framework is used.

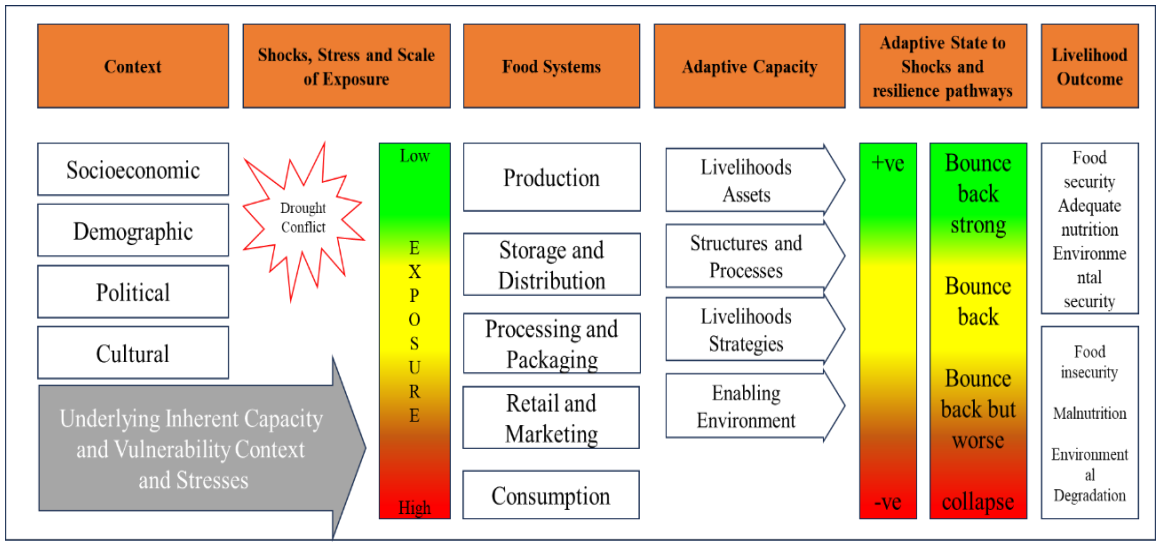


Figure 1.1: Conceptual framework integrating sustainable food system, disaster risk reduction and livelihood framework

Source: adapted by authors from DFID, 2011; and TANGO, 2012

An analysis of the research area's context indicated that it has been affected by recurrent drought, resulting in the failure of rainfall that supports agricultural production. Besides, the population pressure in the area, coupled with the loss of fertility of agricultural land, very fragmented land size, poor technology update, and other factors, have contributed to the high vulnerability of households, particularly the farming community. Repeated pest infestations, the pressure of the recent COVID-19 pandemic, have had a noticeable impact on people's livelihoods and food security. On top of all, the recent conflict that spread from the Tigray region to neighboring Amhara and Afar regions caused tremendous damage to lives and livelihoods and weakened the resilience of the already 'pained' livelihoods of households in the South Wollo zone.

Drought and conflict put pressure on livelihood assets. Deliberate looting and destruction of assets weaken the ability of households to bounce back from the effects of drought and conflict. Looting and destruction of basic services, such as health facilities and water infrastructure, compromise the ability of people in the affected areas to access proper medical services. Communities were affected by disease due to a lack of clean water and inadequate medical services. Market infrastructures were damaged and made inaccessible, which prevents the free flow of basic food commodities that are crucial to ensure food security.

Thousands of people were displaced, abandoning ready-to-harvest agricultural farms because of the conflict that reduced the amount of agricultural production in the zone. It was reported that crops were damaged in a deliberate action. Thousands of people spent months in collection centers and were not able to return to their place of origin to resume cultivation. Children, women, and other vulnerable community members were not able to fulfill their daily energy requirements, and humanitarian aid reached them too late and was not sufficient. Therefore, communities in the South Wollo zone adapted migration (more specifically, internal displacement) as a livelihood strategy during the conflict period, while livelihood diversification, intensification of agriculture through the use of improved and drought-resistant farming practices, and migration were employed in cases of drought

situations. The choice of livelihood strategy to ensure food security for households differs depending on the type of crisis to which households and communities are exposed.

The conceptual framework suggests that in the face of drought and conflict, community structures, systems, and institutions crucial to maintaining positive livelihood outcomes are affected. The negative impact of drought and conflict on assets, processes, and systems leads households to choose resilience pathways that are feasible in their own context. Coupled with initial vulnerability and the impact of repeated drought and conflict, the ability of households' resilience has been compromised significantly. These lead to households experiencing food insecurity as a negative outcome of their livelihood.

1.5.2. Definition of basic concepts

Since the 1948 Universal Declaration of Human Rights, several international instruments highlighted the right of humans to adequate food for the health and well-being of oneself and their families. The 1966 International Covenant on Economic, Social and Cultural Rights (ICESCR) and the UN Committee on Economic, Social and Cultural Rights outlined the responsibilities of governments and the importance of managing international trade to ensure the fulfillment of human rights to food (Girmay, 2019).

Food security, as a complex and multidimensional concept, covers people's ability to make food available, accessible, and utilize it to support the normal functioning of the body for its required physical and mental development. It also encompasses the stability of the other three dimensions of availability, accessibility, and utilization over a longer period (Birara et al., 2015; Motbainor et al., 2016). In other words, food security is a function of the availability, access, utilization, and stability dimensions, which are determined by the interplay of economic, social, environmental, and political factors (MoFED, 2002). It is an essential component of household and personal well-being (Bickel et al., 2000). Conversely, food insecurity refers to the limited or uncertain availability of nutritionally adequate and safe foods or a limited ability to acquire acceptable foods in socially acceptable ways (Bickel et al., 2000). Due to its complex nature, household food security is influenced by multiple economic, social, political, and environmental factors.

The increasing population, diminishing farmland size, political instability, conflict, climate-induced crises, coupled with resource scarcity, loss of soil fertility, and poor farming practices, lead to a worsening food insecurity situation (Bogale & Shimelis, 2009). Conflict and drought are among the major factors that affect people's ability to produce agricultural produce and compromise households' access to food. Conflict deliberately destroys and loots infrastructure and resources, contributing to a weakened ability to cope with disasters and exposing people to disease by undermining basic services that are essential for improving food security and nutrition (Hoddinott, 2001).

Defining resilience is so challenging as it means different things to different people and institutions; measuring resilience is equally complex (Mitchell et. al. 2013). Despite this challenge, resilience thinking has high potential to contribute to food security and sustainable food systems. Nevertheless, while the different definitions of the concept of resilience vary, most of these conceptualizations share commonalities in linking resilience to the ability of systems to function during crises, recover from shocks, and manage change continuously (Bahadur & Florence, 2016).

Armed conflict is defined as "…. a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths in one calendar year" UCDP 2020 as cited by (Fiedler & Rohles, 2021). Accordingly, this study focuses on the impact of the armed conflict in northern Ethiopia on the Amhara region. The conflict involved multiple armed actors, including the Federal force of Ethiopia, regional forces of the Tigray Liberation Front, Amhara regional forces, and Militias.

Livelihood is defined and adapted from the DFID Sustainable Livelihoods Framework (DFID, 2002). It comprises the capabilities, assets, and activities required for a means of living, through interaction in the socio-cultural environment and the vulnerability context, to achieve a better standard of living. It also embraces the social and family support mechanisms on which people rely for living and protection during the crisis period.

Food security, as defined by the FAO (2002), refers to a situation where people have access to sufficient, nutritious, and culturally acceptable food to support their physical growth and mental development. It also encompasses sustainable availability, access, and proper utilization of food.

Social dynamics refer to the social interactions, trust, and cooperation that occur between individuals or groups. The study has explored how conflict affected the intimate relationships, informal social networks, and religious values of families and communities in conflict-affected areas.

1.5.3. Food security and resilience in Ethiopia

Food security in Ethiopia remains a central development challenge, influenced by complex interactions among environmental, socio-economic, and institutional factors. According to WFP (2023), over 20 million Ethiopians required food assistance in recent years due to both acute and structural challenges. Moreover, while the country has made progress through initiatives like the PSNP, food access and availability remain uneven across regions, especially in highland and semi-arid zones.

Resilience-building efforts in Ethiopia have increasingly focused on strengthening household and community capacity to absorb and adapt to shocks without compromising long-term well-being. It also involves improving agricultural productivity, diversifying livelihoods, and enhancing social protection systems through integrated programs that combine climate-smart agriculture, nutrition education, and financial inclusion to reduce vulnerability. The Government of Ethiopia is playing a key role in mainstreaming resilience approaches into development planning. However, addressing systemic issues such as governance gaps, regional disparities, and limited investment in early warning and risk management systems affects the sustainability of these efforts (Oxford Policy Management, 2024).

The dominance of subsistence farming, land degradation, drought, conflict, and inadequate infrastructure has led to food insecurity (Tesfaye & Nayak, 2022). Approximately 90% of Ethiopia's land surface is vulnerable to climate stresses. Prolonged droughts are frequent and have caused significant economic losses, particularly in agricultural productivity. Consequently, more than 16% of the population faces severe food insecurity (Pacillo et al., 2021). A study from Northern Ethiopia (Vaitla et al., 2020) indicated that literacy and livestock holding are key drivers of resilience, which vary depending on whether food security is assessed using the Food Consumption Score (FCS).

1.5.4. Drivers of food insecurity

Drought is a normal feature of any climate; it is a temporary, recurring natural disaster that originates from a lack of precipitation. Drought begins with insufficient precipitation, which can escalate to affect soil moisture, streams, groundwater, ecosystems, and human life, depending on the duration and severity of the drought. According to Takeuchi (1974), drought is a condition in which the amount of water is insufficient to support all of man's activities against the expected amount of water.

Conceptual definitions of drought are vague and provide only a qualitative understanding of drought. However, they do not provide quantitative information to respond to the timing and severity of a drought situation. Therefore, in addition to these conceptual definitions of drought, operational definitions formulated through scientific methods to understand timing, spatial distribution, and severity are important (McKee et al., 1993).

Droughts are classified into four categories: meteorological, agricultural, hydrological, and socioeconomic droughts, depending on various factors, as illustrated in Figure 1.2. Meteorological drought indicates the degree of dryness compared to a normal amount of precipitation, helping to identify the duration of the dry period. 'Dryness' is caused by a deficiency in precipitation, which varies from location to location. Agricultural drought links the characteristics of meteorological drought to the impacts on agricultural activities. Agricultural drought contributes to the susceptibility of crops to water shortages at various stages of growth. Hydrological drought is associated with the impact of drought on the

amount of surface or subsurface water supply. The impact of a precipitation shortage on rivers, streamflow, reservoirs, lakes, and groundwater is often characterized as a hydrological drought. When the demand for an economic good exceeds its supply due to a prolonged weather-related shortfall in water supply, creating multiple stresses across the ecosystem, it is referred to as a socioeconomic drought (Wilhite & Glantz, 1985).

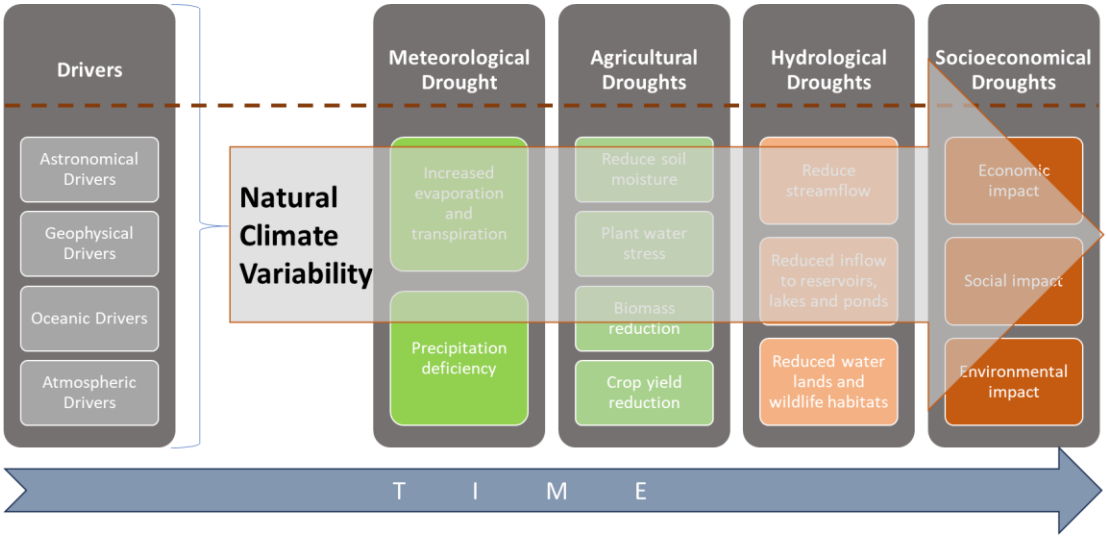


Figure 1.2: Drivers and types of droughts
Source: Adapted from NDMC of the United States, University of Nebraska

Drought is not a situation that can be avoided. However, it can be detected early, and its damage to lives and livelihoods can be minimized by developing preparedness measures. Impacts can be managed by properly defining drought and quantifying its characteristics. Drought is one of the major factors for reduced agricultural production. Despite advancements in technology in several fields, more than 800 million people live with hunger and malnutrition (USDA, 2017).

Drought occurs everywhere without borders (Kogan et al., 2015). It affects agriculture, water resources, transportation, ecosystems, recreation, food supply chain, and many other sectors. Even the most advanced countries with advanced agricultural technologies, like the US, are affected by drought (Wilhite, 2000; Kogan et al., 2016). The impact of drought on crop and pasture development in the US reached $6 billion, with extreme impacts in 1988 reaching $60 billion (Kogan, 1995). Globally, the agriculture sector is hugely

suffering because of drought, with the biggest impact prevailing in developing countries, contributing to severe food shortages, famine, population displacement, conflict, and even death of vulnerable community members.

Households affected by calamities, such as drought, choose different short-term coping and long-term adaptive strategies. These strategies range from adjusting the type and quantity of household food consumption to selling livestock, diversifying livelihoods through petty trade, engaging in casual labor, seeking safety-net programs, and resettlement from degraded to fertile areas for agricultural production (Arega, 2015).

In the context of shocks, communities develop their coping strategies. Coping Strategies (CS) refer to the actions taken by households in response to shocks and stresses resulting from drought, conflict, famine, or other calamities. These actions follow a set of sequences that vary from household to household (Von der Geest & Dietz, 2004). While coping strategies include short-term measures and responses to a shock or shocks, adaptation encompasses long-term strategies that households implement to improve food availability and access sustainably in the face of shocks and stresses. Anticipation of shocks and stresses is a key characteristic of adaptation (Ellis, 2003; Khatri-Chhetri & Maharjan, 2006; Smit & Wandel, 2006). While minimizing risk by implementing short-term coping strategies is important, this approach may not be sufficient or may not be feasible under specific circumstances. Therefore, adaptation strategies should be used to reduce susceptibility to shocks and stresses**.**

It is evident that in areas prone to repeated drought and where the natural resource base is depleted, coping strategies deployed by households do not improve chronic food insecurity. Regenerative strategies are vital, such as targeting chronically food-insecure households in programs like safety net, resettlement, and other flagship initiatives (Arega, 2015).

A report by the United Nations Security Council (UNSC) in 2018 highlighted an intrinsic relationship between armed conflict and hunger. According to this report, conflict displaces people, making it very difficult for them to access food and live active and healthy lives.

In addition, it makes food production difficult, and the marketing of food and Non-food items is constrained by armed conflict. This summarizes the vicious cycle of armed conflict and food insecurity (FAO & WFP, 2018).

Violent conflict has a significant impact on most of the functions of food systems. The primary functions at stake include production, sales, purchasing activities, and distribution systems. Conflict disrupts agricultural activities by posing severe safety and security risks to farming households. Additionally, the injury and killings of conflict-affected individuals, along with the resulting displacement and access constraints, hinder the availability of labor for food production activities, as farming households re among the most affected segments in conflict-prone areas (Puechguirbal, 2010; Holleman et al., 2017; Gebre et al., 2021; Delgado et al., 2023).

The effect of conflict on food systems often results in manifested food insecurity. Hence, conflict and food insecurity are highly correlated, with one causing the other and vice versa. Besides the effects of conflict, environmental stresses, such as a shortage of precipitation, put lives and livelihoods at risk. The food production system is not only important for supplying food, but also provides opportunities for employment. Therefore, the negative impacts of conflict and climate-induced crises jeopardize food security status (Béné et al., 2019; Hawkes et al., 2019).

As one of the major impacts, conflict displaces people from their places of origin, forcing them to abandon agricultural activities that are crucial for meeting the food needs of affected households. Livestock and other productive assets are often vulnerable and primarily targeted during times of conflict. Economic activities are nonexistent during conflicts, leading to a decline in the value of labor. Looting and destruction of infrastructure affect economic activities, which are essential for earning income to fulfill households' basic needs. Due to access constraints resulting from the conflict and the failure of the local market system, households are not only short of staples but also essential vegetables that provide micronutrients. Hence, conflict affects food production activities, marketing, and

distribution, as well as public and private institutions that provide services to maintain good health and nutrition (USAID, 2015).

Conflict affects the entire food system, compromising all activities that contribute to better nutrition and food security. All socio-economic and environmental activities that comprise the food system, including production, processing, distribution, preparation, and consumption of food, as well as the outputs of these activities (HLPE, 2014), are compromised by the impacts of crises. A sustainable food system achieves food and nutrition security without compromising the economic, social, and environmental foundations essential for the food and nutrition security of future generations.

1.5.5. Measuring food security and resilience to shocks

Since food security is multidimensional, measuring it at various levels of the household, community, and national poses a challenge. The most common model for assessing household food security is the Household Food Security Supplemental Module (HFSSM) developed by the USDA. This model considers the overall household experience and categorizes it into several forms of food insecurity. Its approach has been validated for its affordability and simplicity, making it a practical method for measuring household food insecurity in different regions of the world.

There are five commonly used methods to assess food security: i) the Food and Agriculture Organization (FAO) method for estimating calories available per capita at the national level; ii) household income and expenditure surveys; iii) individual dietary intake; iv) anthropometry; and v) experience-based food insecurity measurement scales (Pérez-Escamilla & Segall-Corrêa, 2008).

Measuring resilience requires the use of scales that can be evident at spatial, social, geographical, and institutional levels. The most common types of scales used in resilience measurement focus on the social aspect, where resilience is viewed from individual, household, and community levels. In practical terms, scales from different contexts coexist, making the measurement of resilience both tricky and complex. Despite the challenges of

complexity, using a multiscale lens is advisable to measure resilience and its connection to food security. In earlier research and development endeavors, resilience was considered an indicator of food security. However, the current evolving understanding shows that resilience is a capacity that contributes to sustaining food security development outcomes. Resilience as a capacity is measured in terms of indicators reflecting absorptive, adaptive, and transformative capacities (Béné et al., 2019). There are common developments in resilience measurement by different institutions as outlined below.

The FAO Resilience Index Measurement and Analysis II (RIMA-II) is a quantitative approach that identifies the primary factors contributing to household resilience in relation to food insecurity. RIMA-II measures resilience both directly and indirectly. The model identifies four multidimensional pillars that contribute to resilience: access to basic services, assets, social safety nets, and adaptive capacity. These pillars are measured through both unobservable variables and related observable variables (Bahadur & Pichon, 2016). The RIMA modules include shocks and food security as mandatory components, while subjective resilience, conflict, and other relevant modules may also be included in the analysis.

Resilience Measurement Framework of the Food Security Information Network (FSIN): the indicators required to measure resilience fall under the following components: i) the ex-ante component, which includes initial states and capacities; ii) the disturbance component, representing shocks and stressors; and iii) the ex-post component, which outlines subsequent states and trajectories (Constas et al., 2014). The resilience measurement in this framework focuses on multiple scales, including individuals, households, communities, districts, provinces, nations, and larger systems (Bahadur & Pichon, 2016).

The Resilience Framework of Christian Aid's approach aims to enhance the integration of various program areas, thereby creating a longer-term impact. The framework orients Christian Aid's efforts towards strengthening resilience capacities across seven areas: i) shifting power relations; ii) climate-resilient agriculture and natural resource management; iii) inclusive market development; iv) community health; v) disaster risk reduction; vi) humanitarian response; vii) peacebuilding. The approach advocates for a macro-context analysis of power, vulnerabilities, and conflicts. At the community level, the framework

promotes a power analysis focusing on risks, vulnerabilities, and capacities. It helps plan interventions and integrate ongoing work (Bahadur & Pichon, 2016).

Climate Resilience and Food Security Framework presents approaches to understanding and monitoring food system resilience in the face of climate change. Based on an overview of existing approaches to understanding food systems and climate resilience, this paper describes a new framework designed to support the analysis of community-level food security in the context of climate shocks and stresses, as well as the resilience of food systems at larger scales. By analyzing food access, utilization, and availability at the household level while considering important variables related to ecosystem health, infrastructure, services, and institutions at the system level, this framework aims to provide a comprehensive view of resilience and food security (Bahadur & Pichon, 2016).

Community-based Resilience Analysis (CoBRA) Conceptual Framework and Methodology is a framework that has four broad steps: identifying priority characteristics of disaster resilience for a target community; assessing the degree to which a community achieves these characteristics (in both normal times and periods of crisis); examining the characteristics and strategies of disaster-resilient households; and identifying the most highly rated interventions or services for building local disaster resilience. 'Community resilience characteristics' that lie at the heart of this framework map across the capital assets - physical, human, financial, natural, and social (Bahadur & Pichon, 2016).

1.6. Significance of the Study

The research contributes to existing studies in the areas of drought, conflict, coping strategies, and household resilience, particularly in relation to food security. While the research output can inform policy and serve as a basis for further studies, it also provides new insights into the interplay between drought and conflict on household food security, an area that has been researched mostly separately in the past. The study integrates advanced drought indices, such as the Standardized Precipitation Evapotranspiration Index (SPEI), the Mann-Kendall test, and Sen's slope estimates, and links them to food security and resilience analysis.

The study makes a valuable scientific contribution to guide researchers on handling recall bias in retrospective data collection, which is often conducted in the aftermath of a conflict. The Flashbulb memory test method provides researchers with a guide to deploy key statistical methods to assess the presence of recall bias and build confidence in the reliability of retrospective data for statistical inference in the field of food security and resilience. The Flashbulb memory test utilizes a well-known event as a benchmark to assess respondents' ability to recall and the impact of traumatic experiences on people's memory of past events, leading to the identification of recall bias in retrospective data using statistical models.

1.7. Scope of the Study

The geographical scope for the research is the South Wollo zone of the Amhara region of Ethiopia. Delanta, Dessie Zuria, Kalu, and Worebabo districts, which have a history of drought and recent exposure to violent conflict, are selected for this study. This research is thematically focused on food security, resilience, and coping strategies, as well as the impacts of drought and conflict on the food security status and resilience of households in the selected districts. Additionally, the drought analysis encompasses more than four decades of precipitation and temperature data from the Ethiopian Meteorological Institute (EMI). The period from 1981 to 2022 is considered for the time series drought analysis, while food security and resilience analysis were conducted for a pre- and post-conflict reference period, using the northern Ethiopia conflict as a reference point to define the timeline of the study in the South Wollo zone.

1.8. Limitations of the Study

The study is based on the pre- and post-conflict periods, considering the northern Ethiopia conflict as a reference point for the analysis of food security and resilience. Although the northern Ethiopia conflict served as the reference for the study, and even after the cessation of hostilities related to the northern Ethiopia conflict following the Pretoria agreement between the Government of Ethiopia and the TPLF, an ongoing conflict persisted in the study area, which could have its own implications for the post-conflict study. In addition,

as data were collected after the conflict, assignment of control and treatment groups for the quasi-experimental design was done during the post-conflict period, after the data collection. As a result, the interpretation of some results may require caution. However, significant steps were taken to ensure data reliability through statistical processes, including the assessment of recall bias using the Flashbulb memory test method, which adds immense value to scholarly knowledge in the field. The incompleteness of meteorological data at the Ethiopian Meteorological Institute (EMI), particularly for station data, prompted us to utilize gridded satellite data for drought index analysis.

1.9. Methodological Philosophy and Research Approach

The research was founded on a pragmatism research philosophy. Pragmatism as a research philosophy recognizes that there is no single best way to understand reality. However, there are multiple ways and viewpoints that can provide a more accurate picture of reality. It is constructed on the notion of multiple realities. The use of pragmatism philosophy allows the use of multiple research approaches and strategies (Johnson & Onwuegbuzie, 2004; Saunders et al., 2014).

The researcher collected data from both quantitative and qualitative sources. The use of a combination of qualitative and quantitative data enables the researcher to collect as much relevant information as possible regarding the research objectives and questions, thereby facilitating the triangulation process of facts and evidence. The study employed a Convergent Parallel research approach, a commonly utilized mixed-methods research approach. Considering this approach, both quantitative and qualitative data were collected simultaneously, analyzed separately, and integrated into the research for a holistic understanding of the research themes. In addition, as part of the qualitative data collection to understand the lived experiences of respondents regarding the impact of drought and conflict on food security and resilience, phenomenology research philosophy was considered. In phenomenology philosophy, the researcher collected data and tried to understand respondents' lived experience from their own perspective and in their own understanding. Phenomenological research philosophy involves illustrating and identifying phenomena as they are perceived and understood by the research participants. It is based

on personal knowledge, experience, and understanding of the research participants, whereby subjective experience is the motivation for people's understanding of a phenomenon.

The research was conducted in a rigorous manner, utilizing appropriate data collection techniques. Through the collection of quantitative and qualitative data, including multi-year meteorological data on rainfall and temperature, and the application of robust analytical approaches to analyze food security and resilience data, trustworthy research is produced. Attempts were made to validate the reliability of retrospective data by examining the influence of recall bias in the quantitative aspect using a Flashbulb memory test method. Transparency in data collection, the validity and reliability of measurements, the soundness of methodological processes, and relevance to both academic and real-life experiences have been maintained.

Data was collected using different techniques, including questionnaire-based surveys, focus group discussions, key informant interviews, case studies, literature reviews, and longitudinal meteorological data. An integrated multi-stage stratified sampling and systematic random sampling techniques were deployed to identify survey participants, while the purposive sampling technique was used to select qualitative study participants. The selection of qualitative study participants was conducted based on administrative and technical responsibilities at various government offices, non-governmental organizations, and community levels, with a focus on in-depth knowledge of the local context and areas related to food security and resilience. Primary data was also supported by a detailed review of secondary data from peer-reviewed journal articles, books, book chapters, theses, administrative documents, development plans at district and zonal levels, and reports from various United Nations offices, as well as journalistic materials.

All data collection tools were translated into the local language, Amharic. Detailed training was conducted for enumerators and data collection supervisors to ensure a proper understanding of the data collection tools. Furthermore, 42 years of precipitation and temperature data were obtained from the Ethiopian Meteorological Services for in-depth

analysis of drought trends. All quantitative data were collected for a pre-conflict and post-conflict reference period, taking into account the northern Ethiopia conflict as a reference period to make comparisons in changes in food security and resilience patterns in the context of drought and conflict.

To thoroughly explore the multiple layers of food security and resilience in the face of conflict and drought in the South Wollo Zone, we applied a range of analytical tools, each chosen for its relevance to the specific pillars of food security and the structure of our data. To assess food availability, we used the Household Food Balance Model (HFBM), which estimates per capita calorie intake at the household level. Access-related challenges were examined using two complementary tools: the Household Food Insecurity Access Scale (HFIAS), which measures direct access to food, and the Coping Strategy Index (CSI), which reveals how households adapt when access to food becomes limited due to exposure to crisis. For a broader, multidimensional view, we applied the Resilience Index Measurement and Analysis (RIMA) framework. This tool allowed us to assess not only access, but also food utilization and the stability of food systems by evaluating households' ability to withstand and recover from shocks. Alongside these, the Standardized Precipitation Evapotranspiration Index (SPEI) offered a way to quantify the intensity and pattern of droughts over time.

To better understand how combined shocks, namely conflict and drought, have shaped food security and resilience, we employed a Difference-in-Difference (DiD) model. The DiD helped us compare conditions before and after the shocks in a more controlled way. A probit model further allowed us to estimate the likelihood of households experiencing a drop in food security between these two periods. To explore the factors driving these outcomes, we employed multiple linear and ordered logistic regression models to identify key influencing factors. To address concerns about the statistical reliability of retrospective data, a Flashbulb Memory Test was included to check for possible recall bias, which is complemented by a further analysis that included a questionnaire regarding a well-known event in the survey. Finally, we brought in perspectives from key informant interviews and focus group discussions, which we analyzed thematically. The qualitative study, informed

by the literature review, key informant interviews, and focus group discussions, added valuable insights to the statistical findings. Taken together, this mix of methods strengthened both the validity and depth of the research, allowing us to engage fully with each pillar of food security.

1.10. General Description of the Study Area

The researcher conducted the study in the Amhara region, which has been affected by the conflict in northern Ethiopia that erupted in 2020. The study was specifically conducted in the South Wollo zone. However, a qualitative perspective covers the North Wollo and North Shewa areas of the region, where significant displacement, food insecurity, and livelihood disruption have been reported, in order to provide an overall overview of the impact of the northern Ethiopia conflict.

The South Wollo zone is one of the 11 zones in the Amhara Region of Ethiopia. It is located between 10°10′ N and 11°41′ N latitudes and 38°28′ E and 40°5′ E longitudes (Mekonen et al., 2020). The zone is bordered by the Afar Region and the Oromia Special Zone to the east, the East Gojam and North Gondar zones to the west, the North Wollo zone to the north, and the North Shewa and Oromia Regions to the south.

South Wollo is characterized by its diverse topographic features, including varied elevations. The elevation ranges from 1,000 m to 3,500 m above sea level. The zone experiences a range of different climatic conditions, including hot, arid, cold, and humid areas. The mean annual temperature is between 5 and 22 °C, while rainfall varies between less than 1,000 mm in the western part and more than 1,200 mm in the eastern part of the zone. It exhibits bimodal rainfall patterns, known as Belg (March to May) and Kiremt (July to September), with Kiremt being the longest rainy season in the area (Mohammed et al., 2018).

The zone has the largest population among the zones in the Amhara region, with a population of about 3,435,377 (ESS, 2024), comprising 49.6% males and 50.4% females. The majority of the population lives in rural areas, with only 21.6% residing in urban

centers. The population is predominantly Amhara (96%), and the major religions are Islam (55%), Orthodox Christianity (39%), and Evangelical Christianity (5%).

South Wollo covers approximately 17,067 square kilometers, with a population density of 190 people per square kilometer. The highest point in the zone is Mount Degat (4,261 meters) in Sayint, and the lowest point is Worebabo Arabati (927 meters) above sea level (BoA, 2023). It is characterized by diverse agroecology: Kolla (6.4%), Wyna Dega (42.4%), Dega (43.1%), and Wurch (8.1%). The average annual temperatures range from 15–20°C, and annual rainfall varies from 500 to 900 mm in the lowlands to 950–1,100 mm in the highlands. In addition to underground water resources, the zone contains lakes such as Ardibo, Logo, Maybar, and Golbo, which support tourism, agriculture, and fisheries. Traditional agronomic practices have led to land degradation, resulting in soil fertility loss, low productivity, deforestation, landslides, and sedimentation of irrigation infrastructure (BoA, 2023).

The South Wollo zone is a drought-prone area that is highly vulnerable to climate change and disasters. Poverty in the zone is linked to limited and fragmented agricultural landholdings, with an average of 0.7 hectares per household (Berhanu et al., 2003), which is below the national average (1.01 hectares) and the regional average (0.75 hectares). Agriculture and livestock are the primary sources of livelihood, and only 10.6% of the population is engaged in non-farm activities (Bereket et al., 2022; Yifru & Miheretu, 2022). The population in the zone is characterized by a poor resource endowment and hosts very vulnerable households (Berhanu & Samuel, 2002). The major source of livelihood for households depends on agriculture and related activities, with only 10.6% of the population engaging in non-farm jobs. The same report indicated that the South Wollo zone is a drought-risk zone.

The research was conducted in four districts of the South Wollo zone: Delanta, Dessie Zuria, Kalu, and Worebabo. These districts have been severely affected by the impacts of recurrent drought and the conflict in the Northern Ethiopian region. The Northern Ethiopia conflict began on November 3, 2020, in the Tigray Region, following an alleged attack by

the TPLF on the Northern Command of the Ethiopian National Defense Force. The conflict then spread to the neighboring regions of Afar and Amhara, including South Wollo, resulting in the destruction of infrastructure and causing severe humanitarian crises (Arage et al., 2023). According to the National Institutes of Health (2024), these districts have experienced multiple droughts between 1983 and 2014. Mindat.org and Tageo.com provided the geographic coordinates of these districts:

- Delanta: 11°34′59″ N, 39°10′00″ E
- Dessie Zuria: 11°10′00″ N, 39°19′59″ E
- Kalu: 11°00′00″ N, 39°49′59″ E
- Worebabo: 9°07′00″ N, 34°59′00″ E

This study collected recall data related to food security and resilience of households affected by drought and conflict. The reference periods were twelve months before the conflict (June 2019–May 2020) and twelve months after the conflict onset (June 2021–May 2022). Figure 1.3 shows the map of the four study districts in South Wollo and their bordering areas.

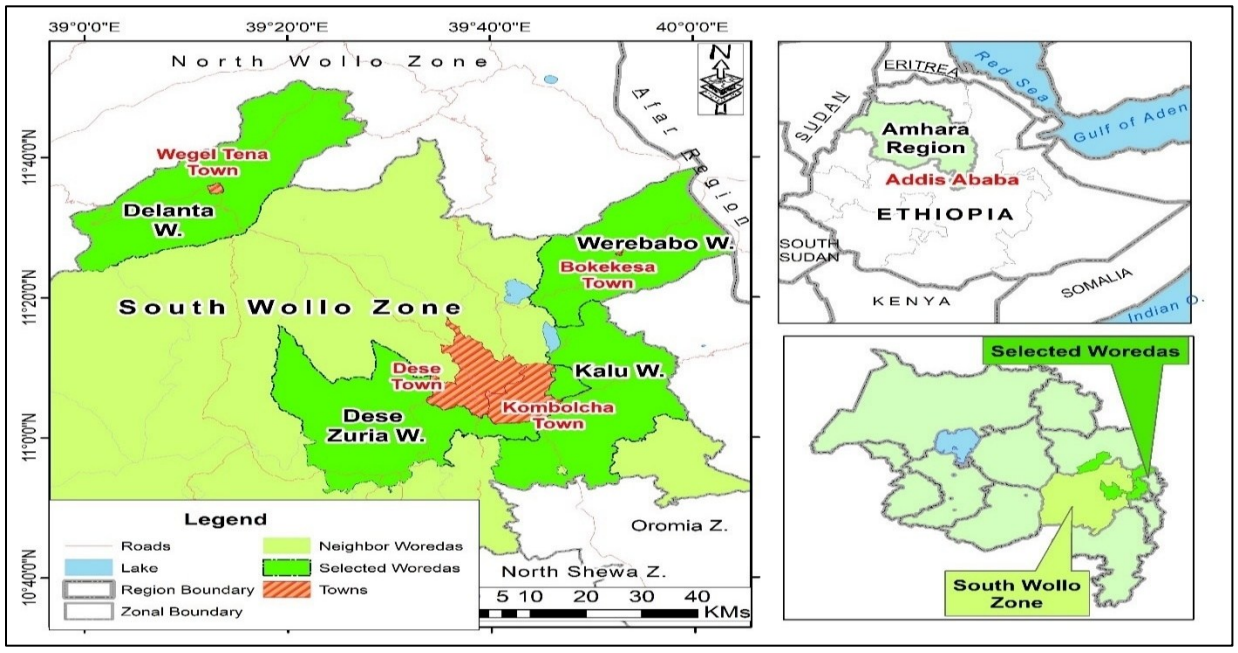


Figure 1.3: Map of the study area
source: ESS (2012) with researcher's adaptation

1.11. Structure of the Dissertation

The dissertation is divided into eight chapters, each with a unique topic. Chapter One provides an overall introduction to the dissertation, and Chapter Eight summarizes the conclusions and recommendations arising from the various manuscripts. The other six chapters present distinct articles derived from the research. Chapter one provides the introductory aspect of the dissertation, covering the study's rationale, objectives, problem statement, scope, and limitations. Chapter Two is based on a qualitative study that synthesizes the impact of armed conflicts on food security, livelihoods, and social dynamics in the Amhara region, Ethiopia. Chapter Three presents the outcome of the food security analysis at the household level, where the household food security status and determinant factors in the pre- and post-conflict references are presented. Chapter Four summarizes the key steps and statistical models employed to assess recall bias in the retrospective post-conflict food security and resilience study. This chapter is an integral part of the study, ensuring the reliability of recall data for statistical inference.

Whereas Chapter Five presents an analysis of household resilience to food insecurity in the context of conflict and drought, Chapter Six examines the causes and characteristics of drought, as well as its implications for household food security in the study area. While the other chapters summarize the pre- and post-conflict situations of households, Chapter Seven provides a concise summary of a cross-sectional post-conflict household food security assessment. Finally, Chapter Eight summarizes the synthesis of the study, summary of the theoretical and methodological perspectives, key conclusions, and recommendations of the entire dissertation.

CHAPTER 2: SYNTHESIZING THE IMPACT OF ARMED CONFLICTS ON FOOD SECURITY, LIVELIHOODS AND SOCIAL DYNAMICS IN AMHARA REGION, ETHIOPIA[1]

The chapter provides a synthesis of the impact of armed conflict on food security, livelihoods, and social dynamics in the Amhara region. The multi-dimensional negative consequences, suffering of communities, and the loss of lives and livelihoods are detailed following a qualitative analysis and review of the literature. The impact of the conflict on food security and relevant sectors that enhance household food security, along with its associated social implications, is elaborated in the various subsections of the chapter.

Abstract

Armed conflicts cause food insecurity and famine by triggering the disruption and destruction of food systems. The conflict that erupted in northern Ethiopia lasted from 2020 to 2022 and affected millions of people. This resulted in severe damage to the food security, livelihoods and social dynamics of communities in the Amhara region of Ethiopia. This study synthesized the impact of the conflict in northern Ethiopia on food security, livelihoods and social dynamics livelihoods in these zones, South Wollo, North Wollo and North Shewa zones of the Amhara regional state. The conflict management response and the scope of humanitarian assistance are also analyzed. The study used a qualitative case study design. Primary data were collected through semi-structured interviews, focus group discussions and observation. Data were collected from local authorities, representatives of displaced people, government and non-government officials who responded to the crisis and from the community members who were directly affected by the conflict. The primary data were supplemented by a review of reports from credible secondary sources. The research used thematic and narrative analysis techniques to synthesize the impact of armed conflicts on food security, livelihoods, and social dynamics in Amhara region, Ethiopia. Over 5.5 million people found to be affected by acute food insecurity and over half a million

[1] This chapter is based on the following published article:
Muhyie, J. H., Yayeh, D., Kidanie, S. A., Metekia, W. A., & Tilahun, T. (2025). Synthesizing the impact of armed conflicts on food security, livelihoods and social dynamics in Amhara region, Ethiopia. *BMC nutrition*, *11*(1), 29.

*people were internally displaced due to the Northern conflict. The monetary value of the damage caused by the armed conflict is estimated at $500 million, due to the damage to basic services and the loss of 14 million quintals of agricultural production. The conflict has disrupted food systems by damaging agricultural infrastructure, causing market distortions and causing food shortages. Livelihoods were threatened by the loss of jobs and the destruction of private and municipal property. The destruction of the basic infrastructure such as health, water and sanitation, agriculture and market institutions inevitably have lasting negative impacts on the overall productivity of the community. Communities' religious and traditional values, informal social networks are affected by the impact of armed conflict, complicating communities' reconstruction efforts. **T**he northern armed conflict has significant negative impacts on the food security, livelihoods and social dynamics of people in the Amhara region. Recognizing the multiple impacts of conflict livelihoods in the region is a critical step in developing effective responses. Government, non-governmental organizations, and community-based institutions should play a crucial role in building community resilience and support post-conflict reconstruction efforts. Future studies can capitalize on this qualitative finding and could design a large-scale assessment using quantified data to further provide evidence on post-conflict reconstruction efforts.*

Keywords: Armed conflict, Displacement, Humanitarian needs, Peace-building, Social dynamics

2.1. Introduction and Justification

Food security is a dimension that has a direct and complex relationship with conflict (Muriuki et al., 2023). Globally, millions of people are affected by food insecurity in the context of a protracted crisis (Martin-Shields & Stojetz, 2019). According to Holleman et al. (2017), 19 countries that the FAO classified as being in a protracted food crisis also experienced conflict and violence. In 2016, the number of undernourished people was 815 million. Of which 60% reside in nations where violent conflict is prevalent (IFAD, 2017).

According to the Integrated Food Security Phase Classification (IPC), millions of Africans are at risk of a level-3 and above category classification, indicating severe crisis, emergency, or catastrophic phases (Bedasa & Deksisa, 2024). The Africa Centre for Strategic Studies (2023) estimated that 149 million people would face the acute food insecurity problem in 2023. 82% of the total food-insecure population is from countries experiencing conflict. More than 66% of the 38 African nations that suffer from severe food insecurity are found in five conflict-affected nations, including Ethiopia. This indicates that conflict is one of the most important drivers of food insecurity.

Armed conflicts directly cause food insecurity and starvation by damaging production and increasing the exposure and vulnerability of livelihoods to catastrophes. Conflict causes disruptions to food systems, reduces the farming population, and destroys basic infrastructure. Social vulnerability was further exacerbated by market distortions and price structures (Weldegiargis et al., 2023). The level of violence under conflict conditions disrupted peaceful food production and distribution (Muriuki et al., 2023; George et al., 2020). In addition, loss of income from agricultural production erodes motivation to work, as people develop risk-averse behavior (Post et al., 2016). Agricultural declines can lead to social inequalities (Barnett & Adger, 2007; Post et al., 2016). By hampering agricultural activities and hastening the displacement of communities, conflict can perpetuate food insecurity and overall poverty, which in turn breeds and perpetrates conditions of conflict. The scarcity of essential resources such as food can exacerbate social tensions, trigger competition among groups, and lead to social unrest (Martin-Shields & Stojetz, 2019). Conflict constitutes an immediate threat to life by compromising access to education, health, and law-and-order services (Bundervoet et al., 2009), in which women and children are the most affected social segments (OCHA, 2023; Woldehanna et al., 2024).

Armed conflict can shatter the vitality of key social fabrics at the family and communal levels by placing pressure on crucial institutions with which people can mitigate occasions of stress and trauma (Sanginga et al., 2007). Social connectedness within the family, among peers, in the wider community, and across the nation can be severely impacted during conflict. For instance, a study by Woldehanna and his colleagues reported the impact of

the 2020–2022 conflict in Ethiopia, highlighting the extensive effects of the conflict on young people's social capital (Woldehanna et al., 2024). Armed conflict also restricts the free mobility of people, with significant implications for their psycho-emotional wellbeing and broader social interactions (Fiedler & Rohles, 2021; Lee et al., 2021).

The conflict in northern Ethiopia began in the Tigray region in November 2020 and expanded to the Amhara and Afar regions in July 2021. Although the Federal Government of Ethiopia announced a unilateral ceasefire by June 2021 to allow farmers in Tigray to carry out agricultural activities, with the assumption of preventing serious food insecurity, the conflict was intensified in the Amhara and Afar regions. Armed forces from the Tigray region launched attacks back and occupied districts in the North Wollo, South Wollo, and South Gondar zones of the Amhara region. This had caused the death and displacement of civilians, which is considered to represent the greatest number of casualties in Ethiopia. The conflict brought about the killing of thousands of people and the displacement of millions. Over 60,000 people had sought refuge in Sudan, and approximately 4 million were internally displaced (UNHCR, 2021; UNICEF, 2021; OCHA, 2023). Conflict has multidimensional impacts on the overall livelihoods and well-being of affected communities.

Thus, North Wollo, South Wollo, and North Shewa zones in the Amhara region, which are known for a higher rate of food insecurity and affected by recurrent drought, found themselves in a double jeopardy situation due to the expansion of the conflict. Even in normal days, these zones are facing various crises related to land degradation, drought, and other climate-related disasters. A study conducted by Aragie and Genanu (2017) reported that 42% of households in North Wollo were found to be food insecure. The South Wollo zone experiences recurrent drought, coupled with fragmentation of farmland, poverty, land degradation, and other climate-induced crises, resulting in a deteriorating food security situation. Another study in the South Wollo zone found that 79.1% of households were food insecure (Agidew & Singh, 2018). It is one of the zones in the Amhara region that is considered food insecure and dependent on food aid (Little, 2008). On the other hand, the North Shewa zone has been experiencing drought since 1981, which has had an adverse

impact on the food security situation (Hilemelekot et al., 2021). This empirical evidence shows that, despite their productive potential, these zones were affected by drought and other calamities that deteriorate food security and livelihoods. Thus, the northern conflict further aggravated the existing situation and put the people in worse circumstances.

Conflict, coupled with food insecurity, affects different communities differently, depending on their specific place of residence. Typically, resource competition has frequently led to conflict in various parts of Ethiopia. However, the conflict that occurred in northern Ethiopia is unique in its dynamics, hence the conflict was caused by a power struggle coupled with ethnic based violence. Moreover, the involvement of strongly armed multiple regional and national forces such as the Federal force of Ethiopia, regional forces of the Tigray Liberation Front, and Amhara regional forces and Militias contributes to the devastating impact. To date, the destructive impact of the conflict on food security, livelihoods, and social dynamics has not been well-documented. Specifically, the impacts of the armed conflict on household food insecurity in the Amhara region are not sufficiently reported. Thus, this study synthesized the impact of the expanded conflict in northern Ethiopia on food security, livelihoods, and social dynamics in the Amhara region. The study also assessed the conflict management response and scale of humanitarian assistance.

2.2. Materials and Methods

2.2.1. Research approach and design

The research employed a qualitative case study design to capture the experiences of communities in the Amhara region, northern Ethiopia, from 2020 to 2022.

2.2.2. Study population and sampling

The study was conducted in the three cities of North Wollo (Woldiya), South Wollo (Harbu), and North Showa (Debre Birhan). The population of the cities is Woldiya (98,911), Harbu (240,778), and Debre Birhan (139,724) (ESS, 2021). Purposive sampling was used to identify Key Informant Interviews (KIIs) and FGD respondents based on exposure to the conflict, experience, and participation in response efforts during the

conflict. Three focus group discussions (FGDs) were conducted, one FGD in each city, with a total of 40 participants, with 12 discussants in each group and 4 moderators. Among the participants, 10 were from IDP representatives and 30 were from affected communities who were not displaced. Participants were drawn from farmers, community leaders, conflict resolution committees, and youth representatives. Moreover, ten KIIs, three from each zonal city and one regional expert, were interviewed from the food security office, the disaster and risk management office, the natural resource management office, the land administration office, and the non-governmental development agents.

2.2.3. Data collection techniques and procedure

Semi-structured interview and group discussion guidelines were developed based on a review of the literature to collect qualitative data from key informants and group discussants, respectively. Data were collected over a six-month period from July to December 2023. The KIIs and FGDs were conducted in the Amharic language. Data were collected by researchers and trained facilitators. FGDs took an average of 90 min, and KIIs took an average of 50 min. In addition to face-to-face group discussions and interviews, a phone-based interview was conducted with one regional expert to collect data from key informants in inaccessible areas during the data collection process.

2.2.4. Techniques of data analysis

The research employed thematic and narrative analysis techniques to organize and interpret the data, based on identified themes, and integrated narrative analysis to capture the stories as experienced and described by research participants (Ugwu & Eze, 2023). Stages of thematic analysis, including familiarization with the data, coding, theme development, and reviewing themes, were followed. The process was iterative, with themes highlighting the relationship between conflict, food security, livelihoods, and social dynamics refined as more data is analyzed. The findings are presented under the following themes: destruction of agricultural products and PSNP services; the impact of the armed conflict on food security and the livelihoods of communities in the Amhara region; the impact of the conflict on infrastructure and basic services; and conflict management responses and the scale of humanitarian assistance.

To ensure the data trustworthiness of the study, the following strategies were employed. The first data collection tools were prepared and administered using the local language. The consistency of the data collection tools was checked by interviewing two community members, and revisions were made accordingly. After data collection, triangulations of the data were made by comparing data from different participants. For the sake of member checking, 3 key informants were asked to review the interview transcripts and preliminary findings to ensure that their views are accurately captured. Additionally, a detailed audit of the research process was maintained to ensure the study's trustworthiness.

2.3. Results and Discussion

This study was conducted in three zones of the Amhara region: South Wollo, North Wollo, and North Shewa. These zones were severely affected by the conflict under consideration. Even after the signing of a peace agreement between the Ethiopian government and the Tigray People's Liberation Front (TPLF) in South Africa in 2022, conflict still rages in the region. However, this study primarily focuses on the impact of the Northern Ethiopia conflict, which spanned from 2020 to 2022, on food security and the livelihoods of urban and rural areas in the three zones where the conflict had a widespread impact. The following section presents the conflict's devastating impact on agricultural products, food security, and livelihoods, as well as community social dynamics, basic infrastructure, and the response to conflict management and the scale of humanitarian assistance.

2.3.1. Destruction of agricultural products and disruption of services

In 2021, Ethiopia projected to cultivate 13.2 million hectares of land and capture 374 million quintals of agricultural production (Reporter, 2021). Although the Ministry of Agriculture (MoA) estimated that 12.5 million hectares of land were cultivated during the harvest season, about 50% of the land remained uncultivated due to the conflict in eight zones of the Amhara region (MoA, 2021). Even those who cultivated their farmland in Gondar and South Wollo zones were unable to harvest their crops as they were displaced during the harvest season and left their homes, fearing persecution and in search of safety.

The Reporter magazine (2021), in an interview with an expert from the directorate of Crop Development at the Ministry of Agriculture (MoA) on November 2021, indicated that the expansion of the armed conflict from Tigray to the Amhara region has cost the region estimated damage in amount of $500 million in basic services (Reporter, 2021). This damage includes an estimated loss of agricultural yields amounting to 14 million quintals. This damage not only impacts agricultural production but also distorts the commodity market, demonstrating the multifaceted impact of the crisis on food availability and access (Reporter, 2021). A study by Muriuki et al. (2023) in Ethiopia and Malawi found that the disruption of agricultural activities was the primary source of vulnerability, as most households rely on agriculture for their livelihoods.

As eyewitnesses revealed, “farmers simply had no opportunity to harvest as their crops were destroyed prematurely and they were not allowed to engage in agricultural activities.” Additionally, the interview with the natural resource management officer revealed that 70% of sesame production is anticipated to originate from conflict areas in the Amhara region, which could have a negative impact on the country’s economy. Regardless of the situation of food availability in the central market, small farmers are more affected as families do not have food until the next harvest.

As the interview with PSNP revealed, farmers who rely on PSNP were affected by the disruption of food distribution due to safety concerns as well as the looting of resources at the PSNP warehouse. The most important feature in this context is the looting of food aid stored in Kombolcha. FGD discussants shared that even after the eviction of TPLF forces from most of the South and North Wollo zones of the Amhara region, thousands of people remain displaced and it is not possible for these vulnerable communities to purchase food as they have no means of income; as their livelihoods are destroyed and stolen, they are dependent on limited assistance.

2.3.2. Impact of the armed conflict on food security and livelihoods of communities

Ethiopia has faced one of its worst crises since 2016 and is in the greatest need of aid in 2021. In northern Ethiopia alone, an estimated 5.5 million people suffer from acute food

insecurity. The country faced numerous threats, exacerbated by desert locust infestations and the COVID-19 pandemic. The armed conflict that began in the Tigray region spread to neighboring Amhara and Afar regions, displacing more than half a million people. This has led to the disruption of livelihoods, including agriculture, which is a significant contributor to the resulting devastating food insecurity (WFP, 2021).

The FAO's Global Information and Early Armed Conflict System on Food and Agriculture (GIEWS) (FAO, 2021) stated that the Amhara region accounts for 30% of national grain production. According to the key informant from BOA, the conflict has had a significant impact at both regional and national levels, affecting production, displacing or killing people, and destroying basic livelihoods. FGD discussants shared that during the conflict, livestock was the main target, with animals being looted and deliberately killed.

As the expert from the office of food security in North Wollo shared, worsening food insecurity posed greater risks to vulnerable communities such as pregnant and nursing mothers, the elderly, and children under five. The risk of malnutrition is increasing so much that these vulnerable groups are exposed to opportunistic diseases such as cholera and typhoid. These factors further worsen malnutrition because the body's immune system is weakened (ICRC, 2021). A study prelude to the testimony on the prevalence and determinants of malnutrition among pregnant and lactating women in Ethiopia's war-affected areas of North Gondar Zone, Ethiopia (Belew et al., 2023), which reported that more than one-third (34.3%) of pregnant and lactating women were severely malnourished.

Key informants from the Food Security and Disaster Prevention Coordination Office indicated that livestock, agricultural equipment, and grain storage facilities were looted in many conflict areas. Many households that rely on labor for their livelihoods are affected as most productive economic activities have been damaged by the conflict. The harvest season is below the expected average, as agricultural activities are affected by farmers being displaced from their farmlands due to the challenging environment created by the conflict, which has hindered agricultural activities.

Hence, the conflict occurred during the harvest season in the Amhara region, forcing communities to flee their homes and abandon their nearly ripe crops. Group discussants in North Shewa and South Wollo said that "the armed forces were consuming immature crops directly from the farm. and the remaining were damaged afterward because farmers were unable to harvest the crops on time." As the expert from the disaster and risk management office explained, "thousands of farmers, whose food and livelihoods depend exclusively on agriculture, were displaced to urban areas such as the towns of Dessie and Kombolcha and forced to go for days without food aid."

Rain-fed farming is dominant in the region, so farmers will take some time to start harvesting in the next few months. This requires the security of their home villages from the threat of armed conflict to ensure the return and resettlement of life back home. An expert from the bureau of agriculture said that "given the looting of food supplies in Amhara by TPLF forces and the fact that the international community, including humanitarian actors, had given little attention to the dire situation for several months, there was insufficient food and cash support to meet the food needs of the displaced community."

2.3.3. Impact of the conflict on the asset and local economy

The armed conflict also resulted in immense destruction of human capital, public and private assets, including the killing of livestock, damage to agricultural land, looting and burning of agricultural equipment, damage to basic services, as well as indirect impacts that have a negative impact on the market. For example, oxen are one of the very important farm animals in the farming community. As group discussants witnessed, "When parts of South Wollo, North Wollo, North Shewa areas were controlled by TPLF forces, farm animals were deliberately killed to break the morale of farmers who resisted the occupation. In addition, they slaughter farmers' livestock to feed their militias." The incident, in addition to its short-term impact in terms of loss of vital assets, will create a bottleneck for small farmers, as cattle are important for plowing agricultural land. A key informant from North Wollo stated that the forces would come to farmhouses or local markets to ask for livestock, including goats, sheep, and oxen, for a substantial amount of money. The farmers had no choice but to sell or withdraw from the transaction. Victim

households had only one choice: sell assets at a price set by armed groups. However, the armed groups came the next day and demanded that the same farmer return the money they had received. As interviews with key informants showed, during the period when TPLF troops controlled most of the Wollo area, the group used the old currency to purchase food and non-food items from residents of Genete town in the South Wollo zone. This has left small businesses economically damaged.

A key informant who witnessed the tragic consequences of the armed conflict said that the armed forces forcibly asked small business owners for food and non-food items without paying for them. In most cases, they even looted the shops mercilessly and physically and mentally abused the shop owners. The groups and individuals involved in such actions were not only those officially involved in the armed conflict, but also opportunistic robbers who stole public and private property. A similar study from the Tigray region (Weldegiargis et al., 2023) reported that high levels of food insecurity may be attributed to a lack of physical and economic access to sufficient food in the communities studied, resulting from armed conflict and siege. Due to the high cost of food and the persistently high levels of war-related poverty, food remains out of reach for people.

Supported findings also showed that farmers may be forced to abandon their fields, reducing food production and ultimately affecting access to adequate nutrition and food supplies (Muriuki et al., 2023). In such situations, basic infrastructures damaged including health, farmer field schools as well as livestock and agricultural products could be stolen, warehouses destroyed and distribution networks could be broken. This has a direct and negative impact on food transport and distribution networks, as well as the health of farmers and their families (Arage et al., 2023).

2.3.4. Impact of the conflict on infrastructure and basic services

Affected by this conflict are agricultural research institutions whose mission is to develop and multiply improved agricultural technologies to improve food security. In addition, the district and zonal bureaus of agriculture, disaster and risk management, and veterinary services were also among the basic private and public facilities affected. This impacts the

vitality of the region's agricultural and livestock sectors in both the short and long term (FAO, 2021). To renovate them and make them functional again, substantial investments are required. The required investments will not be easy to secure, as other essential services, such as schools, health facilities, and industrial parks, have been destroyed by armed conflict. In this case, agricultural research institutions, which form the basic infrastructure for developing and disseminating technologies to increase productivity and production, will suffer for the foreseeable future, affecting the revival of crop and animal production.

The market system was disrupted. Access to the market was severely affected. In some cases, despite access to markets, supply shortages occurred, inadequate access to cash resulted from destroyed livelihoods, and the armed forces' mishandling of market forces compromised the functionality of market centers. Communities were also not interested in going to the market for fear of attacks that could lead to injuries, killings, and abuse. Food accessibility has been significantly affected by the destruction and restriction of local open markets. As FGDs revealed, "the TPLF combatants had laid restrictions upon communities not to go to open markets and make exchange of goods. They would also come to the markets and collect the money from farmers who had sold their crops and livestock".

The water and sanitation infrastructures were damaged as a result of this conflict. Most of these facilities are out of service for several reasons. The main causes include looting, intentional damage, and lack of maintenance services during the period of conflict. In addition, the health system has been under serious strain as health facilities have been looted and damaged, and health workers have left the workplace for fear of persecution, where disease is prevalent, and children, mothers, and other vulnerable community members are unable to access health services. These factors impact the utilization component of food security, as disease and poor nutritional intake place vulnerable groups at risk of malnutrition. The damage to schools, markets, communication facilities, roads, health, and water and sanitation facilities directly and indirectly impacts the food security and livelihoods of communities by affecting the ability of communities in the affected area to access basic services.

2.3.5. Impact of armed conflict on social dynamics

The armed conflict and subsequent violence led to persistent damage to social dynamics such as interaction, trust, and cooperation within the affected communities and with others. The psychological damage that these communities have had to endure over a long period of time has impacted their trust towards the government and institutions. In particular, as the expert from the disaster and risk management office said, internally displaced people faced the most tragic consequences of armed conflict due to a lack of meaningful support from the government and aid organizations. IDPs use negative coping mechanisms such as begging for food, which is culturally sensitive and affects their sense of dignity. Social and religious values have also been undermined as a result of armed conflicts. FGDs reported that some fertile lands were used as cemeteries. This will make matters even more complex as cultivation in cemeteries is considered culturally inappropriate in communities in the Amhara region. This impacts households as means of production are reduced, where food availability is at risk. Fetching water and growing crops in a cemetery are considered culturally unacceptable in the region. Communities in the Amhara region often choose designated religious areas as cemeteries. The purpose of the culture in the region is to open cemeteries only for the burial of corpses.

One of the effects of armed conflict is the disruption of the local interaction mechanisms of the communities. Moreover, the deliberate network blockages and the lack of access to communication channels affected the exchange of goods and services. Communication often helps poor people by facilitating the social interaction that would have enabled poor people to deal with the negative effects of the crisis. It would allow the free flow of information across the armed forces, identifying markets that are functioning well, the safest routes to market, and relatives seeking refuge and comfort with relatives and friends.

The traditional social support mechanisms that Ethiopians have demonstrated for decades, such as *Equb*, *Edir*, *Debo*, and *Mahber*, were the main sources of support for displaced communities in various IDP centers during the escalation of the armed conflict. However, such traditional support mechanisms were disrupted by the immense displacement and lack of resources.

2.3.6. The interconnectedness between conflict, food security, livelihoods, and social dynamics

In this study, the relationship between conflict, food security, livelihoods, and social dynamics is found to be intricate and interconnected, with each element influencing and being influenced by the others. As the interconnectedness of conflict, food insecurity, livelihoods, and social dynamics revealed in this study, these elements created feedback loops where each factor reinforced or exacerbated the others. Conflict can lead to food insecurity, which in turn fuels social tensions and further conflict.

The conflict disrupted food production, distribution, and access, leading to displacement, destruction of infrastructure, and loss of livelihoods, which in turn resulted in food insecurity. Agricultural production was disrupted by the conflict, affecting crops, livestock, and access to markets. This disruption led to food shortages and a rise in prices.

Regarding the relationship between food security and livelihoods, many people were dependent on agriculture and related activities for their livelihoods. Food insecurity arose when these livelihoods were disrupted, affecting income and access to food. Cyclical relationship was unfolded when food insecurity further weakened livelihoods by reducing productivity and income, creating a cycle that is hard to break without external assistance.

With respect to the relationship between livelihoods and social dynamics, prior to the conflict, livelihoods played a crucial role in shaping social dynamics within communities. Economic stability played a role in strengthening the social cohesion and resilience among the studied communities. However, vulnerability of livelihood due to the conflict led to social tensions, competition for resources, and increased vulnerability to external shocks. Furthermore, the absence of a grievance system and limited opportunities for recovery and rehabilitation from the conflict contributed to the disruption of social dynamics. This, in turn, has caused social dynamics within communities to further exacerbate or mitigate conflict risks. Weak social networks and community cohesion contributed to affecting the conflict resolution and peacebuilding efforts.

In conclusion, the relationship between conflict, food security, livelihoods, and social dynamics is complex and multifaceted. Addressing one aspect without considering its impact on the others may not lead to sustainable solutions. Effective interventions require a comprehensive understanding of these interconnections and a multidimensional approach to promote stability, resilience, and sustainable development.

2.3.7. Conflict management response and scale of humanitarian assistance

At the start of the displacement, when thousands of people fled the South Wollo, North Wollo, and North Shewa zones, neither the government nor humanitarian organizations provided assistance. Displaced people utilize their social networks to access basic needs through family and friend networks, as well as unorganized volunteer assistance from the host community. However, it took several months before organized aid failed to sufficiently reach the displaced communities. It was reported that relevant public and humanitarian actors did not fully appreciate the scale of the crisis and chose to politicize the need for humanitarian assistance. Through several advocacy efforts, humanitarian assistance, including food and non-food items, subsequently began to reach displaced communities in the cities where the IDPs were located. Although humanitarian assistance was provided in small quantities compared to needs, the aid only benefited a small proportion of those in need. A key respondent stated that the level of aid does not take into account the scale of the crisis or the psychological and material damage caused by the armed conflict. With poor harvests, limited humanitarian aid, no functioning market system, and restrictions on movement, one can imagine the devastating situation that communities have suffered for months.

2.4. Conclusion

The armed conflict in northern Ethiopia caused severe damage to food security, livelihoods, and the social dynamics of the communities in the Amhara region. The conflicts have reduced the availability, accessibility, use, and stability of food, resulting in the displacement of people. As a result, farmers missed important farming seasons. In areas where farmers chose not to leave their homes, military groups imposed movement restrictions, resulting in farmers being unable to carry out agricultural activities. The

destruction and looting of basic agricultural infrastructures jeopardized the four pillars of food security and impacted the long-term community productivity. The use of old currencies, the frustration of market participants, and the looting of productive assets have contributed to limiting food accessibility. The damage also results in a breakdown of the community's social assets, such as trust, cooperation, and interaction. This has deteriorated the social dynamics that communities in Ethiopia used to live together peacefully. Given the conflict and drought-related disasters Ethiopia is facing, the government's capacity was too limited to provide sufficient support. Moreover, the limited recognition and attention paid by aid agencies to the crisis by the international community contributed to the crisis's severity. This research can provide insight into the impacts of the conflict and serve as a wake-up call for authorities and community structures to implement measures that minimize the adverse effects of the current wave of conflict and inform reconstruction efforts for those previously affected.

2.5. Recommendations

Addressing food insecurity caused by conflict is a matter of fundamental human rights. Given the adversities the Amhara region faced in 2020–2022 and the complex impact of armed conflict on livelihoods, food security, and social dynamics of the affected communities, short- and long-term responses are required. The government and humanitarian organizations should recognize the enormous consequences of the armed conflict in the Amhara region and participate in providing life-saving and recovery measures. While it is important to meet basic needs, investments in long-term measures to strengthen systems and build resilience are recommended. It is recommended that assistance should be based on an adequate understanding of the damage and the needs of the affected communities. Small farmers should be supported to restore their productivity in agricultural production. It is also important to restore basic infrastructure through post-war reconstruction efforts. The government should take up the leading role in coordinating recovery and rehabilitation initiatives by mobilizing non-governmental organizations, the donor community, and community-based institutions to play a crucial role in building community resilience and supporting post-conflict reconstruction efforts as a matter of priority.

Recently, the second wave of armed conflict has also been ongoing in the Amhara region, which could limit the implementation, provision of adequate, safe, and nutritious food to affected communities. The federal government and all armed groups involved in the conflict must be aware of the short and long-term impacts of the conflict on food security and livelihoods in northern Ethiopia. To understand the various consequences, they should initiate the peace dialogue as soon as possible, which requires a political commitment from the Government to facilitate the process.

2.6. Limitation of the Study

This is a qualitative case study that analyzed the impact of conflict on three interlinked themes: food security, livelihood, and social dynamics, from a purposively selected sample. Hence, the damage caused by the conflict was devastating; a large-scale study is recommended, with in-depth analysis and quantification of the gross impact on the community, as well as assessment of the success of post-conflict reconstruction initiatives by relevant stakeholders.

CHAPTER 3: ANALYSIS OF HOUSEHOLD FOOD SECURITY AND DETERMINANTS IN THE FACE OF CONFLICT AND DROUGHT IN SOUTH WOLLO ZONE, ETHIOPIA[2]

The Chapter summarizes the status of household food security in the context of conflict and drought. The food security analysis considers the Household Food Balance Model (HFBM) to characterize food security status and identify the specific impact of conflict and drought on affecting per capita calorie availability at the household level. It draws a comparison between pre-conflict and post-conflict periods, highlighting the individual and combined effects of conflict and drought on household food security. By deploying different regression models, determinant factors of food security have been identified. Additionally, this chapter presents the various coping strategies households employ during a food shortage.

Abstract

The study analyses the impact of conflict and drought on household food security and identifies determinant factors and coping strategies in South Wollo Zone, Ethiopia. Descriptive and quasi-experimental research designs were employed for pre-post retrospective data gathered from 422 randomly selected households. Qualitative data collected from key informants, focus group discussants, and related literature complemented the quantitative aspect of the study. Quantitative data was analyzed using regression models in Stata, while qualitative data was analyzed using thematic analysis. The study revealed that conflict and drought significantly undermine household food security. The combined exposure to conflict and drought increases food insecurity, which highlights the compounded nature of these crises. Per capita calorie availability drops from 1,789 kcal pre-conflict to 1,420 kcal post-conflict was observed, below the Ministry of Health recommendation of 2,300 kcal. This decrease was attributed to the individual and combined impacts of conflict and drought on food security, highlighting an increase in

[2] This chapter is based on the following published article:
Muhyie, J. H., Yayeh, D., & Tilahun, T. (2025). Analysis of Household Food Security and Determinants in the Face of Conflict and Drought in South Wollo Zone, Ethiopia. Ethiopian *Journal of Development Research*, *47*(2).

food-insecure households from 79% to 87%. In comparison, the proportion of food-secure households fell from 21% to 13% using a household food balance model in the pre-post periods. The Coping Strategy Index rose as food security deteriorated, with households resorting to a combination of riskier coping mechanisms to cope with food insecurity. Some coping strategies that households consider include dietary changes, rationing, and reliance on community-based support systems like Equb, Edir, and Debo. The regression analysis identified livestock ownership in total livestock units, agricultural index, work ratio, and age of the household head as positively associated with food security. In contrast, larger family size, exposure to drought, and exposure to conflict and aid were negatively associated. The study offers policy recommendations to build productive livelihood through asset building and livelihood diversification to foster self-reliance, and integrated recovery programs acknowledging the compounding nature of conflict and drought to improve food security.

Keywords: Conflict, Coping strategies, Drought, Food security, Disaster exposure, Vulnerability

3.1. Introduction and Justification

Food security has become a global agenda that affects millions of people and is a central focus of the Sustainable Development Goals (Birkmann et al., 2022). It is a multidimensional and multi-causal phenomenon that encompasses the availability, accessibility, and utilization of food to meet the nutritional needs necessary for physical and mental development. It also requires stability across these dimensions over time (Guiné et al., 2021; Calloway et al., 2023). In developing nations, food insecurity is closely associated with factors such as drought, political instability, conflict, poor governance, rapid population growth, and disease outbreaks (Fyles & Madramootoo, 2016; Mangaliso & Dlamini, 2018; Zhang et al., 2022; Delgado et al., 2023).

Climate change poses a significant threat to food security in Africa because the region's reliance on rainfed agriculture makes it highly vulnerable to climate variability and extremes (Lemma et al., 2013; Sharmake et al., 2022; Ahmed et al., 2023; Yeleliere et al., 2023).

Furthermore, chronic food insecurity and poverty are exacerbated by limited adoption of improved agricultural inputs and technologies (Arega, 2015; Mohamed, 2017). Africa faces diverse conflicts, including electoral disputes, struggles over resource control, civil unrest, religious intolerance, ethnic violence, and territorial disputes (Christakis, 2013; Pate, 2014; Gluhbegovic, 2016; Francis & Vincent, 2021).

The Horn of Africa (HoA), including Ethiopia, remains entrenched in cycles of prolonged crises, resulting in widespread food insecurity (Mohamed, 2017; Anbes, 2020). Despite investments by governments and international organizations in agricultural productivity, infrastructure, microfinance, extension services, and challenges such as recurrent droughts, conflicts, and political instability have hindered developmental progress (Yigezu, 2021).

Violent conflict exacerbates food insecurity by displacing populations, disrupting agricultural production, and damaging public and private infrastructure, including markets, roads, water facilities, and schools (UN OCHA 2018). For instance, Ethiopia has experienced its worst humanitarian crisis in 2021 since 2016, with millions of people in need of assistance. The northern Ethiopian conflict displaced over three million people, with more than 500,000 people from the Amhara region alone, significantly reducing agricultural production due to abandoned farmlands and crop damage (FEWS NET, 2021; UNHCR, 2022).

The South Wollo Zone in the Amhara region exemplifies Ethiopia's challenges as it faces recurrent drought, population pressure, fragmented farmland, pest infestations, and steep slopes prone to flooding. Known as the “famine belt,” South Wollo suffered devastating famines during 1971–1974 and 1983–1984, described as Ethiopia's “worst tragedy” (Mesfin, 1984; Rahmato, 1991; Agidew & Singh, 2018). The northern Ethiopia conflict further degraded food security by disrupting the region's human, financial, physical, natural, and social capital, forcing communities to abandon crops near harvest and delaying recovery for rain-fed agriculture (Justino, 2011; FAO, 2021).

Conflict impacts food systems by constraining all aspects, including production, distribution, and market access. It destroys infrastructure, disrupts institutions, and weakens resilience,

creating a vicious cycle in which food insecurity exacerbates conflict, particularly in fragile contexts (FAO & WFP, 2018; Gatdet, 2021). Vulnerable groups, such as children under five, pregnant women, and lactating mothers, face heightened risks in South Wollo owing to unmet energy requirements, increased malnutrition, and exposure to diseases (IFRC & ICRC, 2021). The Productive Safety Net Program (PSNP), a lifeline for many households, was disrupted by looting and insecurity, leaving thousands struggling even after the cessation of active conflict (GEOGLAM, 2022).

The food security situation in the South Wollo Zone is experiencing severe entanglement, not just due to conflict and drought, but also other factors that interact with the socioeconomic and demographic makeup of the community. Most of the population in the zone relies on rainfed agriculture and livestock, which are highly vulnerable to climate variability and related shocks. Access to loans is limited, particularly during conflict periods, and the unaffordable collateral requirements make conventional loans and credit services inaccessible to poor and vulnerable households. Additionally, limited livelihood diversification hinders the population's ability to withstand economic and environmental shocks (Agidew & Singh, 2018). Market access was compromised due to the conflict's impact, which affected household food security and disrupted the supply chain, leading to increased food shortages and higher food prices (Muhyie et al., 2025c).

In multi-shock environments, addressing food insecurity requires an understanding of livelihoods, gender dynamics, social contexts, and institutional interactions. Household-level food security assessments provide critical insights into the national and community prevalence of food insecurity, informing targeted interventions (Pérez-Escamilla & Segall-Corrêa, 2008).

The South Wollo Zone was selected for this study due to its historical vulnerability to drought and the recent impact of the conflict in northern Ethiopia, which has contributed to food insecurity in the area. The zone is known for recurrent exposure to widespread drought, environmental degradation, and low agricultural productivity, contributing to food shortages (Agidew & Singh, 2018), where the northern Ethiopia conflict has exacerbated

the area's vulnerability by disrupting agricultural activities, affecting supply chains, and displacing people (Seid et al., 2024). The compounded impact of drought, conflict, and other socioeconomic vulnerabilities positions the South Wollo Zone to provide a unique analysis. Furthermore, the zone was relatively accessible for data collection compared to other zones affected by the conflict in northern Ethiopia. Besides, the researchers' prior experience, knowledge of the zone, and familiarity with local conditions allow for a deeper food security analysis.

This study aims to assess the effects of conflict and drought on household food security in South Wollo. It examines how conflict and drought impact household food security, identifies socioeconomic and demographic determinants of household food security, and explores the coping strategies employed by households to mitigate food insecurity. The research contributes to the study of food security by offering context-specific insights into the compounded effects of conflict and drought on the food security of vulnerable households in Ethiopia. Besides, these findings provide evidence for policymakers and practitioners to design interventions that rebuild livelihoods and enhance food security in conflict- and drought-affected communities.

3.2. Materials and Methods

3.2.1. Research design and approach

A combination of descriptive and quasi-experimental research designs, utilizing a Difference-in-Difference model, defined the research methodology. The determinants of food security are identified by establishing causal relationships. Quantitative and qualitative data were collected for the pre-conflict (June 2019 to May 2020) and post-conflict (June 2021 to May 2022) reference periods, which include the two major cropping seasons, *meher*[3] and *belg*[4].

[3] Meher is Ethiopia's main grain growing seasons that covers the period May to September.
[4] Belg is Ethiopia's shorter grain growing seasons that covers the period February to April.

In this study, we employed a quasi-experimental design to evaluate the impact of conflict and drought on food security. The reference period for the study was considered the period before the Northern Ethiopia conflict as a pre-conflict reference and after the Northern Ethiopia conflict as a post-conflict reference period. These reference periods are considered for conflict and drought exposure based on respondents' perceptions of the impact of the conflict on food security. Household data was then collected for the pre-conflict reference based on recall at the post-conflict reference period. We collected recall data for similar households for the pre-conflict and post-conflict references. In the case of conflict, all respondents were unaffected in the pre-conflict period, while all were exposed to some degree of conflict in the post-conflict period. As a result, it was not possible to predefine control and treatment groups during data collection. Instead, respondents were categorized after data collection based on the self-reported intensity of conflict exposure (low vs. high), allowing for variation in treatment effects (Ravallion, 2007). Therefore, unlike randomized control trials (RCT), nonrandomized assignment of control and treatment groups was performed using appropriate statistical models due to the difficulty of random assignment related to contextual and logistic constraints (Duflo & Banerjee, 2008).

Given these constraints and the fact that data were collected from similar respondents for the pre-conflict and post-conflict references, a Difference-in-Difference method considering a fixed effects (FE) model was chosen to control for unobservable household characteristics that remain constant over time (Wooldridge, 2010). The FE model eliminates biases caused by time-invariant factors, such as household location, cultural practices, or socioeconomic background. However, since the sex of the household head and other fixed household characteristics do not change over time, they are absorbed by the FE model and thus dropped from estimation. To address the omission of these variables from the model, an interaction term with time was introduced to assess whether sex influences food security differently in the post-conflict/post-drought period.

The impact evaluation proposed in this paper assesses the impact of conflict and drought on food security as individual factors, as well as the combined effect of conflict and drought on food security. For the sake of comparison, we recommended using the same control

variables across all models (conflict, drought, and combined impact) to maintain consistency, reduce omitted variable bias, and ensure comparability of results (Imbens & Rubin, 2015). By leveraging this quasi-experimental approach, the study captures the causal effects of conflict and drought on food security despite the lack of randomized assignment.

As recall data were used for the study, the potential issue of recall bias resulting from memory decay and the potential consequences of the conflict were assessed using statistical methods, including the Flashbulb Memory Test method and Common Method Bias (CMB). These tests determine whether recall bias is present in the recall data and whether statistical inference is reliable. A complementary question related to a well-known event was included during data collection, and the accuracy of recall, the importance of the event, and the confidence of respondents in their memory recollection were gathered and statistically analyzed, with recall error identified as the dependent variable. The complementary Flashbulb method employed regression analysis, incorporating conflict exposure and control variables of age, sex, and education among respondents. These complementary methods to address recall bias indicated the absence of recall bias in the retrospective data collected for the study, confirming the reliability of the data for statistical inference. Due to its methodological contribution, the recall bias assessment is organized as a separate manuscript, which is under review. The manuscript provides a detailed methodology for recall bias analysis using the Flashbulb Memory Test method and Common Method Bias (Muhyie et al., 2025a).

3.2.2. Methods

3.2.2.1. Sample size determination and sampling technique

The sample size was determined using Taherdoost (2016) with a 95% confidence interval (z value of 1.96) with a 5% margin of error (e), where p is the percentage occurrence of a state at 0.5, to maximize the variance that results in the maximum sample size (Bartlett, 2001).

$$n = \frac{p(100-p)z^2}{E^2} = \frac{0.5(1-0.5)1.96^2}{0.05^2} = 384$$

The four districts were purposively selected in consultation with zonal experts, considering the history of conflict and drought exposure. A random sampling technique was used to select 38 villages, of which 422 households were selected proportionate to the population size, including a 10% contingency. The 10% contingency was added to the required sample size to account for potential nonresponse and data loss. Since all responses were valid, the full sample of 422 was used in the analysis.

Considering the fact that the study covers four different districts in the South Wollo zone, a complete list of the sampling frame was not practical and logistically feasible (Levy & Lemeshow, 2013). As a result, we used a multi-stage stratified random sampling technique. The stratum takes the four study districts, kebeles, and villages within them. The researchers identified the list of kebeles in the four districts and had consultation with district authorities to identify kebeles that were not accessible during data collection due to ongoing conflict in the study areas. The first step in the multi-stage stratified sampling was to identify 30 – 45% of the kebeles from each district using simple random sampling, taking into account kebeles that were identified as safe and secure for data collection. After selecting the study kebeles, a list of villages within each kebele was profiled, and one village was selected using a simple random sampling method from each kebele, where 38 villages were identified. Based on the household data that was collected from district planning and development offices, the 422 samples were proportionately allocated to each village, and a systematic random sampling technique was employed to identify survey participants. While the stratified sampling method helped to manage the diverse nature of the study area by breaking it into smaller strata – kebeles and villages – the random sampling approach ensures an equal chance of representation of respondents and increases the generalizability of data (Lohr, 2019).

A non-random, purposeful sampling technique was employed to select FGD and KII participants, focusing on information-rich samples that provided specific and specialized insights into the areas of food security, drought, conflict, and coping strategies of communities in the research districts. Participants were selected purposively due to the need for expert and context-specific knowledge about food security, drought, conflict, and

socioeconomic situation of the study area and the study population. Individuals who could provide insightful and rich qualitative data were selected from zonal bureaus, district and kebele administration officials, technical experts, elders, and selected respondents who had experienced the impact of conflict and drought in the study area. This approach is relevant when maximum and in-depth information is required to assure.

3.2.2.2.Data sources and collection tools

A questionnaire-based survey was administered to 422 households affected by conflict and drought. In qualitative studies, achieving the saturation point is a key consideration to determine the number of FGDs and KIIs. A total of 10 FGDs and 15 KIIs were conducted for the study, and significant effort was made so that the saturation point was achieved. In the research undertaking, the saturation point was achieved after 7 FGDs and 11 KIIs, and the additional interviews and discussions did not yield new information. Individuals with an in-depth understanding of the impact of conflict and drought on household food security participated in the interviews and discussions.

3.2.2.3.Techniques of data analysis

A Household Food Balance Model (HFBM), originally developed by FAO and further adapted by Degefa (1996) and used by several other researchers (Shishay & Dawit, 2018; Tesfaye et al., 2023; Yagaso et al., 2024), was further adapted by the researchers to compute per capita calorie availability in the pre-conflict and post-conflict reference years. Energy gains and losses from production, purchase, aid, and other transfers for major crop and animal products (maize, barley, wheat, teff, rice, oats, sorghum, cowpeas, peas, chickpeas, beans, meat, and milk) were included in the model. The kcal per kilogram of each of these products was used as described by Tontisirin et al. (2003). The following summarizes the mathematical computation to calculate the amount of calories gained and lost through different mechanisms.

The Total Calorie Availability (TCA) represents the total amount of energy available at the household level, excluding energy losses during the reference period. It considers the total kcal availability from production (GP), purchase or buying (GB), food aid (FA), grin from

gift (GG), and food for work (FW) accounting all grain and animal products in kilogram obtained in the reference year and multiplied by the equivalent calorie amount per kilogram of quantity (Tontisirin et al., 2003).

$$\text{KcalGP} = \sum(\text{Grain production in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalGB} = \sum(\text{Grain Bought in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalFA} = \sum(\text{Grain Food Aid in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalGG} = \sum(\text{Grain Gift in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalFW} = \sum(\text{Grain Food for Work in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalMP} = \sum(\text{Meat product in kilogram} * \text{Kcal per kilo } of\ meat)$$

$$\text{KcalDP} = \sum(\text{Dairy product kilogram} * \text{Kcal per kilo } of\ dairy\ product)$$

Where KcalGP is amount of calories obtained from grain production, KcalGB is amount of calories obtained from grain purchase, KcalFA is amount of calories obtained from food aid, KcalGG is amount of calories obtained from grain gift, KcalFW is amount of calories obtained from food for work, KcalMP is amount of calories obtained from meat product, and KcalDP is amount of calories obtained from dairy product.

Once the total calorie available is computed for the different components of energy gain in the reference period, Total Calorie Availability (TCA) is calculated by summing the energy obtained from various sources.

$$\text{TCA} = \text{KcalGP} + \text{KcalGB} + \text{KcalFA} + \text{KcalGG} + \text{KcalFW} + \text{KcalMP} + \text{KcalDP}$$

The Total Calorie Loss (TCL) was calculated by measuring the amount of grain used for household purposes other than consumption in the reference period, multiplied by the calorie equivalent for the specified grain crops. These consisted of all the energy losses in

the reference period as a result of postharvest loss (HL), grain reserved for seed (GU), grain sold (GS), grain gifted for others (GV), and grain used for social events (GSE) and converted to equivalent kcal amount using the appropriate conversion.

$$\text{KcalHL} = \sum(\text{Grain Harvest loss in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalGU} = \sum(\text{Grain seed reserve in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalGS} = \sum(\text{Grain sold in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalGV} = \sum(\text{Grain gifted to others in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalGSE} = \sum(\text{Grain for social event in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

Where KcalHL is amount of calorie loss due to postharvest loss, KcalGU is amount of calorie loss due to grain reserve for seed, KcalGS is amount of calorie loss due to the sale of grain, KcalGV is amount of calorie loss due to gifts to others and KcalGSE is amount of calorie loss due to grain used for social events. After computing the energy amount for each category of loss in the reference period, the total calorie loss was computed by summing up the energy losses through different mechanisms.

$$\text{TCL} = \text{KcalHL} + \text{KcalGU} + \text{KcalGS} + \text{KcalGV} + \text{KcalGSE}$$

Once the total kcal availability and total kcal loss are computed, the net calorie availability is computed using the following formula.

$$\text{NCA} = \text{TCA} - \text{TCL}$$

Using the NCA, the daily per capita calorie availability for the members of the household was computed by dividing the NCA by the number of members of the household and 365 days, as indicated below.

$$\text{Per Capita Calorie Availability } = (\frac{\text{Net Calorie Avaialbaility (NCA)}}{Household\ size})/365$$

The Difference-in-Difference model was computed to assess the impact of conflict, drought, and their combined effect on food security using the following mathematical formula, and the analysis was conducted in Stata software. The following mathematical computation provides the formula to compute the impact of conflict on household food security.

$$Y_{it} = \alpha + \beta_1 Post_t + \beta_2 (Conflict\ Exposure_{it} * Post_t) + \gamma X_{it} + \mu_i + \varepsilon_{it}$$

Where:

Y_{it} = Food security outcome which is per capita calorie availability for household i at time t

α = constant term

Post_t = 1 for post-conflict, 0 for pre-conflict period

$\text{Conflict Exposure}_{it}$ = level of conflict exposure (0 for low, 1 for high)

$\text{Conflict Exposure}_{it} * \text{Post}_t$ = interaction term capturing the differential impact of conflict in the post-conflict period

X_{it} = control variables (age, sex, education, family size)

μ_i = household fixed effects (capturing time-invariant characteristics)

ε_{it} = error term

The following mathematical computation provides the formula to compute the impact of drought on household food security.

$$Y_{it} = \alpha + \beta_1 Post_t + \beta_2 (Drought\ Exposure_{it} * Post_t) + \gamma X_{it} + \mu_i + \varepsilon_{it}$$

Where:

$\text{Drought Exposure}_{it}$ = level of drought exposure (0 for low, 1 for high)

$\text{Conflict Exposure}_{it} * \text{Post}_t$ = interaction term capturing the differential impact of drought in the post-conflict period.

The following mathematical computation provides the formula to compute the combined effect of conflict and drought on household food security.

$$Y_{it} = \alpha + \beta_1 Post_t + \beta_2(Conflict\ Exposure_{it} * Post_t) + \beta_3(Drought\ Exposure_{it} * Post_t) + \beta_4(Conflict\ Exposure_{it} * Drought\ Exposure_{it} * Post_t) + \gamma X_{it} + \mu_i + \varepsilon_{it}$$

Where:

$Conflict\ Exposure_{it} * Drought\ Exposure_{it} * Post_t$ = interaction term capturing the combined impact of conflict and drought in the post-period

Determinant factors of per capita calorie availability were identified by running multiple linear regression.

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots \beta_n X_n + e$

Where Y is the dependent variable, which is per capita kcal available; X is the independent variable; β_0 is the y-intercept; Bs are the regression coefficients; and e is the model's random error (residual) term.

A thematic analysis method was utilized to thematically organize and analyze secondary data from related literature reviews, FGD, and KII. Food security, coping strategies, and drought- and conflict-related themes were thematically organized according to research themes (Naeem et al., 2023) to facilitate the interpretation, conceptualization, and understanding of the respondents' perspectives.

3.2.2.4.Definition of variables

The names and descriptions of variables that have been used in the regression analysis, alongside the type and direction of expected change regarding the outcome variable, which is the per capita calorie availability, are indicated in Table 3.1. A linear regression model was used to identify the interaction between independent variables to determine the outcome variable, which is per capita calorie availability. Considering that the data is pre-post data, a dummy variable showing the pre-conflict and post-conflict reference has been included as an independent variable, and a joint regression for the pre-post data was undertaken to identify determinant factors using a multiple linear regression model.

Table 3.1: Description of variables and expected direction of change against the dependent variable

Variables	Description of variables	Type of variable	Expected direction of change
outcome	Per capita calorie availability	Continuous dependent	Not applicable
ast_tlu	Total livestock unit	Continuous independent	Positive
age	Age of the household head	Continuous independent	Negative
offincom_tot	Amount of total off farm income in birr	Continuous independent	Positive
ast_agrindex	Agriculture index	Continuous independent	Positive
ast_wealthindex	Wealth index	Continuous independent	Positive
time	Pre=post reference (0 for pre-conflict and 1 for post-conflict)	Binary independent	Negative
loan_yn	Access to loan	Binary independent	Positive
aid	Amount of aid received	Continuous independent	Positive
edu_head	Education of the household in years	Continuous independent	Positive
sex_head	Sex of the household head (1 for male headed and 2 for female headed households)	Binary independent	Negative
fam_size	Total family size	Continuous independent	Negative
work_ratio	Work ration expressed as ration of working force in the household	Continuous independent	Positive
liv_mark	Distance to livestock market	Continuous independent	Negative
marital	Marital status of the household head	Categorical independent	Negative
disaster	Exposure to disaster (drought)	Binary independent	Negative

3.3. Results and Discussion

3.3.1. Demographic information and socioeconomic characteristics

Data were collected from 422 households in Delanta, Dessie Zuria, Kalu, and Worebabo districts. The average household size in the research districts was 5.1 persons per household. Table 3.2 summarizes the per capita calorie availability for the research districts. A two-way ANOVA test revealed a significant difference in per capita calorie availability across the research districts, with a p-value of 0.0000. Additionally, there was a significant difference in calorie availability at the household level between the pre-conflict and post-conflict reference periods, with a p-value of 0.0002. However, the interaction between district and time was found not to be significant, indicating that the

change in per-capita calorie availability does not vary over time for the different groups of districts.

Table 3.2: List of research districts and per capita calorie availability

Name of districts	Number of Respondents	Per capita calorie availability	
		Pre-conflict	Post-conflict
Delanta	89	1,663	1,504
Dessie Zuria	138	2,505	2,023
Kalu	88	1,507	1,309
Worebabo	107	1,204	664
Total/Average	422	1,789	1,420

Source: Survey data by authors

Among the respondents, 64 were female heads and 358 were male-headed, as reported in Table 3.3. The sex of the household head was found to be an important socioeconomic characteristic that provides a differential aspect of household food security. It was found out that the calorie availability for both male and female-headed households reduced at post-conflict compared to the pre-conflict reference period. However, there was no statistically significant difference in the mean per capita calorie availability concerning the sex of the household head.

Table 3.3: Sex of household head and per capita calorie availability

Sex of Household Head	Number of Respondents	Per capita calorie availability	
		Pre-conflict	Post-conflict
Male	358	1,809	1,436
Female	64	1,678	1,328
Total/Average	422	1,789	1,420

Source: Survey data by authors

The age of the respondents ranged from 22 to 79 years, with a mean age of 46 years. Table 3.4 provides a summary of the average calories available per capita for each age group. A two-way ANOVA test indicated that there is a significant difference in per capita calorie availability between the different age categories, with a p-value of 0.0003. In addition, there is also a statistically significant difference in the per capita calorie availability of the different age categories across the pre-conflict and post-conflict reference periods.

However, there was no statistically significant variation in per capita calorie availability across age categories over time (p-value = 0.9935).

Table 3.4: Age category of household heads and per capita calorie availability

Age categories for household heads	Proportion of respondents in percent	Corresponding per capita calorie available	
		pre-conflict	post-conflict
20 - 29 years	3.1	2,326	2,269
30 - 39 years	24.2	1,677	1,266
40 - 49 years	37.4	1,685	1,304
50 - 59 years	22.5	1,757	1,424
60 - 69 years	10.4	2,120	1,745
70 - 79 years	2.4	2,743	2,246
Total/Average	100	1,789	1,420

Source: Survey data by authors

In the post-conflict reference, a notable reduction in per capita calorie availability was recorded for all marital statuses except for separated households. Separated households demonstrated increased per capita calorie availability, despite the immense impact of conflict and drought. It was indicated during FGDs and from the household survey that separated households has relatively higher work ratio than the other groups. Even though it was not strongly substantiated in this research, the higher work ratio could be attributed to an increased workforce that contributes to more income sources, which could have a positive outcome of household food security.

Statistically significant variations between per capita calorie availability and the different groups of marital status were observed in the ANOVA test. However, these differences do not vary between pre-conflict and post-conflict reference periods, nor do they interact with time over a period of time, as the interaction term between marital status and the food security outcome was not statistically significant. Table 3.5 shows the number of respondents disaggregated by marital status, average work ratio, and per capita calorie availability.

Table 3.5: Marital status and per capita calorie availability

Marital status	Number of respondents	Mean work ratio	Corresponding per capita calorie available	
			pre-conflict	post-conflict
Single	27	0.60	2,092	1,959
Married	327	0.57	1,728	1,367
Divorced	22	0.67	2,620	1,578
Separated	4	0.75	2,618	2,948
Widow	42	0.69	1,556	1,256
Total/average	422	0.59	1,789	1,420

Source: Survey data by authors

The education status of the household heads ranges from Illiterate, who have not attended formal education, to 13 years of education, including college and Universities, for some of the respondents. The average school year was 3.6 years of education. Among the surveyed communities, 38% of household heads do not have any formal education, while 20% attended education between grade 1 – 4, 31% between 5 – 8, and 11% attended high school and above. Even though the per capita calorie availability decreased for all education categories during the post-conflict period, there was no statistically significant difference in the mean calorie availability between education status in the pre- and post-reference periods. Table 3.6 shows the number of respondents disaggregated by education status, average work ratio, and per capita calorie availability.

Table 3.6: Education status and per capita calorie availability

Education status	Number of respondents	Corresponding per capita calorie available	
		pre-conflict	post-conflict
No formal education	162	1742.699	1384.586
Primary (grade 1 to 6)	163	1831.762	1475.996
Higher Primary (grade 7 to 8)	22	1558.886	1096.581
High school (9 to 12)	74	1846.452	1427.546
Tertiary (above 12)	1	3203.973	4447.329
Total/average	422	1,789	1,420

Source: Survey data by authors

3.3.2. Off-farm participation

There was evidence of the diversification of livelihoods through off-farm income-generating activities, where 30% of households reported off-farm participation in the pre-

conflict reference period. The non-farm livelihood activities practiced in the research areas include tailoring, hairdressing, carpentry, painting, and daily labor activities.

The per capita calorie availability for households that participated in off-farm activities (1,899 kcal) was higher than for those that did not participate in off-farm activities (1,742 kcal) during the pre-conflict reference periods. As shown in Table 3.7, households that participated in off-farm activities had higher per capita calorie availability, which was also higher than the overall average in the pre-conflict period (1,789 kcal). This demonstrates the contribution of off-farm participation to household food security. Similar studies (Zelalem & Abate, 2014; Meskerem & Degefa, 2015; Tesfaye & Nayak, 2022) have also argued that households that participate in non-farm activities are more food secure. They argued that households' participation in off-farm activities enhances household food security.

Table 3.7: Off farm participation and per capita calorie availability

Off farm participation	Number of respondents	Corresponding per capita calorie available	
		pre-conflict	post-conflict
No	296	1,742	1,440
Yes	126	1,899	1,371
Total/average	422	1,789	1,420

Source: Survey data by authors

However, the situation in the post-conflict scenario was different. Households that participated in off-farm activities during and early after the cessation of the northern Ethiopian conflict were reduced (1,371 kcal) compared to those who did not engage in off-farm activities (1,440 kcal). This is a result of the disruption of business activities and the loss of opportunities caused by conflict. This was also reported by other studies, which was attributed to the impact of conflict on market disruptions, displacement affecting people's participation in off farm activities, damage to infrastructure, and market disruptions due to the conflict that led to diminishing income from non-agricultural activities (UN OCHA, 2023; World Bank, 2023; FAO, 2023).

Labor work was identified as a major alternative livelihood that supports household food security. FGD participants indicated that the major source of labor activity is related to agricultural activities of planting, weeding, and harvesting periods during the *meher* and *belg* seasons. Mining (particularly opal mining in the Delanta district) and construction sectors are also major contributors to labor opportunities.

3.3.3. Exposure to climate-induced disasters: a perception assessment

Exposure to disasters is defined as exposure to climate-related calamities, such as droughts, floods, snow, and pests. 75% of respondents were exposed to at least one of the climate-related impacts during the pre-conflict period, while 74% reported similar exposure during the post-conflict reference period. A Pearson's chi-square test shows that there was no significant difference in the exposure of respondents between the pre-conflict and post-conflict reference periods. However, agroecology has been found to play a significant role in disaster exposure. More than 60% of the respondents indicated that the impact of climate-related disasters on food systems was medium and high during both reference periods as reported in Figure 3.1.

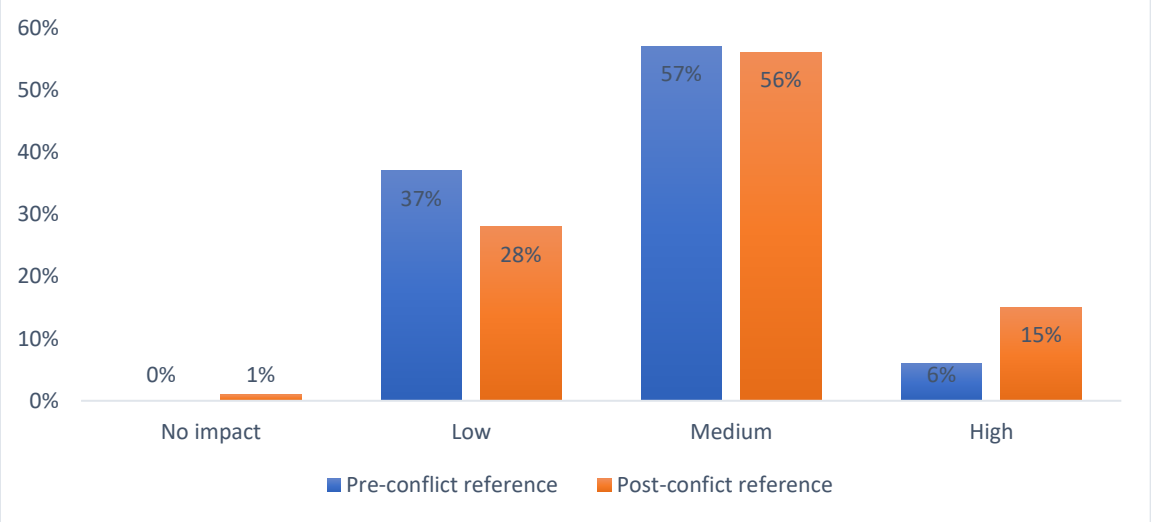


Figure 3.1: Perception of respondents on level of climate change impact on food systems
Source: Survey data by authors

3.3.4. Household food security

3.3.4.1. Household food balance model

The mean per capita energy availability (average kcal/person/day) during the pre-conflict reference period was 1,789 Kcal, while the per capita energy availability during the post-conflict reference period was 1,420 Kcal/person/day.

Table 3.8: Two-sample t-test for calorie available for pre-conflict and post-conflict reference periods

Group	Number of observations	Mean per capita calorie availability	Standard Deviation (SD)	t-Statistic	Degrees of Freedom (df)	p-value
Pre-conflict	422	1789	1523	3.85	842	0.0001
Post-conflict	422	1420	1253			

Source: Survey data by authors

Based on a two-sample t-test with equal variance, there was a significant difference in the mean per capita calorie availability for the pre-conflict reference (M=1,789, SD=1,523) and post-conflict reference (M=1,420, SD=1,253) with conditions of t=3.85 and p = 0. 0001. The conflict increased household food insecurity by limiting calorie availability. The multifaceted impact of conflict on food systems has contributed to the reduction of household food security. Other studies (George et al., 2020; George & Adelaja, 2022; Kafando & Sakurai, 2024) have also argued that conflict, through its widespread impact, negatively affects household food security.

Considering the MoH (2022) cut-off of 2,300 kcal/person/day, 79% of households were food insecure, while food secure households accounted for only 21% of households before the conflict. as shown in Figure 3.2, food insecure households increased to 87%, while the proportion of food secure households decreased to 13% after the conflict.

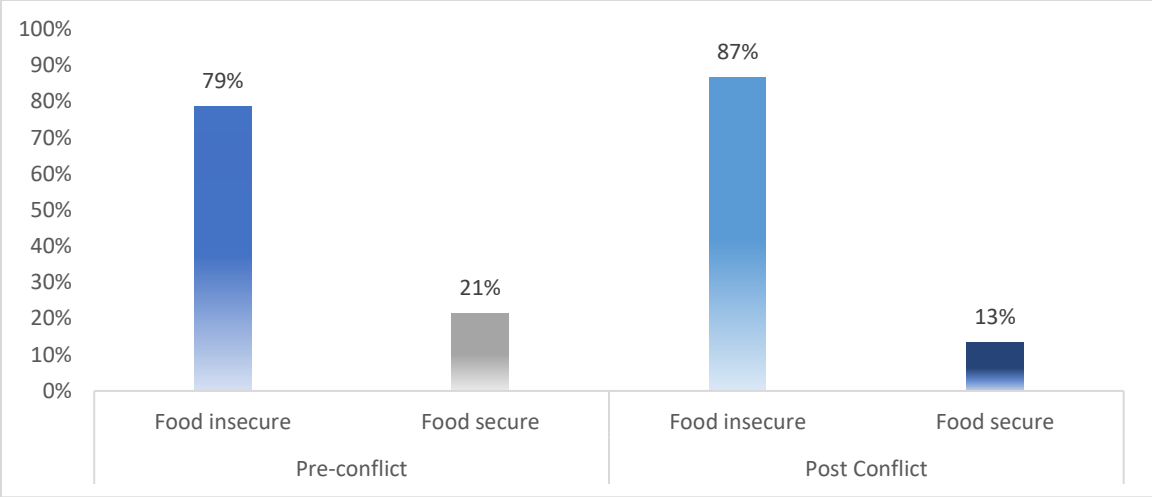


Figure 3.2: Categories of food security status on per capita calorie availability
Source: Survey data by authors

The study analyzed the impact of conflict and drought on household food security using the Fixed Effect (FE) Difference-in-Difference statistical model. Treatment variables included the intensity of exposure to conflict and drought, categorized as low and high based on self-reported household data. The time period considered is a year before and a year after the northern Ethiopia conflict, specifically pertaining to the research zone. Interaction variables were set up, and relevant statistical tests, such as the presence of multicollinearity, were checked using the Variance Inflation Factor (VIF), which showed a value of less than 10, indicating the absence of a multicollinearity problem. In addition, model appropriateness was tested using the Hausman test to determine whether a Fixed Effect (FE) or Random Effect (RE) model was the most appropriate. The test indicated that FE was the best with significant probability. Besides, the pre-post data was collected from similar respondents, which also necessitates the use of FE due to the inconsistency of RE models in such scenarios.

The determinant factors of household food security were identified using a multiple linear regression model for per capita calorie availability. The data were tested for the regression assumptions of linearity in the relationship between the dependent variable and each independent variable, the absence of multicollinearity, normality of the error term, and the absence of heteroscedasticity. Moreover, necessary data adjustments and model specification tests were conducted to account for omitted variables. All tests confirmed the

fulfillment of the linear regression assumptions, and relevant inferential statistics were assessed.

3.3.4.2. Impact of conflict and drought on household food security

A DiD model run to identify the impact of conflict on household food security expressed as per capita calorie availability. In the pre-conflict reference period, all respondents were not affected by conflict. The DiD model indicated that there was an overall negative impact of conflict on household food security which is expressed in terms of per capita calorie availability. The DiD analysis revealed that there was no evidence of differential impact of conflict between households exposed to different intensity of conflict. We found out that conflict reduces significantly household food security between the pre-post reference despite intensity of conflict exposure. Conflict reduced per capital calorie availability by 229.99 units during post-conflict reference.

Table 3.9: Estimates of the overall impact of conflict (pre vs. post) on per capita calorie availability

Variable	Coefficient	Std. Error	p-value	95% Confidence Interval	
Post-conflict (post=1)	-229.99	75.95	0.003	-379.278	-80.701
Total livestock unit	169.56	74.95	0.024	22.231	316.886
Age	13.37	4.96	0.007	3.634	23.116
Total off farm income	0.01	0.004	0.045	0.002	0.171
Agriculture index	263.05	100.63	0.009	65.257	460.840
Wealth index	-163.25	413.11	0.693	-975.267	648.758
Constant	579.21	299.13	0.054	-8.769	1167.188
Individual FE	Yes				
Time FE	Yes				
Observations	844				
R-squared	0.13				

Source: Survey data by authors

Other researches confirm that conflict reduces household food security. Evidence from Ethiopia and Malawi (Muriuki et al., 2023) reported that conflict reduced FCS by more than six units, while Mekonnen and Mitiku revealed that conflict significantly reduces household food security, where about 85% of households experienced food insecurity

(Weldegiargis et al., 2023). These studies complement and support our finding that conflict significantly reduces household food security.

The overall impact of drought was estimated using the DiD model. The impact analysis highlighted that drought reduced per capita calorie availability by 268 units in the post-conflict reference period based on self-reported drought exposure data. Similar to the conflict exposure, there was no evidence of differential impact of conflict among different intensities of drought in the study area.

Table 3.10: Estimates of the overall impact of drought (pre vs. post) on per capita calorie availability

Variable	Coefficient	Std. Error	p-value	95% Confidence Interval	
Post-drought (post=1)	-268.24	75.13	0.000	-415.917	-120.568
Total livestock unit	155.82	77.64	0.045	3.201	308.430
Age	13.02	4.97	0.009	3.252	22.782
Total off farm income	0.01	0.004	0.050	0.000	0.016
Agriculture index	192.89	104.45	0.066	-12.428	398.203
Wealth index	156.86	385.92	0.685	-601.713	915.423
Constant	677.49	317.6	0.033	53.210	1301.772
Individual FE	Yes				
Time FE	Yes				
Observations	844				
R-squared	0.15				

Source: Survey data

To analyze the combined impact of conflict and drought, we created a modified variable that represents the combined exposure to post-conflict and post-drought conditions. This was due to a multicollinearity issue, where the combined effect could not be run using the DiD model. The problem arose because not all respondents were affected by conflict during the pre-conflict period, and most of the drought-affected households were also affected by conflict during the post-conflict period, resulting in a collinearity issue. To mitigate this challenge and provide insight into how the combined effect of conflict and drought is analyzed using DiD, we created a variable that combines post-conflict and post-drought interaction terms.

The new variable is categorized into three groups: the first group includes households that reported post-conflict exposure but not post-drought exposure, the second group includes those who reported post-drought exposure but not post-conflict exposure, and the third group includes those who reported both post-conflict and post-drought exposure. Once the categorical variable was created, we ran the DiD model to understand the combined effect of conflict and drought on household food security.

Table 3.11: Estimates of the overall combined impact of conflict and drought (pre vs. post) on per capita calorie availability

Variable	Coefficient	Std. Error	p-value	95% Confidence Interval	
Post-combined (post=1)					
Post-conflict only	-229.18	216.44	0.290	-654.620	196.254
Post-drought only	-288.87	102.65	0.005	-490.636	-87.103
Post-conflict-drought (both)	-269.47	86.13	0.002	-438.759	-100.180
Total livestock unit	140.79	74.79	0.060	-6.210	287.806
Age	12.59	4.96	0.012	2.840	22.342
Total off farm income	0.01	0.003	0.041	0.000	0.016
Agriculture index	182.99	102.99	0.071	-19.457	385.437
Wealth index	161.46	383.53	0.674	-592.419	915.329
Constant	743.87	307.01	0.016	140.401	1347.338
Individual FE	Yes				
Time FE	Yes				
Observations	844				
R-squared	0.15				

Source: Survey data

As indicated in Table 3.11, the interaction between exposure to conflict and drought provides insight into the combined effect of conflict and drought on household food security. It is noted that this interaction was generated through modification of the variable, and interpretation should be made with caution. While the individual impacts of conflict and drought are provided in the previous sections, the interaction between the two may yield a different result, and interpretation may not be straightforward. The first group of respondents, who were exposed to conflict but not to drought in the post-conflict reference, showed no significant interaction between conflict and drought exposure. This interaction has no significant impact on household food security. Whereas households that were exposed to drought but not conflict in the post-conflict exposure, the interaction between

conflict and drought exposure resulted in a reduction in per capita calorie availability by about 288.87 units, which is higher than both the individual overall impact of conflict (229.99) and the individual overall impact of drought (268.24).

Households exposed to both conflict and drought during the post-conflict reference period experienced a significant decline in household food security. The interaction between conflict and drought for these groups of respondents resulted in a reduction in per capita calorie availability of 269.47 units, which is higher than the individual impact of either conflict or drought. Looking at the interaction of conflict and drought, it is generally indicated that drought exposure resulted in a higher reduction in household food security than conflict exposure in both individual impact analysis and considering the interaction between the two.

3.3.4.3. Determinants of food security: multiple linear regression analysis

The multiple linear regression indicates that total livestock unit (ast_tlu), agriculture index (ast_agrindex), time (pre-post reference), family size (fam_size), work ratio (work_ratio), and exposure to disaster like drought were found to be significant determinant of household food security expressed in terms of per capita calorie availability at p-value less than 0.005. In addition, the age of the household head (age) and the amount of humanitarian aid (aid) were significant at a p-value of 0.1.

These determinant factors, as well as their broader association with household food security, particularly with per capita calorie availability, are discussed in the sections below. We grouped the significant variables into the impact of livelihood assets, demographic characteristics, and the effect of shocks and external assistance.

Table 3.12: Determinant factors of household food security using multiple linear regression

Variables	Betas	Standard Error	t	P>|t|	Confidence Interval (95%)	
					Lower	Upper
ast_tlu	310.079	50.215	6.170	0.000***	211.514	408.643
age	7.920	4.530	1.750	0.081*	-0.972	16.811
offincom_tot	-0.001	0.003	-0.320	0.746	-0.008	0.006
ast_agrindex	252.440	108.018	2.340	0.020**	40.419	464.460
ast_wealthindex	343.855	431.977	0.800	0.426	-504.043	1191.753
time	-180.790	90.268	-2.000	0.046**	-357.971	-3.608
loan_yn	-118.891	86.069	-1.380	0.168	-287.830	50.049
aid	-167.948	86.189	-1.950	0.052*	-337.121	1.226
edu_head	12.543	12.888	0.970	0.331	-12.754	37.840
sex_head	4.199	211.856	0.020	0.984	-411.638	420.036
fam_size	-271.864	37.347	-7.280	0.000***	-345.169	-198.559
work_ratio	893.092	258.490	3.460	0.001***	385.720	1400.464
liv_mark	0.071	0.746	0.090	0.925	-1.394	1.536
marital	-96.949	74.422	-1.300	0.193	-243.028	49.129
disaster	-215.854	104.258	-2.070	0.039**	-420.494	-11.213
constant	1853.850	378.407	4.900	0.000***	1111.100	2596.600

* Significant predictors at 90% confidence interval, ** significant predictors at 95% confidence interval; *** significant predictors at 99% confidence interval Source: Survey data by authors

A one-unit increase in total livestock units resulted in a significant increase in per capita calorie availability by 310 units. This indicated a significant contribution of livestock ownership to better food security outcomes at the household level. A unit increase in the agriculture index, which is expressed in terms of participation in agricultural training and practicing improved agronomic practices like the use of improved seeds, fertilizers, and pesticides, per capita calorie availability increases by 252 units. The number of working people at the household level, expressed as a work ratio, was significant at a 99% confidence level. As the work ratio increases by one unit, per capita calorie availability increases by 893 units, denoting a significant positive association. An increase in family size reduces per capita calorie intake by 272 units, while exposure to drought and conflict significantly reduces per capita calorie availability by 216 units and 181 units, respectively.

Total livestock units, a crucial livelihood asset, played a significant role in determining household food security, as expressed by per capita calorie availability. The TLU was found

to have a positive and statistically significant effect on household food security ($p < 0.01$). With a unit increase in TLU, per capita available calories increase by 310 kcal. This result aligns with existing literature emphasizing the central role of livestock as both a source of income and a coping mechanism during crises (Little et al., 2006; Gebreegziabher et al., 2012).

In South Wollo, KII and FGD participants reported that the conflict severely disrupted livestock-based livelihoods through theft, displacement, and market closures (FAO, 2022). However, despite the challenge that the livestock sector faced during the conflict period, households that retained their livestock were more resilient, using animals for food, labor, or emergency cash through distress sales. Awoke et al. (2022) argued that, in addition to other predictors, tropical livestock units, livelihood diversification, agricultural income, and farm size all contribute to determining a household's food security status.

Similarly, the agriculture index, a proxy for agricultural performance and diversification through the use of improved fertilizers, pesticides, and agronomic practices, was positively associated with food security ($p < 0.05$). This association implies that a unit increase in the agriculture index results in a 252-unit increase in the outcome variable. During the conflict, agricultural activities were significantly hampered by violence, the destruction of farming inputs, and the displacement of labor (UN OCHA, 2022). Nonetheless, households that managed to sustain agricultural practices experienced improved food security, underscoring the critical role of local food production in post-conflict recovery (WFP, 2021). This is due to either relative safety or access to early recovery support.

The work ratio, defined as the proportion of working-age individuals in the household, was also positively associated with food security ($p < 0.05$). In the aftermath of conflict, labor availability became a key determinant of household resilience, with working-age members enabling income diversification through casual labor. This finding is consistent with Headey and Taffesse (2014), who highlighted the role of labor capacity in rural household welfare under crisis conditions.

The age of the household head was positively associated with food security at a 10% significance level. This may reflect the cumulative benefits of experience, social capital, and better adaptation strategies among older heads. In Ethiopian rural settings, older household heads often have stronger community networks and more diversified livelihood strategies, enabling them to better navigate crises (Berhane et al., 2014). In addition, according to focus group discussants, the younger community category was directly involved in the conflict more than the older age groups. This might also be one reason for this interpretation.

Conversely, family size was negatively associated with food security ($p < 0.05$), indicating that as family size increases by one, per capita calorie availability reduces by 272 kcal, denoting larger families experience higher food insecurity. During the conflict, larger families were more likely to experience resource strain. The conflict affected households by limiting their participation in agricultural activities, loss of businesses, and due to displacement. Due to the general impact of the conflict in the research districts, with limited availability of livelihood options, larger families faced a higher level of food insecurity. This finding echoes earlier research by Tafere and Taffesse (2010), which found that household food resources decline on a per capita basis as family size increases, particularly in rural Ethiopia.

A key finding of this study is that the post-treatment or post-conflict time period was significantly associated with a decline in per capita calorie availability at the household level ($p < 0.05$). This reinforces reports from humanitarian agencies that the Northern Ethiopia conflict had devastating impacts on household welfare, particularly in South Wollo Zone, where markets were disrupted, farms abandoned, and humanitarian access was restricted (WFP, 2022; FSIN, 2023).

Paradoxically, aid was found to be negatively associated with food security ($p < 0.1$). This may reflect the fact that aid is targeted to the most food-insecure households, creating a selection effect. Additionally, during the height of the conflict, aid distribution was inconsistent due to insecurity, looting, and logistical breakdowns. As Maxwell et al. (2012)

argue, humanitarian aid in protracted crises can have limited impact when delivery mechanisms are compromised or delayed.

Finally, exposure to drought was significantly associated with lower food security ($p < 0.05$). South Wollo is a drought-prone area, and the recent conflict overlapped with below-average rainfall years, creating a compound crisis. As reported by FEWS NET (2021), the combined impact of conflict and drought severely undermined local coping mechanisms, resulting in widespread food shortages. This finding reinforces the importance of understanding food insecurity as the result of intersecting shocks rather than isolated events.

3.3.5. Major constraints to food security: a perception-based review

Violent conflict, drought, flood, frost, crop, and animal diseases are the major challenges that constrain food security in the research areas. A key informant from the Delanta district food security coordination office noted that, "non-conflict disasters affect some of the food systems depending on the vulnerability of different sectors within the food system. However, violent conflict has been identified as a complex disaster that affects the entire food system."

This was coupled with a lack of sufficient agricultural land, the complete absence of land for young people, limited access to irrigation, population growth resulting in the fragmentation of farmland, and traditional agricultural practices that limited the availability of food. Additionally, cultural and traditional factors contribute to compromised food security. Unnecessary and extravagant spending on social and cultural events, such as weddings, mourning for the dead, births, and other celebrations, leads to debt burdens that affect food security and livelihoods. Focus group participants reported that the lack of appropriate toilets and poor hygiene practices that lead to open defecation contribute to hygiene-related diseases that directly contribute to malnutrition, a manifestation of food insecurity. The lack of proper utilization of natural resources, poor distribution and timing of rainfall, crop and livestock diseases, and other climate-induced disasters jeopardize production ability.

3.3.6. Coping strategies and community support mechanisms

The CSI score was calculated by multiplying the frequency of occurrence of the 12-coping strategy-related questions by the weight assigned to each behavior, as in Maxwell et al. (2003). Accordingly, the mean CSI of the respondents was approximately 22.4.

Table 3.13: Affirmative responses to the coping strategy index questions

	Coping strategies	Number of affirmative responses	(% yes) *
1.	**Dietary change**		
a.	Rely on less preferred and less expensive foods	375	89%
2.	**Short-term measures to increase household food availability**		
b.	Borrow food, or rely on help from others	222	53%
c.	Purchase food on credit	173	41%
d.	Gather food from garbage or collect from leftovers	22	5%
e.	Do labor work for friends, relatives, neighbors in exchange for food	102	24%
3.	**Decrease Numbers of People**		
f.	Send household members to eat elsewhere	52	12%
g.	Send household members to beg	27	6%
4.	**Rationing Strategies**		
h.	Limit portion size at mealtimes	275	65%
i.	Restrict consumption by adults for children to eat	185	44%
j.	Feed working members at the expense of non-working members	67	16%
k.	Reduce number of meals eaten in a day	282	67%
l.	Skip entire days without eating	73	17%

** % yes, was calculated against the total number of observation (422) who affirmatively answered the CS; Source: Survey data by authors*

As indicated in Table 3.14, households classified as 'severely food insecure' have the highest mean CSI, which is even higher than the overall average. This indicates that the higher the household's food insecurity, the higher the likelihood that the household will consider severe and negative coping strategies.

Table 3.14: Food security categorization and corresponding CSI scores

HFIAS Prevalence (Categories)	Summary of mean CSI	Standard deviation of CSI scores	Frequency of respondents
Food insecure	22.893	19.129	366
Food secure	18.911	15.648	56
Total	22.365	18.737	422

Source: Survey data by authors

Food-insecure households often lack the necessary assets and resources to cope with adversities such as conflict and drought, as well as their compounded consequences. This increases their vulnerability and forces them to exercise dangerous and often negative coping strategies. Table 3.15 summarizes key socioeconomic and demographic factors, providing a comparative analysis that shows food-insecure households have less livestock ownership, a lower agriculture index, a higher work ratio, fewer agricultural landholdings, and receive less income from off-farm activities. Conversely, food-insecure households tend to have larger family sizes and are more reliant on external assistance.

Table 3.15: Key household characteristics for food insecure and food secure households

	Mean value of socioeconomic and demographic factors per food security status	
Socioeconomic and demographic factors	Food insecure	Food secure
Total livestock unit	1.68	2.35
Agriculture index	0.56	0.66
aid	0.31	0.19
Family size	5.26	4.23
Work ratio	0.58	0.69
Agricultural landholding	3.04	4.03
Amount of off farm income	2455.00	3977.00

Source: Survey data by authors

The coping strategies were classified into four important categories: dietary change (#1), short-term measures to increase household food availability (#2, #3, #4, and #5), a decrease in the number of people (#6 and #7), and Rationing (#8, #9, #10, #11, and #12). Some households employed a combination of strategies to address food insecurity situations, as illustrated in Figure 3.3.

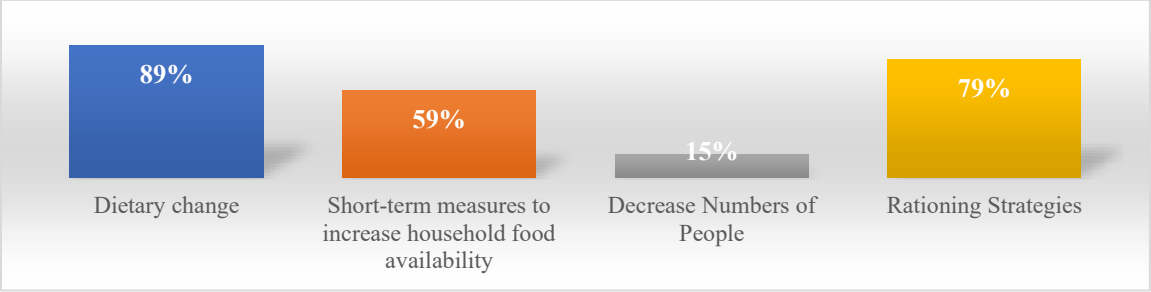


Figure 3.3: Proportion of households deploying different coping strategies
Source: Survey data by authors

According to the KII and FGDs, communities consider different coping strategies during food stock shortages or a lack of financial means to buy it. These include selling valuable household items and productive assets, sending children to engage in labor activities, taking loans to bridge gaps in household food security, and begging in the worst-case scenario for some households. Furthermore, the migration of young people to other parts of the country and the Middle East for employment was identified as a crucial strategy. Mohamed (2017) found similar coping strategies deployed by households to cope with adversities that constrain household food security.

Prior to the northern conflict, some of the coping mechanisms employed by the community during disasters included relocating to another area for labor, selling valuable assets such as livestock, collecting firewood and charcoal, consuming inexpensive food, and borrowing from relatives and friends. However, during conflict, coping mechanisms have undergone significant changes. People have resorted to more severe and dangerous coping strategies, such as migration and the sale of productive assets, including livestock, which are crucial for farming, to cope with the compounded impacts of conflict and drought. The conflict also restricted the movement of people from place to place, as they feared for their lives.

Among the different community structures, *Equb, Edir, and Debo* were the most important. These structures helped the community facilitate borrowing of money, weddings, and mourning events, and mobilize labor resources for one another. In addition to the aforementioned local structures, kebele-level multipurpose service cooperatives provide basic items on a credit basis to poor people.

KIs indicated different opinions regarding the contribution of assets and livestock in mitigating conflict impacts. Fixed assets and livestock play a crucial role in mitigating the impact of conflict by providing a source of income and ensuring access to family loans. However, some studies have reported that livestock and fixed assets play a negative role, as it led to deliberate targeting during the conflict. As a result, assets and livestock are

considered liabilities. However, they played an undeniable role in mitigating the additional suffering of households, despite the parties involved in the conflict targeting assets and livestock.

3.4. Conclusion

This study examined the impact of conflict and drought on household food security using a difference-in-differences (DiD) approach, complemented by multiple linear regression analysis to identify key socioeconomic and demographic factors that influence household food security. It also assesses the different consumption-related coping strategies that households employ to cope with food shortages during crisis periods. The results reveal that both conflict and drought significantly reduced household food security, as measured by per capita calorie availability. The combined exposure to both shocks in the post-conflict period had the most severe impact, suggesting a compounding and mutually reinforcing relationship between these crises.

The multiple linear regression analysis indicated that livestock ownership expressed in terms of total livestock unit (TLU), agriculture index expressed in participation in agriculture activities with a focus on improved agronomic practices, work ratio, and the age of the household head positively influenced household food security. In contrast, larger family size, disaster exposure, and aid were negatively associated with food security. The negative relationship between aid and food security suggests that while aid targets vulnerable populations, its structure and delivery may not be sufficient to improve resilience or ensure long-term food access. Besides, during the conflict, humanitarian aid, including the productive safety net program, was interrupted, untimely, and insufficient, which could have reduced the effectiveness of aid for the particular context of the study.

In general, the multiple linear regression results highlight the important interaction between household assets, demographic characteristics, and exposure to shocks in determining per capita calorie availability in conflict-affected settings. Households with stronger asset bases, such as livestock and agricultural productivity, managed better, while those exposed to large-scale shocks like conflict and drought experienced heightened vulnerability. A

post-conflict recovery strategy that prioritizes support for rebuilding agricultural and livestock sectors, restoring market functionality, and expanding livelihood opportunities for working-age members to enhance household food security is required in the South Wollo zone. Additionally, humanitarian assistance must be more predictable, equitable, and responsive to compounding crises like conflict and drought. Strengthening resilience to both conflict and climate shocks is essential for sustainable food security in this and similar fragile regions of Ethiopia.

In response to the conflict and drought shocks, households adopted a wide range of coping strategies to manage food insecurity, often using multiple strategies simultaneously. These strategies included dietary changes, reducing meal frequency and portion sizes, rationing food among family members, and short-term actions aimed at increasing food availability. As food insecurity worsened, households increasingly resorted to more extreme and potentially harmful coping mechanisms, as reflected in rising Coping Strategy Index (CSI) scores. Food-insecure households had the highest CSI, demonstrating that they resort to dangerous coping strategies due to deteriorated food security. Social institutions and informal networks, such as *Equb, Edir, and Debo, emerged as critical community-based mechanisms for managing crises,* as described by focus group participants. These traditional systems provided a foundation for mutual aid and resource mobilization, particularly during the generalized impacts of conflict and drought. However, the scope and effectiveness have been reduced due to the conflict, which has caused immense livelihood challenges for everyone. Even when the entire community was affected, these structures played a pivotal role in supporting the most vulnerable, though their capacity was often constrained under widespread distress.

This study contributes to the growing body of evidence on the intersection of conflict, drought, and household food security, particularly in a fragile context. By combining a difference-in-differences (DiD) impact evaluation with a determinants-based regression framework, it provides a comprehensive understanding of both the causal impacts of shocks and the underlying household-level factors that shape food security outcomes. Moreover, the inclusion of coping strategies offers important insights into the behavioral

and social responses to compound crises, which is an area often overlooked in quantitative food security research. The findings enrich the scientific dialogue on resilience and vulnerability by emphasizing the compounded effects of conflict and drought, the limitations of current aid modalities, and the critical role of local institutions. These insights are intended to inform not only academic discourse but also the design of more responsive and context-sensitive policies and programs in humanitarian and development settings. This research also provides an understanding of different methods for utilizing retrospective data in post-conflict food security studies, highlighting key steps in addressing recall bias.

3.5. Recommendations

In light of the findings of the study, several key recommendations are proposed. First, it is essential to strengthen both individual and community-level coping mechanisms. Policymakers and development actors should invest in transforming short-term, erosive strategies into adaptive practices that build resilience over time. This includes expanding access to livelihood assets, supporting livelihood diversification, and reinforcing traditional support systems, such as *Equb* and *Edir*, which play a vital role in mobilizing community resources. Second, recovery and resilience programs should integrate responses to both conflict and drought, acknowledging the compound nature of these shocks. Targeted support to livestock and agricultural sectors is crucial in improving household food access and stability.

Aid interventions must also be re-evaluated to ensure they are timely, appropriately targeted, and linked to sustainable development outcomes. Effective aid programs that foster self-reliance and build productive capacity may be more effective than traditional handouts. Promoting labor participation and creating employment opportunities, particularly for young people and women, can reduce vulnerability and enhance household food security. Investment in early warning systems and crisis preparedness is also necessary to help communities anticipate and mitigate future shocks.

Ultimately, future research should examine the long-term effects of various coping strategies, distinguishing between those that are adaptive and those that may actually exacerbate existing vulnerability. A further exploration into the structure, delivery mechanisms, and outcomes of aid programs, particularly in the context of violent conflict, provides valuable insights for designing more effective food security interventions in complex emergency contexts.

CHAPTER 4: ASSESSING RECALL BIAS IN POST-CONFLICT FOOD SECURITY AND RESILIENCE STUDY IN SOUTH WOLLO ZONE, ETHIOPIA[5]

Chapter four presents a step-by-step, detailed, and easy-to-implement strategy for identifying the presence of recall bias in the retrospective food security and resilience study. The chapter highlights how recall bias could be checked using a complementary method called Flashbulb memory to detect and determine the reliability of retrospective data for statistical inference. In addition, the Flashbulb memory test method is further complemented through checking Common Method Bias (CMB).

Abstract

Conflict undermines food security resilience by disrupting the food system, while data collection is often constrained during conflict periods, despite the need for longitudinal studies to inform decision-making. In such situations, retrospective data collection, which is collected after the conflict, is an option. However, recall data lack reliability due to the impact of recall bias. Therefore, statistical methods can be deployed to check the reliability of retrospective data for statistical inference. This research integrated a complementary study using the Flashbulb Memory Test, which included questions regarding a well-known event, and assessed recall bias in the food security study.

- *We collected retrospective data from respondents on household resilience to food insecurity of conflict-affected households in South Wollo Zone, Ethiopia.*
- *By including a set of questions related to a known event, conflict exposure, and control variables (age, sex, and education), we demonstrated how the Flashbulb memory test can be used to identify potential recall bias.*

Conflict exposure and the control variables were not statistically significant in the logistic regression analysis for this study, which ensured that recall bias did not affect the food security and resilience study. We conclude that data can be collected during post-conflict,

[5] This chapter is based on the following published article:
Muhyie, J. H., Ayal, D. Y., & Teshome, T. T. (2025). Assessing Recall Bias in Post-conflict Food Security and Resilience Study in South Wollo Zone, Ethiopia. *MethodsX*, 103321.

and its statistical reliability can be assessed using the Flashbulb memory test and through Common Method Bias (CMB) statistical tests.

Keywords: Conflict, Data analysis, Flashbulb memory test, Food security, Recall bias

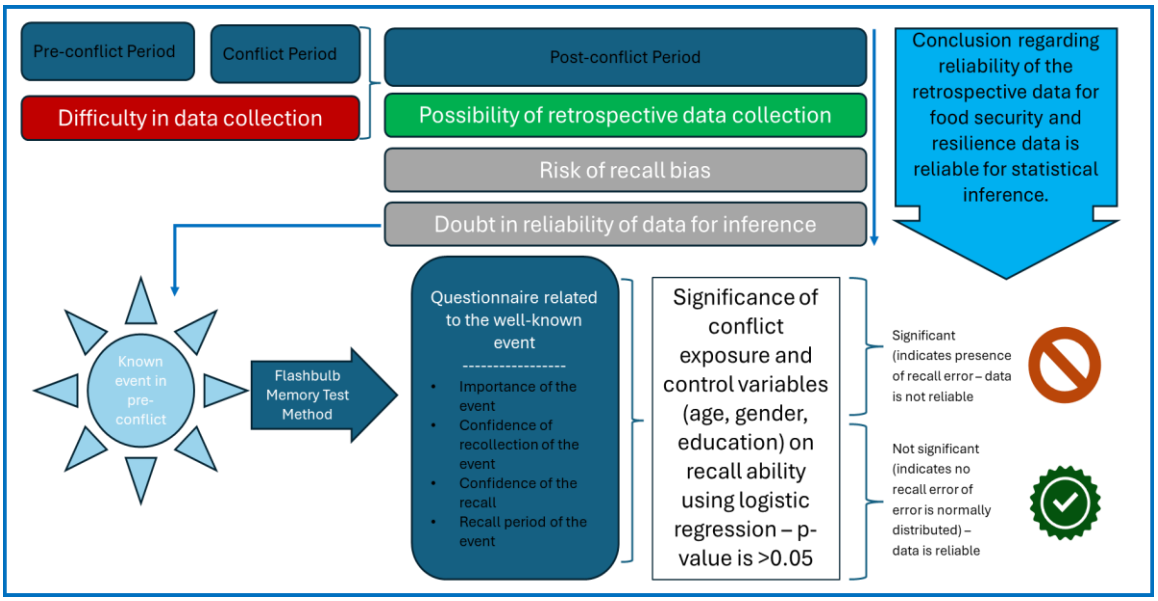


Figure 4.1: Graphical abstract for Flashbulb memory test method
Source: Authors' own construction

Specifications table

Subject area	Food Science
More specific subject area	Resilience to food insecurity study
Name of your method	Flashbulb memory test for recall bias assessment in retrospective data collection
Name and reference of original method	Moreno-Serra, R., Anaya-Montes, M., León-Giraldo, S., & Bernal, O. (2022). Addressing recall bias in (post-) conflict data collection and analysis: lessons from a large-scale health survey in Colombia. Conflict and health, 16(1), 1-14.
Resource availability	Not applicable

4.1. Introduction and Justification

Conflicts have become more common in developing countries, with devastating and disproportionate impacts on the socio-economic well-being of people as a result of the disruption of economic activities, destruction of basic service infrastructures, causalities, and displacement (Justino, 2006; Blattman & Miguel, 2010; Kruk et al., 2015; Policinski & Kuzmanovic, 2019; Fang et al., 2020; Le et al., 2022). Assessment of health trends and

well-being is crucial for the development of policies pertaining to conflict-affected communities (Brück et al., 2016). Even though it is essential to establish trends in data, data collection is often constrained during times of conflict due to access and safety concerns, which affect the reliability of making statistical inferences (Justino, 2006; Blattman & Miguel, 2010).

In the context of violent conflict, researchers rely on recall information, which poses a significant risk to the quality of the data, as recall is affected by several factors (Moreno-Serra et al., 2022). These factors include the types and phrasing of questions, a decrease in the ability to recall information over time (Bhandari & Wagner, 2006; Clarke et al., 2008), erroneous retrieval of events due to the negative emotional and mental consequences of the conflict, and the deliberate provision of incorrect information out of fear.

Despite the method of data collection, reliance on recall data for past events is subject to recall bias owing to inaccuracies or poor recollection of past events by participants. When the recall error is random, the data can be used for inference. However, if a certain group of respondents is particularly affected by recall bias due to certain characteristics, this affects the reliability of the data analysis (Clarke et al., 2008; Brusco & Watts, 2015).

Researchers collect conflict-related baseline information by asking households or individuals to recall the event and provide data on the impact of conflict on certain socio-economic outcomes, such as health and food security. However, people may not recall all the important events during the conflict period, which affects the quality of the baseline information gathered through recall. In addition to the time factor, recall bias may also result from the potential psychological impact of conflict on the mental well-being of affected individuals, which can create a bias in recall (Moreno-Serra et al., 2022). Therefore, recall bias is considered a significant problem in analyzing conflict information collected through recall (Brück et al., 2016).

Recall bias cannot be entirely avoided. However, different strategies can be employed to identify the presence of recall bias and verify the reliability of the data for statistical

inference. The study incorporated a complementary analysis using the Flashbulb memory test to assess recall bias in the food security and resilience study in South Wollo Zone, Ethiopia. The official announcement of the late Prime Minister Meles Zenawi's death was used as a reference event to evaluate respondents' recall accuracy. This approach enabled the evaluation of the presence and distribution of recall bias among respondents, assessing whether recall errors were random and ensuring the reliability of retrospective data for robust statistical inference. The Flashbulb memory test method was used to assess recall bias by examining respondents' vivid and detailed recollections of significant events, serving as a benchmark to evaluate the accuracy of retrospective data (Hirst & Phelps, 2016). The method is relevant for checking the consistency of respondents' memory over time and provides insightful information regarding the reliability of data collected based on recall (Brück & d'Errico, 2022). However, there are limitations to the Flashbulb memory test method that should be clearly understood. Despite their vividness, Flashbulb memories also suffer from inaccuracies and can be influenced by personal bias and external factors. In addition, the Flashbulb memory test may be more accurate if conducted across multiple surveys, which would require extensive data collection and could be time-consuming and expensive (Winograd & Neisser, 1992; Brück & d'Errico, 2022).

We integrated the Flashbulb memory test, a complementary method, into the food security and resilience study to identify whether recall bias was present or statistically significant, and to determine data reliability for statistical inference. However, the use of retrospective data is also problematic in general, and it is important to check for the Common Method Bias (CMB) to strengthen the reliability of retrospective data. CMB arises when variance in study results is attributable to the measurement method rather than the actual constructs of interest. CMB occurs due to factors such as reliance on the same respondents, uniform question formats, or consistent timing in data collection, which can lead to inflated relationships between variables (Podsakoff et al., 2003). CMB should be tested on the actual study variables, not the recall bias regression model. CMB should be identified and appropriately assessed to increase the validity of statistical conclusions from retrospective data. MacKenzie and Podsakoff (2012) indicated that the identification and mitigation of CMB help deal with unrealistic correlations between variables that may result from

response biases. Therefore, employing such a statistical method increases the credibility of empirical results and confirms the robustness of research conclusions.

4.2. Method Details

4.2.1. Sampling techniques

The selection of the four districts where the food security and resilience study was conducted was made in consultation with key informants, considering the prior history of exposure to drought and the northern Ethiopia conflict. However, the selection of villages and survey participants was conducted through a randomization process. A profile of household information was developed for each of the four districts in each village. In the four districts, 38 villages were selected by lottery. Simple random sampling was employed to select participants for the questionnaire-based survey. A list of households was developed for all residents of the 38 randomly selected villages. A quota of samples was assigned to each village based on the total number of samples determined as indicated below. Then, systematic random sampling was used to identify survey respondents in proportion to the population of each village. This approach helped to ensure the representativeness of survey respondents. The sample size was determined based on Taherdoost (2016) at a 95% confidence interval with a 5% margin of error with 10% contingency included, which makes the total sample 422, where n is the sample size and p is the percentage of occurrence of state estimated at 50% to produce the maximum sample size (Bartlett et al., 2001).

$$n = \frac{p(100 - p)z^2}{e^2}$$

$$n = \frac{0.5(1 - 0.5)1.96^2}{0.05^2} = 384$$

4.2.2. Data sources

Primary data were collected through a questionnaire-based survey of 422 households (15% were female-headed households). The recall bias questions were part of a questionnaire-based survey administered to collect recall data on the socio-economic situation, food

security status, and resilience of drought- and conflict-affected households. In addition to the household survey, secondary data were collected as part of a review of related literature.

4.2.3. Techniques of data analysis

The Flashbulb memory test was used to analyze recall bias in food security and resilience studies. Moreno-Serra et al. (2022) argued that ex-post health surveys, which collect recall data from conflict-affected populations, are reliable for empirical inference using standard regression methods, as supported by the Flashbulb test, a concept developed in the fields of psychology and psychometry. In this research, the same method as that used by Moreno-Serra et al. (2022) was used for food security and resilience studies. The empirical specification of conflict, as adapted to reflect the food security outcome, is as follows.

$$Y_i = \alpha_0 + \alpha_1 D_i + \mu_i$$

where Y_i is the food security outcome for household i, α_0 is the intercept that measures the impact of conflict on the outcome variable, Di is the conflict exposure of household i, which takes the value of 1 if exposed or 0 if the household is not exposed to conflict. The general understanding is that in communities affected by conflict, all households are considered to be exposed to conflict impacts and μ_i is the sum of all errors.

When retrospective data are used in a survey, recall errors may occur, which can be attributed to memory issues and the negative impact of conflict on individuals' ability to recall past events (Moreno-Serra et al., 2022). This recall error affects the estimation of α_1. The interaction is indicated mathematically by the formula below:

$$\mu_i = \omega_i + \varepsilon_i$$

where ω_i is the survey recall error, and ε_i takes all other errors (observed and unobserved) that are considered random. Conflict exposure is correlated with household characteristics, which results in a more realistic model of recall bias.

$$Y_i = \alpha_0 + \alpha_1 D_i + X_i' a_x + \omega_i + \varepsilon_i$$

In this model with covariates, the condition required for recall errors not to bias α_1 is that the conditional independence assumption cov (Di|Xi, ω_i) = 0 holds in the data. This means

that recall errors are randomly distributed across conflict and non-conflict areas once observable characteristics are controlled for. Brown and Kulik (1977) suggested a complementary model to understand recall bias, called the Flashbulb test, which suggests that major events such as natural disasters or traumatic events can be recalled through the use of well-known events and objectively corroborated. X is the presence of recall bias computed using pre- and post-conflict scenarios, as a comparison between the two times is necessary.

$$\omega_i = \begin{cases} 0 \text{ if } Z_{t-1} = \hat{Z}t - 1, \text{by individual i at the time of the post} - \text{conflict survey t} \\ 1 \text{ if } Z_{t-1} \neq \hat{Z}t - 1, \text{by individual i at the time of the post} - \text{conflict survey t} \end{cases}$$

where Z_{t-1} is a well-known past event occurred at time "t − 1" (pre-conflict) and $\hat{Z}t - 1$, it denotes the recall of the event by individual i at the time of the post-conflict survey "t". We can then test the conditional independence assumption in a model with covariates cov (Di|Xi, ω_i) = 0 by estimating the following regression:

$$\omega_i = \beta_0 + \beta_1 D_i + X_i'\beta_x + \varphi_i$$

where $\omega_i \in \{0, 1\}$ is an indicator that takes the value of zero if individual i accurately retrieves the past event (recall accuracy by comparing responses of respondents to the actual timing of the event), and 1 if the individual retrieves the event inaccurately, β_0 is the intercept, $Di \in \{0, 1\}$ is an indicator that takes the value of 1 for conflict-affected and 0 otherwise, Xi contains the control variables, including age of the household head, education in years of the household head, sex of the household head, and φ_i is the error term.

For the Flashbulb memory test, this research considers the official announcement of the death of the late Prime Minister of Ethiopia, Mr. Meles Zenawi. Respondents were asked to indicate whether they recalled the event, and statistical inference was used as a proxy to determine the presence of recall bias in the food security and resilience study. A questionnaire was designed to assess the clarity of the recall, the importance of the event, the accuracy of the recall against known timelines, the level of confidence of respondents in their recollection of the event, and their recall.

The questionnaire was an integral part of the food security and resilience survey, administered alongside the main research undertaking. Stata was used as the analysis software for conducting the analysis, employing appropriate statistical approaches. Other control variables that did not often change because of exposure to conflict were included in the logistic regression model. Data were collected as an integral part of the food security and resilience survey using the following questions for recall bias analysis.

Table 4.1: Flashbulb recall test questionnaire

S/N	Recall questions	Response options
1	How clearly you recall the official announcement of the death of the late prime minister Mr. Meles Zenawi of Ethiopia?	1. Does not recall it 2. Recalls it vaguely 3. Recalls it more or less clearly 4. Recalls it very clearly 5. Recalls it vividly
2	At that time, how much importance did you attach to the event?	1. Not important at all 2. Less important to me 3. Somewhat important 4. Considered it very important 5. Considered it extremely important
3	What was the year and month of the official announcement of his death?	1. August 2011 2. August 2012 3. August 2013 4. January 2011 5. January 2012 6. January 2013
4	On a scale of 1 to 5 (where 1 is not at all confident and 5 is extremely confident), how confident do you feel about this remembrance?	1. Not confident at all 2. Less confident 3. Moderately confident 4. Very confident 5. Extremely confident

Source: Researchers' construction

Several statistical techniques are available to detect CMB in Stata, including Harman's Single-Factor Test, the Marker Variable Technique, and the Correlation Matrix Approach.

Harman's Single-Factor Test: One of the most commonly used techniques, Harman's Single-Factor Test, assesses whether a single factor accounts for most of the variance in the dataset. If one factor explains more than 50% of the total variance, CMB may be present (Podsakoff et al., 2003). The mathematical formulation of this test is based on exploratory factor analysis (EFA), where the total variance explained by the first factor is computed as:

$\lambda_1 / \sum \lambda_i$

where: λ_1 is the eigenvalue of the first unrotated factor, $\sum \lambda_i$ is the sum of all eigenvalues. Interpretation of Harman's Single-Factor Test: If the first factor accounts for more than 50% of the variance, it indicates potential CMB and suggests that additional remedies may be required.

Marker Variable Technique: This technique introduces a theoretically unrelated variable, known as a marker variable, to detect potential method bias. If the inclusion of the marker variable significantly alters regression coefficients, CMB is likely influencing the results (Lindell & Whitney, 2001). The statistical formulation of this test is:

$Y = \beta_0 + \beta_1 X + \beta_2 MV + \varepsilon$

where:

Y is the dependent variable, X represents the independent variables, MV is the marker variable, β_2 captures the effect of the marker variable, and ε is the error term. Interpretation of the Marker Variable Technique: A significant change in the coefficients after including the marker variable suggests the presence of CMB.

Correlation Matrix Approach (Full Collinearity Test): High correlations among independent variables, particularly above 0.90, indicate the possibility of CMB. The mathematical formulation for detecting multicollinearity using a correlation matrix is:

$$\rho_{ij} = \frac{Cov(X_i, X_J)}{\sigma x_i \sigma x_j}$$

where: ρ_{ij} is the Pearson correlation coefficient between variables and $X_i \, and \, X_J$, $Cov(X_i, X_J)$ is the covariance between the two variables, and $\sigma x_i \, and \, \sigma x_j$ and are the standard deviations of the respective variables. Interpretation of Correlation Matrix Approach (Full Collinearity Test): If correlations exceed 0.90, it suggests multicollinearity that may be driven by common method variance.

4.3. Method Validation

4.3.1. Demographic characteristics of respondents

Among the respondents, 15% were female-headed and 85% were male-headed households from whom data were collected.

Table 4.2: Number of samples per study district and sex of the household head

Name of study districts	# of observations			Proportion of response (%)
	Male-headed households	Female-headed households	Total number of households	
Delanta	72	17	89	21
Dessie Zuria	123	15	138	33
Kalu	77	11	88	21
Worebabo	86	21	107	25
Total	358	64	422	100

Source: Survey data by researchers

Respondents reported on their perceived exposure and the severity of conflict-related damage to the overall food system, which affects household food security. Only 10% reported that their food security was not affected by the conflict, and 19%, 25%, and 46% of respondents indicated mild, moderate, and severe damage, respectively.

Table 4.3: Level or severity of conflict impact on the food system

Rate of conflict impact on food system	Number of observations	Proportion of response (%)
No damage	43	10
Mild damage	79	19
Moderate damage	107	25
Severe damage	193	46
Total	422	100

Source: Survey data by researchers

The minimum age ranges from 20 years, and the maximum age of the household head was 79 years. Generally, the majority of respondents fell within 30 – 49 years, representing a cumulative proportion of more than 61%.

Table 4.4: Age categories of household heads and proportion of respondents

Age categories of household heads	Number of observations	Proportion of response (%)
20 – 29 years	13	3.1
30 – 39 years	102	24.2
40 – 49 years	158	37.4
50 – 59 years	95	23.5
60 – 69 years	44	10.4
70 – 79 years	10	2.4
Total	422	100

Source: Survey data by researchers

In the study areas, only 30 percent of respondents reported engaging in off-farm activities for income generation in the post-conflict context, with labor activities representing the largest proportion. The conflict negatively affected livelihood diversification, which limits the ability of households to access food at the household level. Based on the Flashbulb memory test questionnaire designed for the study, respondents were asked questions to check the clarity of their recall of the official announcement of the death of the former Prime Minister of Ethiopia. The question was intended to check whether the respondents clearly recalled the event.

Table 4.5: Clarity of the recall of the event by respondents' answer

Clarity of recall	Number of observations	Proportion of response (%)
Does not recall it	105	24.9
Recalls it vaguely	106	25.1
Recalls it more or less clearly	92	21.8
Recalls it very clearly	55	13.0
Recalls it vividly	64	15.2
Total	422	100

Source: Survey data by researchers

Additionally, we assessed the value or importance that respondents attributed to the event. The importance of the event is linked to whether respondents are interested in the event due to its national and political dynamics, and whether the event was personally relevant.

Table 4.6: Importance or relevance of the recall of the event by respondents' answer

Importance of recall	Number of observations	Proportion of response (%)
Not important at all	90	21.3
Less important to me	199	47.2
Somewhat important	59	14.0
Considered it very important	39	9.2
Considered it extremely important	35	8.3
Total	422	100

Source: Survey data by researchers

Finally, the respondents were asked to indicate the exact period of the event. Considering that the data collection took place in the rural context of Ethiopia, the researchers opted to request the year and month of the event instead of the exact date of the official announcement of the death of the late Prime Minister of Ethiopia, Mr. Meles Zenawi. Responses were provided to the respondents to help them better recall the event.

Table 4.7: Exact period of the event by respondents' answer

Exact period of the event	Number of observations	Proportion of response (%)
August 2011	19	4.5
August 2012	297	70.4
August 2013	29	6.9
January 2011	27	6.4
January 2012	30	7.1
January 2013	20	4.7
Total	422	100

Source: Survey data by researchers

Further to the recall of the event as indicated above, respondents were asked how confident they felt in the recollection of the event and in the response, they provided to the confidence question.

Table 4.8: Respondents' confidence on the recollection of the event

Confidence level of the recall	Number of observations	Proportion of response (%)
Not confident at all	94	22.3
Less confident	111	26.3
Moderately confident	86	20.4
Very confident	60	14.2
Extremely confident	71	16.8
Total	422	100

Source: Survey data by researchers

The question related to the exact period of the event (in terms of year and month) was used to determine how many of the respondents recalled the event correctly. Table 4.9 indicates that 70% of respondents recalled the event correctly in August 2012, while 30% received the recall incorrectly.

Table 4.9: Proportion of respondents and accuracy of recall

Correctness of recall	# of observations	Proportion of response (%)
Correct recall	297	70
Incorrect recall	125	30
Total	422	100

Source: Survey data by researchers

Based on the correctness of the recall of the event, the responses were categorized into two groups for the Flashbulb memory test. Respondents who recalled the event correctly were assigned a value of 0, while respondents who recalled the event incorrectly were assigned a value of 1, denoting the recall error or bias. This category forms the recall error as an outcome variable, and logistic regression is used to identify factors with or without recall bias.

4.3.2. Recall bias and association with socio-economic and demographic characteristics

A chi-square test was run to determine any significant association between recall error and different socioeconomic and demographic characteristics of the respondents. The socioeconomic and demographic characteristics included district (Pr = 0.880), sex of household head (Pr = 0.544), marital status (Pr = 0.879), conflict exposure (Pr = 0.863),

severity of conflict impact (Pr = 0.997), food security status on an HFIAS scale (Pr = 0.257), age of the household head (Pr = 0.495), agroecology (Pr = 0.584), off-farm participation (Pr = 0.314), and food security status on the household food balance model (Pr = 0.284). The chi-square test indicated that none of the socioeconomic or demographic characteristics were significantly associated with the respondents' ability to recall past events.

4.3.3. Flashbulb memory test

A logistic regression model was used for the recall error as a binary dependent variable, taking a value of 0 for correct recall and 1 for incorrect recall. The level of importance that respondents attached to the event, the rate of conflict damage on food systems, and its impact on household food security, as well as categorical variables such as sex, age, and years of education of the household head, were the independent variables included in the regression model. The inclusion of sex, age, and education of the household was identified as a key control variable for the study. Gender plays a crucial role in memory and emotional connection, which can affect memory ability differently (Hirst & Phelps, 2016), particularly in a conflict setting. Besides, memory varies with age, and cognitive ability could decline as age increases (Winograd & Neisser, 1992).

Education also plays a crucial role in the processing of information and memory retention, with educated individuals being able to recall events accurately due to cognitive differences (Brück & d'Errico, 2022). In the study, other socioeconomic and demographic factors were excluded due to their indirect influence on memory. Income, family size, or occupation may affect stress and improve well-being, which could in turn relate to memory ability. However, it is not particularly strong and often has an indirect effect on memory ability. Therefore, we recommended including the age, sex, and education status of the household head who provided the response during the survey as control variables. A logit model was constructed for the two sets of predictor variables. The first set of variables consisted of the level of importance that respondents attached to the event and the rate of conflict damage on food systems, as well as its impact on household food security, categorized into four levels (no damage, mild damage, moderate damage, and severe damage), without

using any of the control variables. As indicated in Table 4.10, only the importance of the event was a significant predictor of recall error at a p-value of less than 0.01. However, conflict exposure in general and specifically the intensity of conflict expressed in terms of severity of damage to food systems with implications on household food security were found to be insignificant.

Table 4.10: Logistic regression of recall error without the control variables

Recall error	Coefficient	Standard Error	z	P>|z|	Confidence Interval (95%)	
Recall importance	-1.559	0.156	-10.0	0.000***	-1.865	-1.254
Conflict exposure						
Mild	0.168	0.533	0.32	0.753	-0.877	1.213
Moderate	0.258	0.519	0.50	0.619	-0.759	1.276
Severe	0.072	0.475	0.15	0.880	-0.859	1.003
_cons	4.715	0.589	8.00	0.000* **	3.559	5.870

* Significant predictors at 90% confidence interval, ** significant predictors at 95% confidence interval; *** significant predictors at 99% confidence interval. Source: Survey data by authors, Number of observations is 422; LR Chi2=181.47; Prob > chi2 = 0.0000 and Pseud R2 = 0.3539; Source: Survey data by researchers

The second option was to run the logistic regression, including the control variables of age, sex, and education of the household head, which remained unchanged due to exposure to conflict impacts. While including the control variables in the model, the importance of recall and the level of conflict's impact on the food system were kept in the regression process.

Table 4.11: Logistic regression of recall error including the control variables

Recall error	Coefficient	Std. Error	z	P>|z|	Confidence Interval (95%)	
Recall importance	-1.565	0.156	-10.02	0.000***	-1.871	-1.259
Conflict exposure						
Mild	0.114	0.538	0.21	0.832	-0.941	1.169
Moderate	0.213	0.523	0.41	0.684	-0.812	1.237
Severe	0.045	0.477	0.10	0.924	-0.890	0.981
Sex	-0.230	0.382	-0.60	0.547	-0.979	0.519
Age	0.008	0.014	0.54	0.593	-0.020	0.035
Years of education	0.025	0.043	0.59	0.558	-0.059	0.109
_cons	4.593	1.054	4.36	0.000***	2.527	6.658

* Significant predictors at 905% confidence interval, ** significant predictors at 950% confidence interval; *** significant predictors at 99% confidence interval Source: Survey data by authors, Number of observations is 422; LR Chi2= 182.52; Prob > chi2 = 0.0000 and Pseud R2 = 0.3559, Source: Survey data by researchers

In the logit model, only the recall importance was a significant predictor. Neither conflict impact nor any of the control variables were significant, as the p-value for all was greater than 0.05. As a result, conflict exposure did not affect recall ability, or at least, the pattern of recall bias was normally distributed. This implies that either conflict did not affect recall or that the impact of conflict is random, which does not affect the use of data, considering that there is no pattern in recall ability for any segment of the respondents. The results of the recall bias analysis based on the Flashbulb memory test method indicated that the food security and resilience data were not affected by recall bias. Hence, inferences can be made using data from the food security and resilience analysis in the context of conflict exposure in the South Wollo Zone.

4.3.4. How the finding of the Flashbulb memory test compares to other studies

The finding of our study indicates that conflict did not affect recall ability in the context of the study population. However, it also contradicts existing evidence where conflict affected recall ability, which leads to recall bias. For instance, Moreno-Serra et al. (2022) utilized a Flashbulb memory test to check recall accuracy. They found that individuals in conflict-affected areas tend to overstate past situations, particularly in terms of economic conditions and suffering. This indicates that traumatic experience due to conflict exposure could affect memory ability, leading to overstating or understating pre-conflict situations. However, these biases were not universal across all types of questions or across all demographic groups, highlighting the complexity of recall bias in conflict settings, suggesting that while conflict exposure may lead to certain memory distortions, it does not always result in a systematic over-reporting or under-reporting of all experiences (Moreno-Serra et al., 2022). The study highlights the importance of carefully considering these biases when analyzing retrospective data in conflict-affected populations. In addition to traumatic experiences, other factors, such as the political situation, media, and humanitarian aid, can also influence recall bias.

Our findings indicated that recall ability could be stable even in a conflict context. A study by De Waal (1997) indicated that communities affected by recurrent food insecurity develop recall mechanisms that help them accurately remember retrospective information.

remember past events. This finding could be related to the context of the South Wollo Zone. The South Wollo zone is considered a ‘famine belt’ of Ethiopia due to recurrent exposure to drought. People in South Wollo are exposed to several climate-induced calamities, including drought, which may help inform the development of such recollection strategies. These strategies should be further studied to fine-tune the findings of the study.

In addition, demographic characteristics like age, sex, and education were not found to be significant, which differs from El Tayeb et al. (2014), who reported that sex, age, and education affect recall ability. The differences in the findings of these studies could be attributed to the type of questions, the intensity of the conflict's impact, and other socioeconomic factors.

We argue that generalizing similar studies may be problematic, as understanding of recall bias in a conflict setting requires a context-specific assessment. While some research indicates systematic distortions in retrospective self-reports due to traumatic events, our findings suggest that, at least for food security and resilience assessment in the study areas, recall remains relatively accurate across various demographic groups. This affirms the reliability of the recall data for statistical inference. This underscores the importance of not generalizing recall bias effects and highlights the need for tailored methodologies when assessing recall accuracy in diverse conflict-affected populations by incorporating a complementary approach, like the Flashbulb memory test method in food security and resilience studies, and appropriate actions should be taken before deciding to use data for statistical inference.

4.3.5. Testing common method bias

The Common Method Bias test was conducted by deploying a combination of different statistical methods: Harman’s Single-Factor Test, Marker Variable Technique, and Correlation Matrix Approach to strengthen the statistical validity of research findings for inference.

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.74236	0.67093	0.1507	0.1507
Factor2	1.07142	-0.13735	0.0927	0.2434
Factor3	1.20877	0.20752	0.1046	0.3480
Factor4	1.00125	-0.03424	0.0866	0.4346
Factor5	1.03549	0.31952	0.0896	0.5242
Factor6	0.71596	-0.23270	0.0619	0.5862
Factor7	0.94866	-0.16609	0.0821	0.6682
Factor8	1.11476	0.15461	0.0964	0.7647
Factor9	0.96014	0.13398	0.0831	0.8477
Factor10	0.82617	0.27765	0.0715	0.9192
Factor11	0.54852	0.16322	0.0475	0.9667
Factor12	0.38530	.	0.0333	1.0000

Figure 4.2: Harman's Single-Factor Test
# of observation = 422, retained factors = 12, # of params = 150, Schwarz's BIC = 907.14 and Akaike's) AIC = 300.389; Source: Survey data

As the first factor in Figure 4.2 accounts for less than 50% of the variance, it indicates that Common Method Bias (CMB) is not a problem for the data. The Marker Variable Technique also determined that CMB is not a problem for the retrospective food security and resilience analysis. The researchers selected a factor variable called district. The p-value for the district was 0.130, which is greater than 0.05, indicating that it is not significant, and thus CMB is not a problem for the retrospective data. The multicollinearity test for the independent variables indicated that there are no highly correlated variables. In the statistical test, multicollinearity, which could be a result of CMB, was not detected. The maximum correlation between the independent variable was 0.48, which is not high enough to determine the presence of CMB. The Variance Inflation Factor (VIF) was also less than 3 for all independent variables, indicating no serious multicollinearity, affirming that CMB is not a problem for the retrospective study in our study context.

4.4. Conclusion and Recommendations

Recall bias assessment and analysis were conducted as a complementary study to the study of household food security and resilience of drought- and conflict-affected households in the South Wollo Zone. Following the Northern Ethiopian conflict, which devastated thousands of households in the zone, a food security and resilience assessment was conducted in four districts: Delanta, Dessie Zuria, Kalu, and Worebabo.

This study aimed to compare household resilience to food insecurity during pre-conflict and post-conflict reference periods, taking into account a one-year baseline period preceding the Northern Ethiopian conflict, one-year periods of the conflict, and a follow-up period after the peace agreement. Due to the ongoing conflict, it was not possible to collect real-time data during the conflict period, and no pre-conflict data were available for reference. As a result, it was necessary to collect retrospective data for the two reference periods based on the respondents' recall.

In the context of conflict, making comparisons before, during, and after the conflict is crucial for developing effective policies that address the needs of conflict-affected communities. The challenges of access and safety concerns make data collection during conflict periods very difficult. As a result, recalling information was the most appropriate option. However, recall data suffer from reliability and credibility issues due to potential errors, such as loss of memory or forgetfulness, erroneous retrieval of past events, psychological consequences of the conflict, or deliberate misinformation resulting from fear. Reliability makes it difficult to make statistical inferences with the expected level of confidence.

To minimize recall bias, researchers are recommended to conduct research that covers a short time span to guarantee proper retrieval of past events. In addition, the design of surveys should also consider the potential for recall bias, which can affect the credibility of research recommendations. However, in the case of this research, there were times when data collection was not possible during the conflict, and a comparison between two reference periods is necessary to understand the impact of the conflict on food security, livelihoods, and resilience mechanisms. The decision to use recall data is imperative.

While testing for the presence of recall bias using methods such as the Flashbulb memory test to determine the statistical reliability of inferences, it is essential that researchers employ different strategies to minimize recall bias in retrospective data collection. In this study, we implemented different strategies during the design of surveys and at the time of data collection to ensure accurate data was collected. These strategies include the use of

seasonal references during production-related questions in the food security study. The major agricultural seasons in the study include *belg* and *meher*. These agricultural seasons were used as a reference to collect questions related to agricultural production and disaster exposure in the study, helping respondents accurately recall such information.

The other aspect was related to the selection of enumerators and the quality of training on the data collection tools provided to them. The researchers identified agricultural experts who are familiar with the local context and possess an understanding of food security, disaster risk reduction, and resilience. This was accompanied by comprehensive training on the household questionnaire, which enhanced their understanding. The training also included instruction on interviewing skills to ensure that some information could be verified and triangulated for accuracy. The allocation of sufficient time for data collection was another strategy employed. This helped enumerators collect a few questionnaires every day and allocate a sufficient amount of time when dealing with older people and those who require support during the interviews. Despite the financial burden of this strategy, it was found to be relevant, considering that rushing would result in even greater costs, leading to poor-quality data.

Therefore, when designing surveys, it is recommended to include a well-known event and assess whether respondents can recall it. The questionnaire also included questions related to the clarity of recall, the importance of the event, the actual timing of the event, and the respondents' confidence in their recollection of the event. The recall error, an outcome variable, is generated, and a logistic regression is run using predictors such as recall importance and intensity of conflict to understand whether conflict exposure was a significant predictor of recall bias. Control variables such as age, education, and sex of the household heads were included in the model. The regression outcome indicated that conflict exposure, expressed as the intensity of conflict in the food system, an indicator of household food security, was not significant. The research concluded that recall bias does not affect food security and resilience. Hence, the statistical inferences were valid and reliable as they were not influenced by recall bias.

The findings of the Flashbulb memory test could be generalized to other conflict-affected contexts if there are similarities in conflict dynamics, population characteristics, and other socio-economic factors that could help explain the observed patterns in the study, which may be applicable in other contexts. However, it is essential to acknowledge that there are limitations to generalizing the findings, as memory ability can be influenced by various factors, including cultural and social differences, conflict intensity, media influence, and sample representativeness. Therefore, future studies should replicate the methodology in diverse conflict settings to strengthen the external validity of the results. This study underscores the importance of not generalizing recall bias effects and highlights the need for tailored methodologies when assessing recall accuracy in diverse conflict-affected populations by incorporating a complementary approach, like the Flashbulb memory test method in food security and resilience studies, and appropriate actions should be taken before deciding to use data for statistical inference.

Finally, we recommend complementing the Flashbulb memory test method with other statistical methods, such as Harman's Single-Factor Test, Marker Variable Technique, and Correlation Matrix Approach, which can be used to assess the presence of Common Method Bias (CMB), which is a major problem in retrospective studies. This approach helps identify issues, address them using the statistical method, and confirm the validity and rigor of statistical inference in retrospective food security and resilience studies.

CHAPTER 5: ANALYSIS OF HOUSEHOLD RESILIENCE TO FOOD INSECURITY IN THE CONTEXT OF CONFLICT AND DROUGHT IN SOUTH WOLLO ZONE, ETHIOPIA[6]

This chapter highlights the concepts and empirical evidence pertaining to household resilience to food insecurity. It primarily identifies the four pillars of resilience – assets, access to basic services, social safety net, and adaptive capacity - and their interaction to determine the ability of households to bounce back from the impact of crises and cope with and absorb adversities affecting household food security. The study considers the Resilience Index Measurement and Analysis (RIMA) approach to analyze household resilience to food insecurity. In addition, the resilience capacity index is linked with household food security to determine food security loss pre-post conflict for the impact of conflict and drought. It also provides key information regarding determinant factors of food security loss and gains in the aftermath of the impact of conflict and drought in the South Wollo zone, Amhara region.

Abstract

The research analyzed household resilience to food insecurity in the context of conflict and drought and identified determinants of food security loss in South Wollo zone, Amhara region, Ethiopia. Descriptive research complemented with a quasi-experimental design using Difference-in-Difference model was used for data collected from 422 randomly selected households, and this was complemented by literature reviews and data from purposively selected key informants and focus group participants. The resilience index measurement and analysis, and thematic analysis methods were used to analyze quantitative and qualitative data. The research found that access to basic services, assets, adaptive capacity, and social safety nets contributed 21.96%, 27.7%, 31.34%, and 19% to resilience capacity, respectively, pre-conflict. Assets alone contributed 60.55%, while access to basic services was not relevant in determining resilience post-conflict. The resilience capacity index decreased from 45.1 to 38.8 during post-conflict. Households with high conflict exposure experienced a 7.85-point greater decline in resilience capacity

[6] This chapter is based an article that is approved as publishable by advisors.

compared to a 3.32-point decline for low-exposure at p-value <0.01. Whereas, a statistically significant decline in RCI by approximately 6.43-point for low drought-exposed households but no statistically significant differential impact of drought between groups. Livestock ownership, agricultural index, work ratio, and number of crops cultivated were significant determinants of reduced food security loss. The research recommends increasing investment in livestock and agricultural assets, livelihood diversification, uninterrupted access to aid during conflict, access to affordable loan services, and promoting community-based support mechanisms to build household resilience to food insecurity.

Keywords: Conflict, Determinants of resilience, Drought, Food security loss, Household resilience

5.1. Introduction and Justification

Food security is a multicausal phenomenon that is often affected by drought, political instability, conflict, poor governance, population growth, and disease epidemics (Dorward & Kydd, 2004; Mangaliso & Dlamini, 2018). It is a complex concept, and the multidisciplinary sector encompasses four pillars: availability, accessibility, utilization, and stability (Food and Agriculture Organization, 1996; Birara et al., 2015; Motbainor et al., 2016). It is a function of economic, social, environmental, and political factors (Debebe, 2018; Wahbeh et al., 2022).

Climate change is threatening food security in Africa, where communities are mainly dependent on rain-fed agriculture (Parry et al., 2007; Lemma et al., 2013; Adamu, 2020; Akpa, 2024). These challenges, coupled with limited resource availability, loss of soil fertility, and poor farming practices, lead to food insecurity (Bogale & Shimelis, 2009; Righettini & Bordin, 2023) and dangerous coping mechanisms that constrain the ability of households to return to normalcy (Saad, 2014). The continent is also being severely affected by various kinds of conflict, including election disputes, control over resources, civil unrest, religious intolerance, ethnic-motivated violence, and boundary conflicts (Allen

& Okeke-Uzodike, 2010; Alozieuwa, 2010; Amungwa, 2011; Bere, 2011; Christakis, 2013; Pate, 2014).

The Horn of Africa, including Ethiopia, is experiencing cycles of protracted crisis (Cerdà-Bautista et al., 2023). Investments by the Ethiopian government and aid agencies in enhancing production and productivity, market infrastructure, microfinance institutions, and extension services in several sectors (such as agriculture, health, water, and sanitation) have not brought the desired food security outcome because of the adverse impact of recurrent drought, conflict, desert locus infestation, and political instability in different corners of the country (Famine Early Warning Systems Network, 2021).

Ethiopia is facing its worst crisis, with more than 20 million people projected to require humanitarian assistance in 2024 (Office for the Coordination of Humanitarian Affairs, 2024). Since the northern Ethiopia conflict expanded in the neighboring regions of Amhara and Afar in November 2020, it has been reported that more than half a million people have been displaced, resulting in the disruption of livelihoods, destabilization of communities, and food insecurity. Livelihood activities, including farming, have been affected by conflict (Office for the Coordination of Humanitarian Affairs, 2018). Displacement, loss of life, destruction of basic service facilities, and disruption of economic activities are some of the impacts of the conflict. A conflict generally affects human, financial, physical, natural, and social capital, which are relevant assets for household food security, leading to the erosion of resilience capacity (Food and Agriculture Organization, 2021). In addition, existing aid mechanisms, such as the Productive Safety Net Program, have been disrupted, leading to increased vulnerability, compromised resilience capacity, and food insecurity (Group on Earth Observations Global Agricultural Monitoring, 2022).

The term resilience describes a transformative process of strengthening the capacity of men, women, communities, institutions, and countries to anticipate, prevent, recover from, and transform in the aftermath of shocks, stresses, and change (Winderl, 2014). The resilience concept includes capacities at the community, household, and individual levels to minimize exposure to shocks and stresses by making proactive and informed choices

based on changing conditions (Winderl, 2014; Bahadur & Pichon, 2016). It is a complex concept that can mean different things to different people and institutions. Consequently, measuring resilience is challenging (Mitchell et al., 2013).

Resilience is built when households or affected people or communities are supported to cope with change, adapt livelihoods to changing circumstances, and improve the structures, systems, and entire ecosystem so that people are able to avoid or minimize the impact of future crises. Exposure to disasters reduces the adaptive and transformative capacity of the poor by limiting their choices and opportunities. This further leads to the erosion of livelihoods, which is important for resilience. Disasters such as drought and conflict affect people disproportionately, depending on differences in adaptive capacities and the level of existing vulnerabilities (Thomas et al., 2019). Vulnerable households with poor asset bases and communities that have climate-sensitive livelihoods, such as those dependent on agriculture and livestock, are highly affected (Dinda, 2015; Birkmann et al., 2022). The recurrent exposure to drought and conflict, coupled with other calamities, has made the South Wollo zone the most food insecure and famine-prone area in Ethiopia (Little, 1992; Little et al., 2006).

In conflict-affected areas, resilience-building is often undermined by displacement, economic disintegration, and weakened governance structures (Maxwell et al., 2017). The relationship between conflict and food security deteriorates with climate change, exacerbated by recurring droughts and irregular rainfall, leading to reduced agricultural output (Raleigh & Kniveton, 2012). In Ethiopia, protracted conflict, along with environmental shocks, has led to recurrent food crises that largely harm vulnerable rural communities.

This research aims to analyze household resilience to food insecurity and provide evidence of household resilience to food insecurity by determining influential factors and showing a link between resilience and household food security in the context of drought and conflict in the South Wollo zone, Ethiopia. The study will also guide future researchers and

development practitioners in designing interventions to build better resilience to food insecurity.

5.2. Materials and Methods

5.2.1. Research design and approach

A descriptive research design, complemented by a quasi-experimental design using the Difference-in-Difference model, was employed to characterize the research samples (Thomas & Zubkov, 2020). It provides an understanding of household resilience to food insecurity in the context of conflict and drought by comparing the resilience capacity index in the pre-conflict and post-conflict reference periods. Quantitative and qualitative data were collected based on the FAO's Resilience Index Measurement and Analysis (RIMA) model (Food and Agriculture Organization, 2016). Retrospective data were collected for the pre-conflict reference period (June 2019 to May 2020) and the post-conflict reference period (June 2021 to May 2022) using a Flashbulb memory method to statistically assess the influence of exposure to conflict on memory recollection and determine the statistical reliability of the data. Even though the study provides the pre-conflict and post-conflict resilience capacities of households, the difference in resilience capacity may not be attributed solely to the impact of conflict or drought as confounding factors were not controlled for causal inference.

5.2.2. Sampling techniques and data sources

The four research districts were selected based on consultation with key informants, considering the districts' history of recurrent exposure to drought and the northern Ethiopian conflict. However, a lottery approach was used to randomly select 38 villages, from which 422 respondent households were identified through systematic random sampling for a questionnaire-based survey. The sample size was determined based on Taherdoost (2016) at a 95% confidence interval with a 5% margin of error, where n is the sample size, and p is the percentage of occurrence of state estimated at 50% to produce the maximum sample size (Bartlett et al., 2001) and a corresponding z-score for a 95%

confidence interval of 1.96. A 10% contingency sample was used to obtain a total sample of 422 households.

$$n = \frac{p(100-p)z^2}{e^2} = \frac{0.5(1-0.5)1.96^2}{0.05^2} = 384$$

Purposive sampling was used to identify the FGD and KII participants. Ten FGDs of mixed demographic and socioeconomic characteristics and 15 KIIs were purposively selected with the assumption of reaching the saturation point. A total of 10 FGDs and 15 KIIs were conducted for the study, and significant effort was made so that the saturation point was achieved. In the research undertaking, the saturation point was achieved after 7 FGDs and 11 KIIs, and the additional interviews and discussions did not yield new information. KII participants were technical experts in government and nongovernmental organizations, authorities, and community leaders. Furthermore, related research works, government and nongovernmental reports, books, and other literature were systematically reviewed and synthesized as a part of the research process.

5.2.3. Data analysis techniques

The RIMA method, developed by the Food and Agriculture Organization (2016), is the foundation of the research on resilience measurement and analysis. The RIMA calculation is based on a latent variable model of estimation, where the model highlights observed variables as manifestations of underlying unobserved latent concepts, and the latent variable is also affected by other variables or correlates. The observed endogenous variables were access to basic services (ABS), assets (AST), adaptive capacity (AC), and social safety net (SSN), which influence resilience and can also be influenced by resilience capacity.

The study used descriptive analysis complemented with a quasi-experimental design using the Difference-in-Difference model, which is a direct measurement of the resilience capacity index (RCI) and resilience structure matrix (RSM). RCI measures the ability of a household to avoid long-term consequences from stresses and shocks, whereas RSM shows

the contribution of each variable in computing resilience capacity. In addition, the determinant factors of resilience capacity were identified using inferential statistics.

The researchers used the FAO tool to analyze resilience capacity. The tool was designed based on the Multiple Indicators, Multiple Causes (MIMIC) model. This model explains the relationship between observable and unobservable variables. The RCI analysis outputs were integrated into the main dataset for further corroboration and analysis using Stata software. Per capita calorie availability and the household dietary diversity score (HDDS) were the two food security variables used to determine resilience capacity, based on the mathematical computation by Buehn and Schneider (2008).

$$y = \lambda r + \epsilon$$

$$r = \gamma x' + \varepsilon$$

where (y_1, y_2, …, y_n) are indicators of the latent variable r (resilience), γ is the coefficient of r, and (x_1, x_2, …, x_k) are the causes of r. The measurement model is specified by per capita calorie availability (per capita kcal) and the HDDS.

$$\begin{bmatrix} HDDS \\ Per\ capita\ kcal \end{bmatrix} = [\gamma_1, \gamma_2] * [r] + [\varepsilon_2, \varepsilon_3]$$

The basic causes of the structural model used in the modeling process of the MIMIC model are ABS, AST, AC, and SSN; that is,

$$[r] = [\beta_1, \beta_2] * \begin{bmatrix} ABS \\ AST \\ AC \\ SSN \end{bmatrix} + [\varepsilon_1]$$

Resilience, r, was measured by its causes and indicators and estimated with its error and disturbance of the structural estimation model. A value of 1 was assigned to kcal availability where the coefficients were not measured. The assignment of a value of 1 means that a one-standard-deviation increase in resilience will result in a significant increase in the standard deviation of per capita kcal availability. This helps to define the

unit of measure of resilience and the variance of the food security outcome variables, per capita kcal, and HDDS, as indicated below:

$HDDS = \Lambda 1\ r + \varepsilon 2$
$Per\ capita\ kcal = \Lambda 2\ r + \varepsilon 3$

A regression model was used to identify the determinants of food security gain and loss. Based on the difference in per capita kcal availability between the pre-conflict and post-conflict reference periods, households that registered a decline in kcal availability post-conflict were assigned a value of 1, and those that registered increased kcal availability were assigned a value of 0. Therefore, a dummy variable was generated, and the determinants of food security loss and gain were identified using a probit model.

$Pr\ (Yh = 1) = \Phi\ (xh\ \beta')$

To estimate the causal effect of conflict and drought on household resilience, a Difference-in-Differences (DiD) approach was applied using a fixed-effects regression model. The analysis compares households with high exposure (treatment group) to those with low exposure (control group), using the Resilience Capacity Index (RCI) as the outcome variable across both pre- and post-conflict periods. The interaction term (treatment) captures the DiD effect, which is the differential change in RCI due to conflict exposure and drought separately.

The use of retrospective data poses a significant challenge as it affects the statistical reliability of data. The research deployed a complementary analysis to identify the presence of recall bias using a Flashbulb memory test method. Considering that data was collected based on recall, a well-known event was identified, and key questions about the respondents' memory recollection, including clarity of recall, confidence in the recollection of the event, the importance of the recall, and the actual timing of the event, were collected as part of the resilience to food insecurity study. A complementary model, as suggested by Brown and Kulik (1977), known as the Flashbulb Memory Test, was used to understand

recall bias and was objectively verified. X is the presence of recall bias computed using pre- and post-conflict scenarios, as a comparison between the two times.

$$\omega_i = \begin{cases} 0 \text{ if } Z_{t-1} = \hat{Z}t - 1, \text{by individual i at the time of the post} - \text{conflict survey t} \\ 1 \text{ if } Z_{t-1} \neq \hat{Z}t - 1, \text{by individual i at the time of the post} - \text{conflict survey t} \end{cases}$$

where Z_{t-1} is a well-known past event that occurred at time "t − 1" (pre-conflict) and $\hat{Z}t - 1$, it denotes the recall of the event by individual i at the time of the post-conflict survey "t". The conditional independence assumption was tested in the model with covariates cov $(Di|Xi, \omega_i) = 0$ by estimating the following regression:

$$\omega_i = \beta_0 + \beta_1 D_i + X_i'\beta_x + \varphi_i$$

where $\omega_i \in \{0, 1\}$ is the recall error that takes the value of zero if individual i accurately retrieves the past event defined as accurate recall compared to the timing of the well-known event which was the year and month of the official announcement of the late Prime Minister of Ethiopia, Mr. Meles Zenawi, and 1 if the individual retrieves the event inaccurately, β_0 is the intercept, $Di \in \{0, 1\}$ is an indicator that takes the value of 1 for conflict-affected and 0 otherwise, or severity of conflict impact based on perception of respondents (0 for no, 1 low, 2 medium or 3 severe damage). Xi contains the control variables, including the age of the household head, the education in years of the household head, the sex of the household head, and φ_i is the error term. A logistics regression model was run for recall error as the dependent variable and the independent variables, including recall importance, conflict exposure, and control variables as used in Moreno-Serra et al. (2022). The findings of the regression analysis confirmed the absence of recall bias, or at least, it could be concluded that any recall error, if present, was not statistically significant or uniform across different socioeconomic and demographic groups, which makes the data collected for food security and resilience analysis reliable for statistical inference. The Flashbulb Memory Test, a complementary study to this research, is presented in detail in Muhyie et al. (2025a).

A thematic analysis method was deployed to analyze qualitative data from the literature, KIIs, and FGDs. These methods facilitate the identification and organization of themes when interpreting and conceptualizing data (Naeem et al., 2023; McLeod, 2024).

5.3. Results

5.3.1. Demographic information of respondents

There were 64 female-headed and 358 male-headed households that participated in the questionnaire-based survey. As shown in Table 5.1, the average family size per household in the four districts was 5.1, which is greater than the Amhara regional average of 4.3 (WSP, 2017) and is similar to the country-wide average of 5 persons per household (ILO, 2021).

Table 5.1: List of research districts and resilience capacity index

Name of districts	Number of respondents	Average household size	Mean RCI		Did RCI improve?
			Pre-conflict reference	Post-conflict reference	
Delanta	89	5.5	38.6	36.6	No
Dessie Zuria	138	4.9	50.9	47.2	No
Kalu	88	5.3	47.4	43.8	No
Worebabo	107	4.6	41.3	25.6	No
Total/average	422	5.1	45.1	38.8	

Source: Survey data by authors

The respondents' ages ranged from 22 to 79 years, with a mean age of 46 years. The majority of respondents were aged between 40 and 49 years (37.4%), followed by those aged between 30 and 39 years (24.2%). Respondents older than 60 years of age represented 12.8% of those surveyed, those between 50 and 59 comprised 22.5%, and those between 20 and 29 represented 3.1%. The age categories of the household heads and their corresponding resilience capacity index (RCI) for the pre- and post-reference periods are indicated in Table 5.2.

Table 5.2: Age of household heads and corresponding resilience capacity index

Age categories for household heads	Number of respondents	Corresponding RCI		% change in RCI at post-conflict in RCI
		Pre-conflict	Post-conflict	
20–29 years	13	42.0	39.8	-5%
30–39 years	102	45.0	34.6	-23%
40–49 years	158	47.8	39.7	-17%
50–59 years	95	44.5	42.0	-5%
60–69 years	44	37.8	35.9	-5%
70–79 years	10	47.7	46.5	-2%
Total	422	45.1	38.8	-14%

Source: Survey data by authors

Generally, there is a reduction in the trend of resilience capacity at the post-conflict reference on household resilience. However, it was identified that the resilience of households with heads in the age groups between 30 and 39 years and 40 and 49 years reduced at a rate of 23% and 17%, respectively. These reductions are greater than the overall average reduction of 14%.

As indicated in Table 5.3, approximately 78% of household heads were married, followed by 10% widowed, 6% single, 5% divorced, and 1% separated households. In the aftermath of the northern Ethiopian conflict, single households had the lowest reduction in resilience capacity, while separated households resulted in the highest reduction in resilience capacity, which was above the overall average. For the other groups, the reduction in resilience capacity was nearly similar to the overall average reduction due to conflict.

Table 5.3: Marital status and corresponding resilience capacity index

Marital status	Number of respondents	Corresponding RCI pre-conflict	Corresponding RCI post-conflict	% change in RCI at post-conflict in RCI
Single	27	42.4	39.4	-7%
Married	327	47.4	40.5	-15%
Divorced	22	40.9	34.8	-15%
Separated	4	39.8	31.9	-20%
Widowed	42	32.2	27.9	-13%
Total/average	422	45.1	38.8	-14%

Source: Survey data by authors

Approximately 30% of the respondents indicated that they participated in off-farm activities. Among them, 53% highlighted that their major off-farm livelihood was labor work. However, tailoring, hairdressing, carpentry, and painting were among the off-farm livelihood options practiced by the participants.

5.3.2. The resilience pillars and their contribution to the resilience capacity index

The RCI was constructed taking into account the four pillars of resilience: ABS, AST, AC, and SSN. The contributions of these pillars and their respective components to resilience capacity were assessed in terms of pre-conflict and post-conflict references.

As shown in Figure 5.1, during the pre-conflict period, which served as the baseline and spanned a one-year period preceding the northern Ethiopian conflict, the contributions of ABS, AST, AC, and SSN were 21.96%, 27.7%, 31.34%, and 19%, respectively. However, the post-conflict period was completely different from the baseline. The contribution of the resilience pillars has significantly changed compared to the pre-conflict period. AST contributed 60.55% to determining the household resilience capacity. Adaptive capacity still played a key role, contributing 25.16% to the RSM, despite a slight reduction in its contribution compared to the pre-conflict situation. SSN contributed 14.03%, whereas ABS contributed only 0.26%.

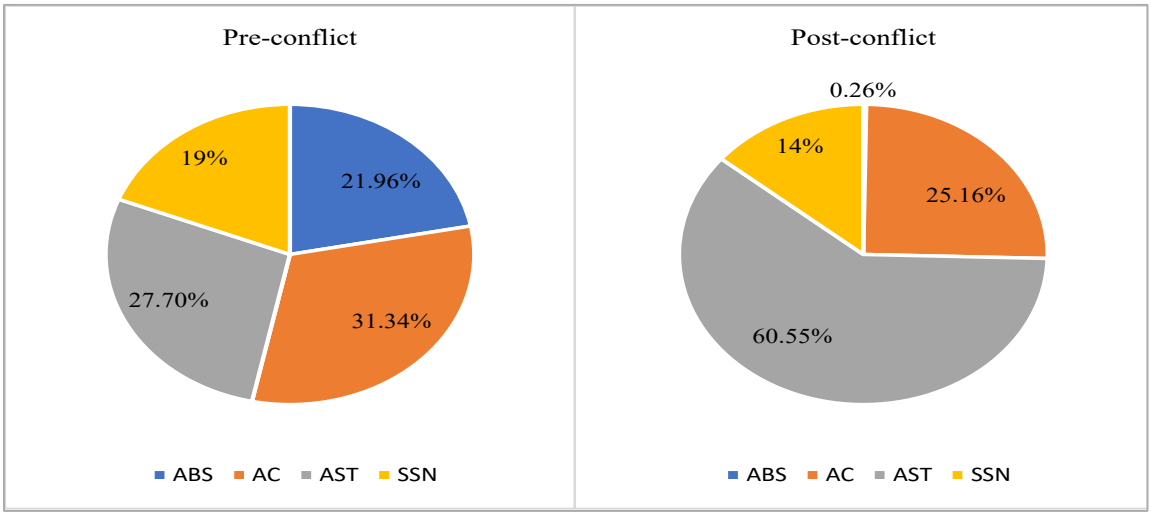


Figure 5.1: Resilience structure matrix and contribution of resilience pillars
Source: Survey data by authors

5.3.2.1. Access to basic services

The variables found relevant and considered in the construction of the ABS pillar were closeness to improved and clean water supplies, health facilities, schools, and transport facilities.

The contribution of access to an improved water supply to the construction of the ABS pillar was nearly the same during both the pre-conflict and post-conflict periods. Closeness to school played a larger role, with slightly higher relevance after the conflict. The contribution of access to health services, defined as proximity to health facilities, increased in relevance to the determination of the ABS pillar after the conflict compared to the pre-conflict context. Access to transport services played a lesser role during and after the conflict. The shift in the contribution of closeness to these basic services and their respective contribution to the ABS resilience pillar is shown in Figure 5.2.

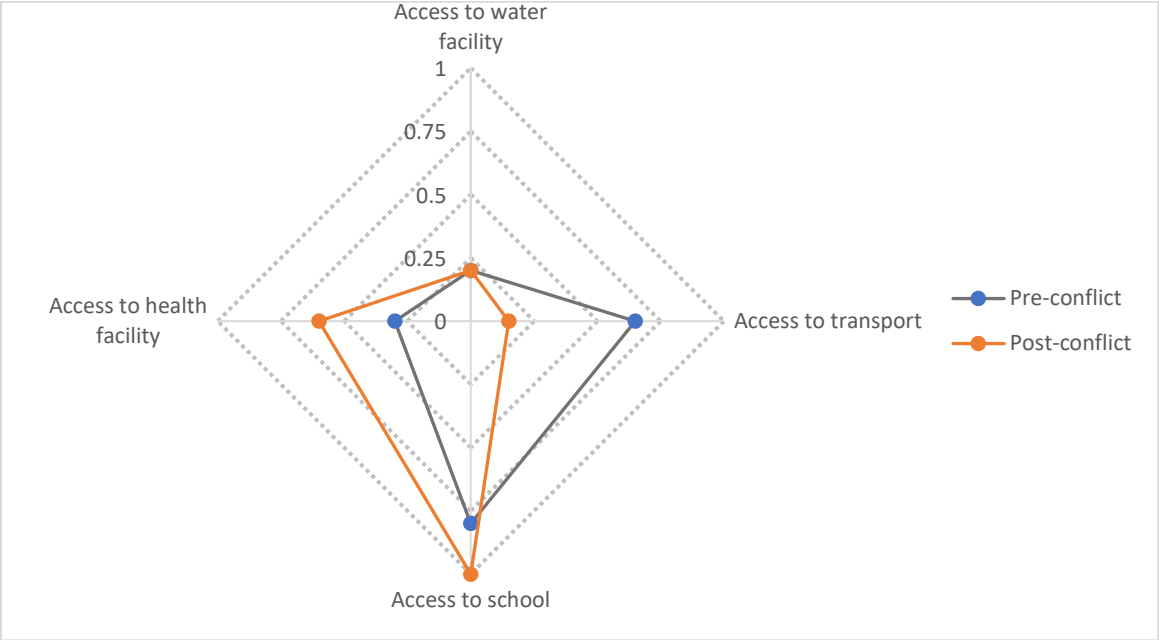


Figure 5.2: Closeness to basic services and contribution to resilience pillar
Source: Survey data by authors

5.3.2.2. Assets

The asset pillar was constructed from three variables: the total livestock unit (TLU), the agricultural index, and the wealth index. The TLU was computed for all the households'

livestock ownership and converted to TLU factors. The agricultural index was a variable generated based on the households' experience with the use of improved seeds, pesticides, and fertilizers to enhance soil fertility. The wealth index was generated from the households' ownership of various durable assets, both productive and nonproductive.

The asset triangle increased after the conflict, resulting in higher contributions of assets to the overall resilience capacity in the aftermath, as indicated in Figure 5.3. This higher contribution of assets was primarily due to the increased contribution from livestock ownership, which demonstrated a significant shift. Before the conflict, livestock's contribution to resilience was lower, and the contribution of durable assets was higher for the same reference period. However, the capacity for durable wealth to determine resilience decreased after the conflict, while TLU played a crucial role in its contribution to the AST pillar. This was due to the fact that livestock were used as a source of food to support household food security and exchanged for money to meet basic needs. However, the conversion of durable assets to cash to support household food security and resilience was not strong. There was no significant shift in the contribution of the agricultural index before or after the conflict.

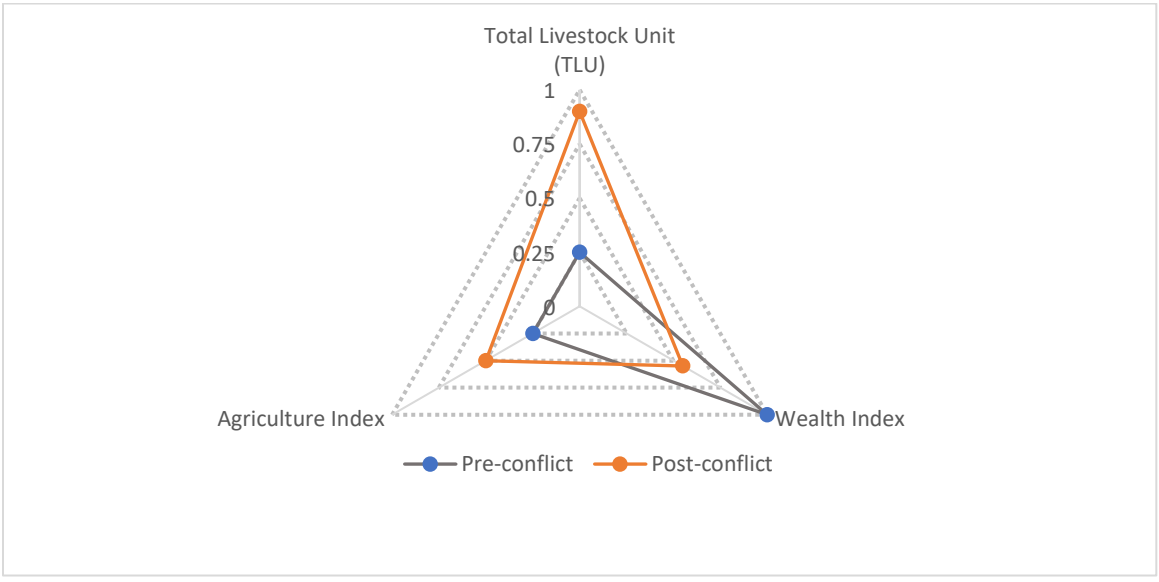


Figure 5.3: Contribution of asset variables to resilience pillar
Source: Survey data by authors

5.3.2.3. Adaptive capacity

This pillar was constructed using the following variables: work ratio, number of crops cultivated, participation in off-farm activities, access to irrigation, the number of years of formal education among household heads, and the number of years of informal education among household heads. The contribution of the asset variables and the shift between the pre- and post-reference periods are shown in Figure 5.4, which provides an understanding of the change in the interaction of variables in determining the adaptive capacity of households and ultimately their household resilience capacity. The work ratio was computed as the proportion of household members aged between 15 and 60 years who were assumed to be working and meaningfully contributing to a household's livelihood. Formal and informal education inform a household head's ability to assess and analyze adversity and its impact on household resilience and food security.

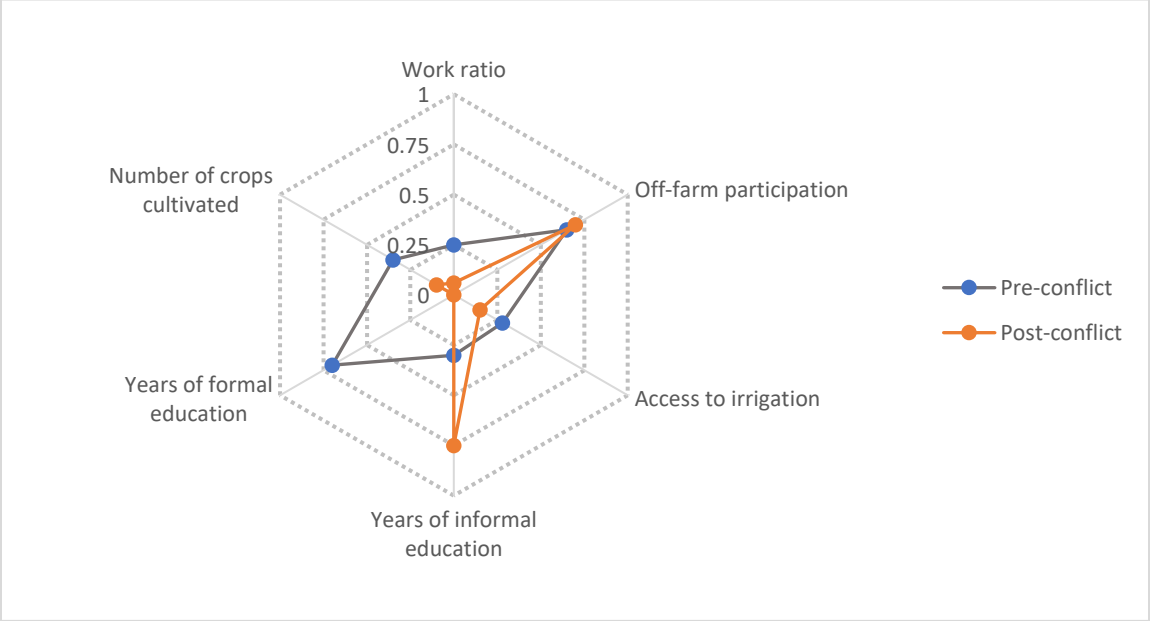


Figure 5.4: Variables determining the adaptive capacity of households
Source: Survey data by authors

The size of the AC pillar decreased during the post-conflict reference period compared to the pre-conflict context, characterized by shifts in the variables' contributions to the AC pillar. AC played a little role in determining the resilience capacity of the RSM in the aftermath of the conflict. Off-farm participation demonstrated similar levels of contribution

before and after the conflict. Before the conflict, the roles of formal education, the number of crops cultivated, the work ratio, irrigation activities, and informal education all demonstrated a noticeable contribution in determining the AC pillar. However, a significant shift was observed after the conflict. The contributions of work ratio, formal education, and the number of crops cultivated were reduced to almost zero, with the contribution of irrigation being reduced to a large extent.

5.3.2.4. Social safety net

Access to loans, access to formal aid, access to peer support from informal networks, the number of unions, and access to support from other household members were used to determine the contribution of SSN to household resilience.

The contribution of SSN to household resilience capacity decreased during the post-conflict reference period, with a noticeable shift in the contribution of the relevant variables, as demonstrated in Figure 5.5. Before the conflict, access to humanitarian aid, the number of memberships in unions and cooperatives, the number of peers, and access to family support played a bigger role in determining the SSN pillar. During a similar period, access to loans did not contribute significantly to the SSN pillar. However, in the post-conflict reference period, a shift was observed in SSN pillar contributors. Although it was reported during the household survey that there was an interruption in Productive Safety Net Program support and irregularity in humanitarian assistance, aid was found to be the major contributor in determining the SSP pillar in the RSM.

The conflict affected the social support mechanisms in the surveyed communities, where the role of unions and cooperatives, peers, and family support mechanisms decreased during the post-conflict period. These social support mechanisms were also affected by the conflict, resulting in a reduction in their contribution to household resilience. Though in small proportion, loans played a more important role during the post-conflict period.

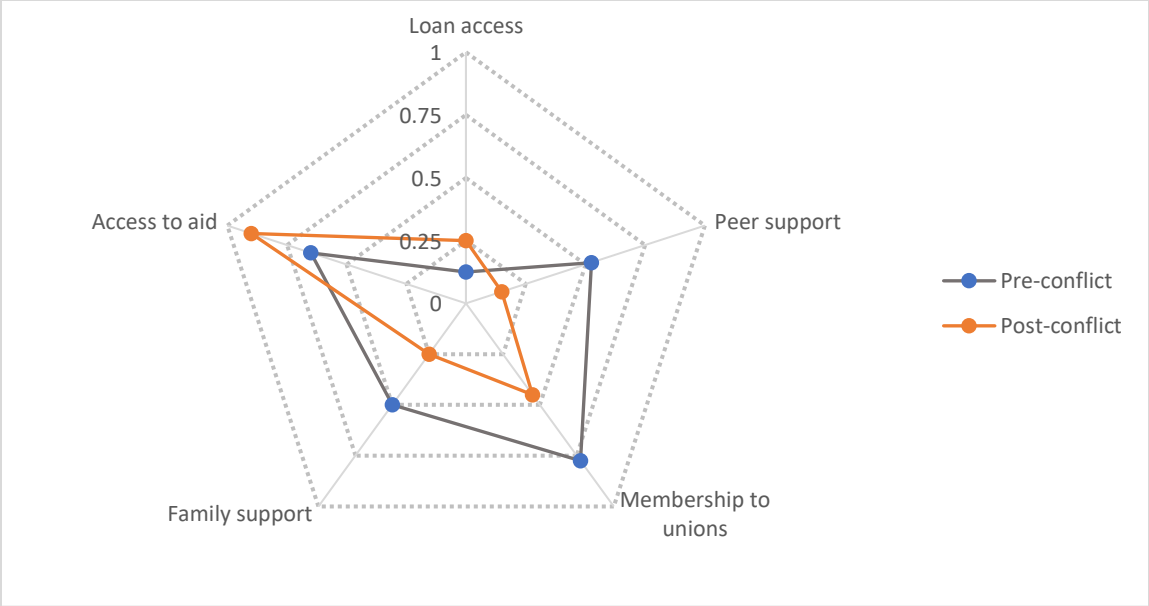


Figure 5.5: Variables contributing to the social safety net resilience pillar
Source: Survey data by authors

5.3.3. Resilience, socioeconomic characteristics and exposure to crisis

The mean RCI was 45.1 during the pre-conflict reference period. The RCI decreased to 38.8 in the post-conflict scenario. During the pre-conflict reference period, all respondents indicated that they were not exposed to violent conflict. As shown in Table 5.4, a two-way t-test revealed a significant difference in the mean RCI between the pre-conflict and post-conflict periods, with a p-value of less than 0.01.

Table 5.4: Two-sample t-test for the resilience capacity index for pre-conflict and post-conflict references

Group	Observations	Mean	Standard error	Standard deviation	95% confidence interval	
Pre-conflict	422	45.1	0.918	18.751	43.355	46.943
Post-conflict	422	38.8	0.903	18.557	36.989	40.540

t= 4.9712, p=0.000. Source: Survey data by authors

Households exposed to drought demonstrated a higher resilience capacity (45.4) compared to households that reported no exposure (44.5) during the pre-conflict period. However, the post-conflict context was different. Households indicated that exposure to drought demonstrated less resilience capacity (37.7) than those that had not experienced such disasters (41.9).

Villages from the *Weyna Dega*[7] agroecology zone had the highest resilience capacity, followed by villages in the *Dega* and *Kolla* agroecology zones both before and after the conflict. Although the order of resilience capacity did not change, the resilience of households from *Dega* and *Weyna Dega* was reduced by 14% and 17%, respectively. Meanwhile, households residing in the Kolla agroecology zone demonstrated a 14% increase in resilience capacity.

Further to the descriptive analysis, the differential impact of conflict and drought exposure was analyzed using a DiD model comparing the impact of crisis between low and high exposure to conflict and drought. The DiD regression result (Table 5.5) shows that the interaction term is negative and statistically significant at a p-value <0.01. Households with high conflict exposure experienced a 7.85-point greater decline in RCI post-conflict compared to those with low exposure, suggesting that conflict has a substantial and detrimental impact on household resilience capacity.

Table 5.5: Difference-in-Difference regression on conflict impact on resilience capacity

Variable	Coefficient	Std. Error	t	p-value	95% CI
Post-conflict (Control)	-3.32	1.09	-3.06	0.002	[-5.46, -1.19]
Treatment (DiD)	-7.85	1.47	-5.33	0.000	[-10.74, -4.95]
Age	0.04	0.08	0.51	0.612	[-0.11, 0.19]
Gender × Time	8.31	2.19	3.79	0.000	[4.01, 12.61]
Family Size	-0.02	0.90	-0.02	0.982	[-1.79, 1.74]
Land Owned	2.27	2.49	0.91	0.362	[-2.62, 7.16]
Constant	36.10	9.73	3.71	0.000	[16.97, 55.22]

Note: Robust standard errors clustered at household level (n = 422). Model: Fixed-effects regression with household panel data (n = 844 observations). Source: Survey data by authors

The post-conflict dummy is also negative and significant, indicating a general decline in resilience across all households, which may reflect broader systemic shocks. Among the covariates, the sex-time interaction (indicating sex-specific time effects) is the only control

[7] Ethiopia has five major agroecological zones based on altitude above sea level; 3,200 m above sea level is *Wurch*, 2,300 – 3,200 m above sea level is *Dega*, 1,500 – 2,300 m above sea level is *Weyna Dega*, 500 – 1,500 m above sea level is *Kolla* and less than 500 m above sea level is refereed as *Bereha*; Source: Hurni et al. (2016)

variable that shows statistical significance, suggesting that resilience dynamics varied meaningfully by sex across the two periods.

A similar DiD analysis was conducted to assess the impact of drought on RCI. Households were categorized into high- and low-drought-exposure groups based on self-reported drought severity. The fixed-effects model was used to estimate whether changes in RCI differed significantly between the two groups during the pre- and post-drought periods. The results (Table 5.6) show that the post-drought period is associated with a statistically significant decline in RCI of approximately 6.43 points, even among households with low drought exposure. However, the interaction term (treatment) is not statistically significant, indicating no significant differential impact on RCI between households with high and low drought exposure.

Table 5.6: Difference-in-Difference regression on drought impact on resilience capacity

Variable	Coefficient	Std. Error	t	p-value	95% CI
Post-drought (Control)	-6.43	1.74	-3.69	0.000	[-9.86, -3.00]
Treatment (DiD)	-1.20	1.91	-0.63	0.530	[-4.95, 2.55]
Age	0.05	0.08	0.57	0.568	[-0.11, 0.20]
Sex × Time	9.13	2.25	4.07	0.000	[4.72, 13.55]
Family Size	-0.09	0.89	-0.10	0.921	[-1.84, 1.66]
Land Owned	1.76	2.79	0.63	0.529	[-3.73, 7.25]
Constant	37.79	10.78	3.51	0.001	[16.60, 58.98]

Note: Robust standard errors clustered at the household level (n = 422). Model: Fixed-effects regression with household panel data (n = 844 observations). Source: Survey data by authors

The finding suggests that drought had a generalized negative effect on household resilience. However, the difference in exposure intensity did not significantly alter the magnitude of the drought impact. Similar to the DiD model for the conflict, sex-time interaction remains significant, hinting at sex-differentiated responses or vulnerabilities.

5.3.4. Resilience capacity and sex of household heads

Female-headed households were identified as the most vulnerable and had lower resilience capacity even before the conflict (38.3). This was demonstrated through a 17% reduction in the resilience capacity of female-headed households during the pre-conflict period (29.5)

and a 27% reduction in resilience capacity in the post-conflict period compared to their male counterparts. Female-headed households had a higher reduction in resilience capacity after the conflict (23%), while the reduction in resilience capacity for male-headed households was only 13%.

5.3.5. Resilience capacity and food insecurity

Resilience capacity and food security are interlinked, and the research provides a comparative analysis of different food security categories based on the household food balance model with an RCI. The basis for this comparison was a food security study conducted in four districts, which indicated that 87% of households were food insecure, while 13% of households were considered food secure (Muhyie et al., 2025b). For food-insecure households, the overall resilience capacity deteriorated during the post-conflict reference period (35.7) compared to the pre-conflict RCI of 42.2. Household resilience fell short by 15%, and the ability of households to return to normalcy was compromised.

The resilience capacity of food-secure households increased from 56.0 to 59.0 despite the exposure to conflict and drought during the post-conflict reference period. The difference in resilience capacity between food-secure and food-insecure could also be attributed to the status of asset ownership. It is indicated in Table 5.7 that food-secure households have higher livestock ownership, agricultural index, and wealth index. Asset plays a critical and significant role in the resilience structure matrix in determining household resilience capacity.

Table 5.7: Asset index and food security status

Type of asset indices	Mean asset index by food security category	
	Food insecure	Food secure
Total livestock unit (TLU)	1.45	2.12
Wealth index	0.07	0.11
Agricultural index	0.44	0.61

Source: Survey data by authors

5.3.6. Resilience and determinants of food security loss

The determinants of food security loss or gain were analyzed using a probit model based on per capita kcal availability. The probit model was selected due to its assumption of normally distributed errors, better handling of central probability ranges common in food security data, and its established use in resilience and food security research, including within the FAO RIMA framework. Households that maintained the pre-conflict per capita kcal availability or gained more were considered more resilient because their calorie availability was not severely affected during the post-conflict. Accordingly, 70% of households experienced food security loss, as their post-conflict per capita kcal availability was less than that in the pre-conflict situation, while 30% of households did not experience food security loss, even though their per capita calorie intake could still be below the recommended threshold.

Based on this data, a regression analysis highlighted the significant variables that determine food security loss, which indicates resilience capacity. As shown in Table 5.8, the regression analysis indicated that TLU (p-value at <0.01), agricultural index (p-value at <0.01), work ratio (p-value at <0.01), and number of crops cultivated (p-value at <0.05) were found to be significant determinants to reduce food security loss at the household level. Years of informal education were also found to be a significant variable at a p-value of less than 0.1 and reduce food security loss at the household level. However, access to a loan was found to be a significant predictor at p-value less than 0.05, but it increases food security loss at the household level by 0.44 units.

Table 5.8: Probit regression model for determinants of food security loss from a resilience perspective

Determinants of food security loss	Coefficient	Standard error	z	P>|z|	95% confidence interval	
					Lower bound	Upper bound
Access to basic services (ABS) variables: Closeness to						
Water facility	-1.3720	1.8317	-0.75	0.454	-4.9621	2.2181
Health facility	6.5873	4.0091	1.64	0.100	-1.2704	14.4449
School	1.8111	3.8231	0.47	0.636	-5.6821	9.3042
Transport	0.3953	0.3030	1.30	0.192	-0.1985	0.9891
Asset (AST) variables						
Total livestock unit (TLU)	-0.2666	0.0709	-3.76	0.000***	-0.4055	-0.1277
Agricultural index	-0.4181	0.1585	-2.64	0.008***	-0.7287	-0.1075
Wealth index	-0.3626	0.6185	-0.59	0.558	-1.5747	0.8496
Adaptive capacity (AC) variables						
Work ratio	-1.2973	0.3441	-3.77	0.000***	-1.9716	-0.6229
Number of crops cultivated	-0.1356	0.0646	-2.10	0.036**	-0.2622	-0.0090
Years of formal education	-0.0381	0.0230	-1.66	0.097*	-0.0831	0.0069
Years of informal education	-0.0428	0.0597	-0.72	0.473	-0.1598	0.0742
Access to irrigation	-0.0518	0.2102	-0.25	0.805	-0.4638	0.3602
Off-farm participation	0.0120	0.1566	0.08	0.939	-0.2949	0.3189
Social safety net (SSN) variables						
Access to loans	0.4432	0.2040	2.17	0.030**	0.0434	0.8430
Access to aid	-0.1849	0.1614	-1.15	0.252	-0.5013	0.1314
Access to family support	-0.0378	0.1881	-0.20	0.841	-0.4064	0.3308
Number of unions or cooperatives	-0.0040	0.2040	-0.02	0.984	-0.4038	0.3958
Number of peers supporting the household	-0.0117	0.0850	-0.14	0.890	-0.1783	0.1548
Constant						
_cons	2.3383	0.3414	6.85	0.000***	1.6691	3.0075

Number of observations (422), LR Chi2 (18) (76.05), Prob > chi2(0.0000), and Pseudo R2(0.1473); * Significant predictors at 90% confidence interval, ** significant predictors at 95% confidence interval; *** significant predictors at 99% confidence interval Source: Survey data by authors. Source: Survey data by authors

5.4. Discussion

5.4.1. Household resilience capacity in the context of conflict and drought

Violent conflict reduces a household's resilience capacity by affecting its ability to cope with and recover from adversity. The research found a significant decrease in the overall resilience capacity of households after the conflict compared to a pre-conflict reference period. Brück et al. (2019) and Agwu (2023) also confirmed a reduction in resilience capacity due to violent conflicts. In the context of this research, all four resilience pillars made notable contributions to the construction of resilience capacity prior to the northern Ethiopia conflict.

The DiD analysis reveals that conflict had a strong, statistically significant negative impact on household resilience, particularly for those reporting higher exposure. In contrast, drought was associated with an overall reduction in RCI; however, the difference in effect between the high- and low-exposure groups was not statistically significant. These findings highlight the disproportionately disruptive effect of conflict on resilience while suggesting that drought-affected households are more uniformly affected across exposure levels.

5.4.1.1. Role of access to basic services in household resilience

Access to basic services is often directly impacted by crises such as drought and conflict. The closure of roads and interruption of transport services that limit the mobility of people compromise the relevance of basic services to household resilience. However, access to health services remains relevant regardless of the destruction of facilities and looting of resources from health institutions, which affect the reachability of such important services at times of conflict. Mossie et al. (2024) identified a negative relationship between resilience capacity and ABS, indicating a less relevant contribution to determining resilience capacity.

As a result of exposure to drought and conflict, access to irrigation and the ability of the workforce to move in search of livelihood affect household adaptive capacity. Particularly in the context of conflict, people’s ability to move from place to place is seriously

constrained as opposed to the context of drought. During droughts, people can easily relocate to less affected areas in search of labor opportunities, which play a crucial role in enhancing household adaptive capacity. The household's education status and availability of the working force at the household level do not add significant value during and in the aftermath of the conflict, as livelihood opportunities were not available, and people were unable to move from place to place in search of livelihood activities. However, informal education, characterized by biblical and Quranic education, increases community acceptance, which has helped families of such status cope with the conflict's impact. As a result, these households did not have to implement dangerous coping mechanisms due to favorable community support. The contribution of social safety nets to household resilience decreases during conflict periods due to the reduction in family and peer support mechanisms. However, access to aid enhances resilience capacity despite its irregularity and the insufficiency of aid at times of conflict.

5.4.1.2. Role of assets in household resilience

Assets, as defined by FGD participants, include cash and any liquidable property and skills at households' disposal that can be converted to cash during difficult periods to meet basic needs, thereby preventing households from falling short in their resilience capacity during times of crisis. Some focus group participants also mentioned that social and natural support mechanisms are available either as direct support or as a source of income at their disposal. Although participants did not explicitly mention human capital as an asset, they indicated, in their own words, that "nothing is better than being healthy" when discussing the importance of physical readiness, health, skills, and the ability to use them to make a living. Assets made an undeniably larger contribution to household resilience, even though the conflict resulted in looting, destruction, a reduction in asset value, and a lack of access to market facilities. Livestock ownership and the agricultural index increase resilience capacity even at times of conflict. Asset ownership is a crucial component of livelihood that contributes to household resilience during shocks. Other studies (Guyu & Muluneh, 2015; D'Errico et al., 2018; Ado et al., 2022) have also found that assets play a greater role in determining household resilience to food insecurity.

Particularly, livestock ownership plays a key role in both drought and conflict periods. During drought periods, the value of livestock is always reduced owing to deteriorated body conditions. In severe cases, livestock also suffer the most because of a lack of feed and death. Meanwhile, conflict disrupts the market system. Therefore, livestock owners are unable to sell their animals due to the market disruption and the fear of persecution when traveling from their villages to the markets. Livestock are also targeted in deliberate attacks and looting in some places. Despite these challenges, the role of livestock in household resilience is immense. A few respondents indicated that livestock ownership increases vulnerability by exposing households to looting and physical threats from individuals and groups involved in the conflict.

5.4.1.3. Role of adaptive capacity in household resilience

The ability to logically understand and characterize shocks is assumed to enable households to adapt to adverse conditions by deploying different mitigation and adaptive strategies. Participation in off-farm activities helps households increase their capacity for resilience through livelihood diversification. Tesafa et al. (2023) found that off-farm participation could enhance household resilience by increasing the capacity to cope with shocks and improving agricultural production. In addition, irrigation access plays a significant role for households in continuing agricultural activities during drought periods. Both access to irrigation and participation in off-farm activities increase households' ability to absorb and quickly bounce back to normalcy. Conflict affects a household's ability to cope and recover from crises due to its multidimensional impact on various socioeconomic functions within communities. Consequently, reduces household resilience capacity. Moreover, violent conflict was also new to the study area at least in recent years; hence, the adaptive and resilience mechanisms were not well established to deal with the effects of conflict compared with that of drought.

During the post-conflict reference period, there was a decline in the trend of household resilience capacity due to the reduced contribution of the adaptive capacity pillar. There appeared to be an indiscriminate impact, regardless of the level of formal education, the number of crops cultivated, and other significant positions held by household members.

Informal education facilitated the acceptance of people within the community, and even in times of conflict, it helped to reduce the direct implication on households. While informal education facilitates community acceptance, people who are advanced in their biblical or Quranic education were less affected by the adverse consequences of conflict and other disasters. Their community support mechanism is stronger, and hence, it increases household adaptive capacity.

5.4.1.4. Role of social safety net in household resilience

In the FGDs, family support, peers, membership in various cooperatives, and traditional associations, such as *Debo*, *Mahber*, *Equb*, and *Edir*, were identified as key social structures. These are very important support mechanisms that communities in the research districts use to collaborate with and support each other during times of happiness and mourning. Communities contribute money on a regular basis and mobilize labor to work on agricultural activities, thereby mitigating financial and labor shortages. In addition, cooperatives are utilized as local financial services, providing credit and loans, and facilitating the buying and selling of agricultural inputs to maintain affordable prices with long-term payment schedules. These support mechanisms are very important during drought periods. Although drought directly and indirectly affects the ability of these associations and the family support mechanism in terms of their capacity to provide sufficient support to those in need, the mechanisms remain available during drought periods and are utilized as key strategies to mitigate climate-related adversities.

The northern Ethiopian conflict affected these systems in different ways. Some of the institutions were directly affected by the conflict through the looting of resources, closure of institutions, and displacement of people, and the existing systems were not in a position to provide the usual level of support to vulnerable households. The impact of the conflict was so complex that almost everybody was affected, leaving little option for community-based support initiatives. According to the FGD participants, banks, rural savings and loan associations, family or relatives, and moneylenders were among the options for accessing credit and loan services. These options played an important role during the drought periods in the study area. The limitation of formal institutions is their requirement of collateral to

be eligible for loan services, a condition that poor households generally do not meet. Therefore, their services were barely accessible to poor people even during “normal” periods. Informal sources are the most accessible support mechanisms that are also not immune to the severe implications of conflict.

5.4.2. Household resilience capacity and sex-differentiated analysis

Based on a descriptive analysis, female-headed households had a lower average RCI compared to male-headed households. However, the DiD regression analysis revealed a contrasting pattern: the interaction term for sex and post-conflict period (sex-time) was positive and statistically significant. This suggests that, despite their lower initial resilience, female-headed households experienced a relatively greater improvement or a smaller decline in resilience following the conflict compared to male-headed households. This divergence implies that women may have mobilized stronger coping mechanisms, received more targeted support, or adapted more effectively during the post-conflict period. Therefore, it is important not to rely solely on descriptive averages, as dynamic responses can reveal different resilience patterns across sex over time.

In the context of drought, a similar sex dynamic emerged. While the descriptive statistics again showed that female-headed households had lower average RCI scores than male-headed households, the DiD model painted a more nuanced picture. The sex-time variable was positive and statistically significant, indicating that women experienced a relatively better change in resilience after the drought shock. The increased resilience or lower decline of RCI for female-headed households could reflect enhanced women's adaptive responses during stress. However, women started from a lower baseline, as indicated by descriptive analysis. These findings underscore the value of longitudinal approaches, such as DiD, in uncovering how different groups respond to shocks like conflict and drought over time.

5.4.3. Interlinkage between resilience capacity and food security

Food security and household resilience are interrelated. Food security increases household resilience and vice versa. The more households are food-secure, the higher the resilience

capacity. Food-secure households demonstrated an increase in resilience capacity even after exposure to the conflict, whereas the resilience capacity of food-insecure households further deteriorated significantly. The higher resilience capacity of food-secure households was attributed to better asset ownership expressed in terms of a higher TLU, wealth index, and agricultural index. Assets also played a significant role in the overall resilience capacity of households in the post-conflict reference period. Households exposed to the double burden of drought and conflict experience significant food security losses, which are reported as the inability of households to maintain at least a similar level of energy availability at the household level during the baseline period, pre-conflict.

The influence of conflict on the resilience of food-secure households was different. Food-secure households had a higher resilience capacity in the aftermath of the conflict. As the severity of food insecurity increases, the RCI decreases and vice versa. This can be attributed to several factors. Among these factors, the asset ownership of food-secure households was higher than that of food-insecure households, and assets were found to play a major role in determining resilience capacity. In addition, the overall higher adaptive capacity for food-secure households contributed to improved resilience capacity during the post-conflict period.

5.4.4. Household resilience and determinants of food security loss

The TLU (livestock asset ownership), agricultural index, work ratio, and number of crops cultivated are key determinants that reduce food security loss resulting from exposure to conflict. Similarly, Beyene and Senapathy (2023) identified most of these factors as determinant factors in their study. The amount of assets (livestock ownership and agricultural index), the work ratio characterized by the number of working members in the household, and the number of crops were found to increase resilience by diversifying risk and maintaining household food security. These factors played a significant role in supporting households per capita of kcal availability, even after exposure to the severe consequences of conflict on the food and overall social systems of the communities. Years of formal education were found to be significantly associated with reducing food security loss at the 90% confidence level.

In addition to enhancing dietary diversity and improving health outcomes, cultivating different types of crops can diversify risk related to climate-induced shocks, such as drought (Mihrete & Mihretu, 2025). Besides the consumption benefits, surplus production could increase the ability of households to earn income from the sale of surplus and strengthen economic capacity, which is a crucial resilience factor even at times of conflict. In the context of conflicts that distort market systems, affecting the supply chain and the impact of drought on monocrop farmers, crop diversity could help households tackle food insecurity and mitigate livelihood losses.

An increased work ratio within households enhances food security by reducing food security loss by increasing the availability of labor for agricultural and off-farm income-generating activities. Labor provides additional capacity to households to cope with the adverse impact of crises such as conflict and drought. Labor provides opportunities for maximized access to food, engagement in small businesses, enhancing market engagement of the family, and migration strategy in search of livelihood opportunities (Debela et al., 2021; Food and Agriculture Organization, 2023). Therefore, the increase in work ratio at the household level increases households' resilience to food insecurity and minimizes food security loss.

However, access to loans was found to contribute to a decrease in food security. The negative contribution of loans could be the limited access to credit and loan services in the surveyed communities. This finding contradicts that of Dereje et al. (2024), who identified a positive contribution from access to credit on household resilience capacity. In addition to the limited accessibility of credit and loan services during the pre-conflict period, these services were significantly interrupted by the conflict. As a result, households seeking loans had only the option of finding locally available moneylenders, who often demand higher interest rates, which could, in turn, contribute to the deterioration of household resilience. Other studies highlighted the negative interaction of access to loans and household resilience to food insecurity. In a conflict setting, a loan can be a burden to poor households due to disrupted repayment capacities and economic instability. Agricultural activities,

market systems, and displacement could limit income generation (Food and Agriculture Organization, 2023). This leads to asset liquidation and loss of collateral, which further reduces the ability to access food. The interruption of financial services during conflict periods left the option of moneylenders to access loans at higher interest rates, which increases vulnerability. The interruption of banking services that limit cash withdrawals reduces food purchases and leads to financial distress, which affects household resilience to food insecurity (World Bank, 2023).

5.4.5. Recommendations: insights for policy and practice

The research identified key recommendations for governments, nongovernmental organizations, researchers, and communities who are interested in building household resilience to food insecurity in the context of drought and conflict. These recommendations are based on the interlinkages of several socioeconomic, demographic, and food security factors with household resilience.

Policies should recognize the key role that assets play in household resilience, and investments should be made to increase the asset base of households. In the context of violent conflict, the contribution of livestock ownership and agricultural assets plays a significant role in maintaining household resilience, and policy, development, and humanitarian programming should focus on building these components. Investments in asset-building programs, particularly in productive assets, will help households cope with calamities and quickly return to normalcy in the aftermath of a crisis involving drought and conflict.

Livelihood diversification through participation in off-farm activities and the growth of various crops should be prioritized as a pathway to increase household resilience. This increases the ability of households to diversify risks and provides opportunities for them to ensure that their basic needs, including food, are met during conflict and drought periods. Due to the unique nature of violent conflict, which disrupts the agricultural sector through the destruction of crops, loss of livestock, and displacement, diversification of livelihoods in the off-farm sector can help distribute risk and expand income-generating opportunities

for conflict-affected communities. Particularly when off-farm livelihoods include marketable skills, displaced communities can have the opportunity to establish their lives by providing labor or skill services in exchange for money to support displaced families. The susceptibility of the agriculture sector to drought could be mitigated by supporting household income through livelihood diversification. Livelihood diversification reduces heavy dependence on single income sources in the agriculture sector, which are susceptible to conflict or drought. Livelihood diversification can yield sustainable and lasting results when differential sex and age needs are considered to devise women- and youth-friendly activities that align with individual aspirations, technical and economic capabilities, and other societal factors, thereby enhancing productivity. The multiple income sources increase household resilience and improve household food security. Better and diversified income sources can also enhance social capital as communities could engage in small business groups and associations, which ultimately build social support mechanisms that are vital during crisis periods like conflict.

In the context of violent conflict, efficient and uninterrupted access to humanitarian aid is crucial because household resilience heavily depends on such assistance. During active conflict, ongoing fights, military blockade, targeting, and looting of humanitarian convoys pose a significant challenge in effectively delivering humanitarian aid to conflict-affected households. However, it is recommended that a coordinated effort be made by the Government, local authorities, military groups, humanitarian organizations, and the United Nations to ensure access is negotiated in accordance with humanitarian principles. While aid should be provided purely from a humanitarian perspective, non-governmental organizations should adhere to humanitarian principles, particularly of neutrality and independence, and should not be involved in the politicization of aid. Timely advocacy at various levels of the Government is a crucial step for humanitarian organizations and the UN to ensure a humanitarian corridor is established. In addition, while the government takes responsibility for facilitating humanitarian access, the humanitarian community should hold itself accountable for the equitable and ethical distribution of aid and avoid the potential for aid diversion, which could pose a major threat to uninterrupted access to aid. In summary, negotiating safe access, leveraging local networks, strengthening coordination

among humanitarian actors, focusing on the restoration of critical infrastructure, advocacy, and fundraising are key parts of the uninterrupted access to humanitarian aid. Furthermore, prioritizing neutrality and impartiality in aid distribution will ensure that the most vulnerable populations receive the support they need to rebuild their lives and enhance their resilience to food insecurity. Ultimately, uninterrupted humanitarian aid delivery must be an integral component of a broader strategy that links relief efforts with long-term development and peacebuilding initiatives.

Additionally, it is also recommended to ensure the organization of communities in local institutions as collective support mechanisms in the context of drought. Understanding the differential impact of conflict and drought on sex requires a thorough analysis and more targeted interventions to bridge this gap. Women, girls, and children are affected more than men, and targeted resilience-building initiatives must be implemented.

Access to affordable credit and loan services is crucial for supporting recovery and reconstruction efforts in post-conflict periods. Rural households are constrained from rebuilding their livelihood after a devastating consequence of violent conflict. Affordable loan and credit services include reasonable interest rates, more lenient collateral requirements, integration of financial literacy, and extended repayment periods. This could help households build productive assets, establish off-farm businesses to diversify their livelihoods, and enhance other essential services, such as education, healthcare, and water, among others, that are crucial for building resilience and household food security. The initiative to facilitate access to affordable credit and loan services should also consider supporting microfinance institutions and conventional banks that were affected by the conflict.

In addition, it is essential to raise public awareness to address grievances and public distress caused by conflicts between conflict-affected communities and financial service institutions, which have resulted in these institutions being unable to provide the required services during the conflict.

Resilience and food security are closely related. Investments in improving one will result in positive outcomes for the other. Food security programming should aim to build resilience instead of focusing solely on short-term food security outcomes. Furthermore, the researchers recommend further exploration of why and how access to loans contributed to food security loss in the post-conflict scenario despite the positive contribution in the RSM.

CHAPTER 6: CHARACTERISTICS OF DROUGHT AND IMPLICATIONS TO HOUSEHOLD FOOD SECURITY IN SOUTH WOLLO ZONE, ETHIOPIA[8]

This chapter presents trends in the frequency and severity of droughts in the study area for the period 1981–2022. The Standardized Precipitation and Evapotranspiration Index (SPEI) is a key drought index used to characterize drought trends at various timescales. It also provides insights into the implications of drought to food security and forward policy recommendations for consideration to minimize the negative consequences of drought on household food security.

Abstract

Due to climate change, drought conditions are increasing, threatening the food security of communities reliant on rainfed agriculture in Africa, where drought has become protracted and has resulted in a widespread food insecurity crisis. The study aims to systematically analyze drought trends over a long period (1981 to 2022) and provide insight into its implications for household food security in the South Wollo Zone, Amhara region, Ethiopia. Longitudinal meteorological data consisting of rainfall, minimum temperature, and maximum temperature covering the period from 1981 to 2022 were used to compute the Standardized Precipitation and Evapotranspiration Index (SPEI) to characterize drought conditions at different timescales. The study deployed the Mann-Kendall (MK) test and Sen's slope estimates to analyze the direction and magnitude of drought trends. Besides, qualitative data from survey participants was corroborated to complement the quantitative drought analysis to link it with household food security. The Potential Evapotranspiration (PET) and Climatic Water Balance (CWBAL) shown an upward trend, but not statistically significant, for all of the four study districts – Delanta, Dessie Zuria, Kalu, and Worebabo – in South Wollo, which highlights an overall deficit of climatic water balance. The SPEI analysis indicated that the frequency and severity of drought conditions have increased with a significant decreasing trend for all districts for SPEI-3, SPEI-6, SPEI-9, and SPEI-12. Both the short-term and long-term drought conditions have increased between 2000 and 2015.Mann-Kendall (MK) test and Sen's slope estimates demonstrated a statistically

[8] This chapter is based an article that is approved as publishable by advisors.

significant decreasing trend at a p-value <0.05 for SPEI timescales. The significant downward trend in SPEI highlights increasing drought severity and frequency. The study recommends integrated drought early warning systems to help predict meteorological droughts and their socioeconomic impacts on food security. The northern Ethiopia conflict highlights the importance of strengthening resilience to climatic shocks and social and political instability, which can further exacerbate vulnerabilities. Besides, investments in climate adaptation programs like awareness in disaster risk reduction, promoting irrigation and drought-resistant farming should be prioritized to enhance the long-term resilience of vulnerable communities in South Wollo.

Keywords: Adaptation, Climate change, Drought trend, Food security, Resilience, SPEI, Vulnerability

6.1. Introduction and Justification

Drought is a climate feature characterized by a lack or shortage of precipitation against the expected normal, which constrains human activity and leads to economic losses. Depending on the severity and duration of the dry period, drought may affect soil moisture, natural water reservoirs, and socioeconomic activities of human beings. The scale of drought's impact on water bodies and human activity helps in identifying the types of droughts (Smakhtin & Hughes, 2004).

Drought is not a situation that can be avoided. However, it can be detected early, and its damage on lives and livelihoods can be minimized by developing preparedness measures and impacts can be managed through properly defining drought and quantification of its characteristics. Drought is one of the major factors for reduced agricultural production. Despite advancements in technology in several fields, more than 800 million people live with hunger and malnutrition (USDA, 2017). Drought occurs everywhere without borders (Kogan et al., 2015). It affects not only agriculture but also water resources, transportation, ecosystems, recreation, food systems, and many other sectors. Even the most advanced countries with advanced agricultural technologies, like the US, are affected by drought (Wilhite 2000; Kogan et al., 2015). The impact of drought on crop and pasture development

in the US reached $6 billion, with extreme impacts in 1988 reaching $60 billion (Kogan, 1995). Globally, the agriculture sector is hugely suffering because of drought, with the biggest impact prevailing in developing countries, contributing to severe food shortages, famine, population displacement, conflict, and even death of vulnerable community members.

Droughts are classified as meteorological, agricultural, hydrological, or socioeconomic depending on the origin, timing, and impacts of water deficiency in different systems. Meteorological drought indicates the degree of dryness compared to the average amount of precipitation, used to identify the duration of a dry period. Agricultural drought contributes to the susceptibility of crops to water shortages at various stages of growth. It links the impact of meteorological drought on agricultural activities. When the impact of drought is associated with a reduction in the amount of surface and subsurface water supply, it is referred to as hydrological drought. Socioeconomic drought refers to a situation when water demand for economic activity exceeds its supply for a prolonged period due to weather-related factors that impact the ecosystem (Wilhite & Glantz, 1985).

Impacts of climate change are major threats to food security in Africa, where the community is mainly dependent on rain-fed agriculture that is vulnerable to climate change consequences (Aklilu & Alebachew, 2009; Lemma et al., 2013; Hall et al., 2017; Berhanu & Wolde, 2019; Pickson & Boateng, 2022; Adesete et al., 2023; Bedasa & Bedemo, 2023). Population growth and land degradation exacerbate the chronic food insecurity situation, exposing people to increased vulnerabilities. These factors further contributed to widespread poverty, characterized by continuous out-migration, illiteracy, hunger, conflict over scarce resources, the inability to utilize improved inputs and technologies, and a poor asset base (Arega, 2015). Besides, the continent is severely affected by various kinds of conflict, ranging from election disputes, control over resources, civil unrest, religious intolerance, ethnically motivated violence, and boundary conflicts (Allen & Okeke-Uzodike, 2010; Alozieuwa, 2010; Amungwa, 2011; Bere, 2011; Christakis, 2013; Pate, 2014). Recently, the conflict in Northern Ethiopia has had devastating impacts on the community's food security situation (Regassa et al., 2010).

Communities in the Horn of Africa, including Ethiopia, are experiencing protracted crises that have led to widespread food insecurity (Mulat et al., 1995). Investments in the agriculture and service sectors did not bring the expected food security outcomes. Efforts have been made by the government and the international communities through funding and non-governmental organizations (NGOs) to expand investments in enhancing production and productivity, market infrastructures, microfinance institutions, and extension services in several sectors (like agriculture, health, and water and sanitation). However, these efforts had an insignificant impact due to several challenges that Ethiopia has faced in recent years, including recurrent drought, conflict, and political instability in different parts of the country (Kidane et al., 2006).

The country is experiencing multiple hazards due to conflict, civil unrest, floods, epidemics, and drought, which have resulted in a devastating food insecurity situation. This impact has the potential to reduce adaptive and transformative capacities by limiting the choices and opportunities available to the poor. Floods, droughts, and storms are among climate change-induced disasters that result in mortality, exacerbate poverty, lead to migration, increase inequality, reduce access to basic services, and weaken the governance capacity of communities and the Government. All these are interlinked problems where one affects the other and vice versa.

The IPCC (2022) report indicated that mortality related to floods, droughts, and other storms in vulnerable countries, such as Ethiopia, was 15 times greater than in countries with low vulnerability. Climate-induced crises not only aggravate further vulnerabilities and inequalities but also undermine the achievement of the Sustainable Development Goals (SDGs) particularly the goals related to no poverty (SDG1), zero hunger (SDG2), gender equality (SDG5) and reducing inequality (SDG10) while it has direct and indirect negative impacts on several of other sustainable development goals of the United Nations (Birkmann et al., 2022).

Climate change impacts the erosion of livelihoods that are important for resilience. It affects people disproportionately depending on differences in adaptation capacities and the level of existing vulnerabilities. However, women, youth, the elderly, ethnic and religious minorities, and refugees are the most impacted. Most importantly, households and communities with climate-sensitive livelihoods, such as agriculture and livestock, are highly impacted segments of the community (Birkmann et al., 2022).

The Food and Agriculture Organization of the United Nations (FAO) has indicated that drought and other climate change-induced factors affect all four pillars of food security. Drought and climate impacts have long-term consequences on food security and longer-term development. According to Dorward and Kydd (2004), drought reduces the productivity of the rural economy by reducing the return on agricultural investment, pushing investment from income-maximizing activities towards risk-reduction activities, and discouraging investment in agriculture, which leads to long-term stagnation of development and an increase in rural poverty.

Agriculture is the main source of Gross Domestic Product (GDP) for Ethiopia, which is characterized by erratic rainfall, and the economy is recurrently affected by drought. Regardless of its agricultural production potential, the Amhara region, particularly the South Wollo zone, is the most disaster-prone zone in the country with a significant level of food insecurity. South Wollo zone is one of the zones in the Amhara region that is periodically affected by drought.

Previous records showed that drought episodes occurred in the last four decades, specifically in 1984, 1987/1988, 1992/1993, 1999, 2003/2004, 2007/2008, 2009, and 2012, which were among the worst drought years in Ethiopia's history. The year 1984 was the most drastic and extreme drought episode in South Wollo and other parts of Ethiopia (Masih et al., 2014; Mohammed et al., 2018). Such extreme weather events threaten crop production, exacerbate food insecurity issues, and ultimately impact the socio-economic conditions of smallholder farmers (Suryabhagavan, 2017).

The South Wollo zone is affected by recurrent drought, and the area is often considered the heart of Ethiopia's 'famine belt'. The zone was severely affected by the drought-induced famines in 1971-74 and 1983-84 (Mesfin, 1984; Rahmato, 1986). Drought, conflict, high population, fragmentation of farmland, steep slopes often prone to flooding, frost-affected areas, severe pest impacts, and other calamities have made the South Wollo zone the most food insecure and famine-prone area (Little, 1992; Little et al., 2006). On top of all, violent conflict that spread from the Tigray region to neighboring Amhara and Afar regions caused tremendous damage to lives and livelihoods and weakened the resilience of the already 'pained' livelihoods of households in the South Wollo zone.

According to the Integrated Drought Management Programme (IDMP), as referenced in Vicente-Serrano et al. (2010), SPEI is based on the Standardized Precipitation Index (SPI). SPI considers precipitation information only to analyze drought conditions, whereas SPEI integrates temperature to understand the influence of evapotranspiration on drought analysis. The inclusion of temperature makes SPEI a versatile and ideal index compared with SPI for analyzing the impact of climate change in different future scenarios. Monthly precipitation and temperature data for 30 to 50 years are required for an adequate estimation of the index.

SPEI assesses drought conditions from a climate variability and change perspective. As precipitation deficit is the primary condition for drought, SPEI helps to compute the difference between water supply and demand, integrated with the influence of temperature. The SPEI is calculated on a 3-month, 6-month, 9-month, and 12-month timescale to understand drought situations from both short-term (3-month and 6-month timescales) and long-term (9-month and 12-month timescales) perspectives. The 3-month and 6-month timescales provide information on the impacts of drought on agriculture, while the 9-month and 12-month timescales provide the hydrological impacts of drought (Asong et al., 2018). SPEI is robust in that it considers information related to air temperature, evapotranspiration, wind speed, and soil water-holding capacity (Vicente-Serrano et al., 2010).

The research provides a systematic, quantitative analysis of drought trends over a long period (1981-2022). It analyses and characterizes the causes of drought over a long period and its implications for household food security in the South Wollo Zone of the Amhara region in Ethiopia. It examines the variability of drought through different indices, including the SPEI at different timescales. Additionally, it provides empirical evidence of the implications of drought for household food security.

6.2. Materials and Methods

6.2.1. Research design and approach

The research is based on a longitudinal design, where time-series precipitation and temperature data are analyzed to provide quantitative information about trends and variability. Rainfall and temperature data from 1981 to 2022 were received from the EMI of Ethiopia. The researcher then described and systematically presented analysis outputs and linked them with other food security outcomes and the impact of the northern Ethiopia conflict on household food security. Both quantitative and qualitative data were utilized from meteorological data, household questionnaire-based surveys, KIIs, FGDs, and a review of related literature.

The Standardized Precipitation Evapotranspiration Index (SPEI) was utilized to evaluate meteorological droughts in the South Wollo Zone from 1981 to 2022, using precipitation and temperature data from EMI. However, due to the Northern Ethiopia conflict, which began in late 2020, the availability of temperature data for the study area was disrupted. For household food security and resilience data, a survey was conducted for the period June 2019 to May 2020 and June 2021 to May 2022 as pre-conflict and post-conflict references based on retrospective survey data, with supplementary data gathered through KIIs and FGDs.

The study used the data to assess the impacts of previous drought events on household food security. While there is a temporal gap between the drought data (1981–2022) and the food

security survey, qualitative findings from KIIs and FGDs provided valuable context for understanding the persistent effects of past droughts.

6.2.2. Sampling techniques and sample size determination

Through a non-random sampling method, the researcher selected the four research districts, considering their knowledge of the areas and records of frequent exposure to drought and the impact of violent conflict. However, profiling of kebeles and villages in the four districts and random selection of 38 villages, where 422 households were selected for the questionnaire-based survey, using simple and systematic random sampling techniques.

The sample size was determined using Taherdoost (2016), considering a 95% confidence interval with a 5% margin of error, 1.96 of the z value corresponding to the confidence interval, and 0.5 as an estimator of P, aiming to maximize variance to produce the maximum possible sample (Bartlett et al., 2001). An additional 10% contingency sample was used to compensate for data collection errors. However, the collected data from the contingency households was acceptable and used in the analysis process.

$$n = \frac{p(100 - p)z^2}{E^2} = \frac{0.5(1 - 0.5)1.96^2}{0.05^2} = 384$$

The number of FGDs and KII was determined based on non-randomization, and the decision was based on the saturation point where additional FGD and KII would not bring new information. KII data was used to understand expertise and context-specific information pertaining to the specific objectives of the research. Ten FGDs and 15 KIIs were conducted in the research, and it was confirmed that 7 FGDs and 11 KIIs achieved the saturation point where no new information was extracted from the additional group discussions and interviews.

For the time series drought analysis, the period from 1981 to 2022 was taken, which covers 42 years of precipitation and temperature data. As the chosen drought analysis technique was Standardized Precipitation Evapotranspiration Index (SPEI), 30 – 50 years of meteorological data is required (Integrated Drought Management Programme [IDMP],

n.d.). This period was made to cover the food security, resilience, and coping strategy analysis deployed for the pre-conflict and post-conflict reference period, taking the northern Ethiopia conflict into account.

6.2.3. Data sources and collection tools

Data was collected through quantitative and qualitative methods. The major data utilized for the drought analysis was a time series of meteorological data from the EMI of Ethiopia. Qualitative data were collected from KII and FGD to understand the perceptions of respondents regarding exposure to drought, compounded by the impact of conflict, and its implications for household food security. Important and relevant kinds of literature were reviewed as part of the data collection process.

6.2.4. Techniques of data analysis

Several indices help characterize drought over time. Among these indices, the Standardized Precipitation Evapotranspiration Index (SPEI), developed by Vicente-Serrano et al. (2010), was identified as the most flexible and practical index for understanding drought situations and their impact on food security in this research. A time series of data on precipitation and temperature was used to determine the SPEI. The meteorological variable patterns for 42 years of rainfall and temperature data were analyzed. The R software package was used in analyzing and presenting SPEI and related analysis outputs.

To compute the SPEI, the Potential Evapotranspiration (PET_{HG}) was first calculated using the Hargreaves method (Hargreaves & Allen, 2003), which requires average precipitation, minimum temperature (T_{min}), and maximum temperature (T_{max}), latitude, and the extraterrestrial radiation (Ra), which makes it preferable for its simplicity (Berti et al., 2014).

$$PET_{HG} = 0.0023 \text{ x } (T_{mean} + 17.8) \text{ x } \left(\sqrt{T_{max} - T_{min}}\right) \text{ x Ra}$$

Once PET was estimated, D_i was calculated as the difference between precipitation and PET using the following equation:

$D_i = P_i - PET_i$, where D_i is the climatic water balance (CWB) in a given period (mm), P_i is the precipitation in a given period (mm), and PET_i The potential evapotranspiration in a given period (mm) is calculated using the Hargreaves method.

Finally, SPEI was calculated using the R software packages, considering the approximation method developed by Abramowitz and Stegun (1965) and used in Bereket et al. (2022), Zhang et al. (2020), and Vicente-Serrano et al. (2020).

$$SPEI = W - \frac{C_0 + C_1 W + C_2 W^2}{1 - d_1 W + d_2 W^2 + d_3 W^3}$$

$W = \sqrt{-2\ln(p)}$ for $p \leq 0.5$,

Where p is the probability of exceeding a determined D value, p=1-F(x). If p>0.5, then p is replaced by 1-p, and the sign of the resultant SPEI is reversed; the constants are C_0=2.515517, C_1=0.8022853, C_2=0.010328, d_1=1.432788, d_2=0.189269, and d_3=0.001308.

After determining SPEI, drought conditions were categorized into different categories according to McKee et al. (1993). These drought classifications are extremely dry, severely dry, moderately dry, near normal, moderately wet, severely wet and extremely wet with equivalent SPEI values of ≤ -2.0, > -2.0 to ≤ -1.5, > -1.5 to ≤ -1.0, > -1.0 to < 1.0, ≥ 1.0 to < 1.5, ≥ 1.5 to < 2.0 and ≥ 2.0, respectively. Besides, drought conditions are plotted at different time scales for comparison.

Trend Detection in Time Series of SPEI: using the R software package, the non-parametric Mann-Kendall (MK) test was run to determine the statistical significance of decreasing or increasing trend in the time series of the SPEI data (Kogan, 1997; Haile et al., 2019). The MK statistic (S) is mathematically computed as follows:

$$S = \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \mathrm{sgn}(x_j - x_i)$$

Where N is the number of data points. Assuming $(x_j - x_i) = \theta$, the value of $\mathrm{sgn}(\theta)$ is computed as follows:

$$\mathrm{sgn}(\theta) = \begin{cases} 1 \text{ if } (x_j - x_i) > 0 \\ 0 \text{ if } (x_j - x_i) = 0 \\ -1 \text{ if } (x_j - x_i) < 0 \end{cases}$$

where seasonal and annual values in years are j and i, j > i. $(x_j - x_i)$ is the sigma function. The test statistic (S) is assumed to be asymptotically normal, with E(S) = 0. A positive value of S indicates an increasing trend, whereas a negative value indicates a declining trend in the data. For n ≥ 10, the statistic S is approximately normally distributed with the mean, and E(S) becomes 0 (Kendall, 1975). It is necessary to compute the probability associated with S and the sample size, n, to statistically quantify the significance of the trend. Statistical Kendall's τ (tau) test can be compared (Amrender et al., 2015).

$$\tau = \frac{S}{N(N-1)/2}$$

Where τ has a range of −1 to +1 and is analogous to the correlation coefficient in regression analysis. The null hypothesis of no trend is rejected when S and τ are significantly different from zero. In this case, the variance statistic is given as;

$$V(S) = \frac{1}{18}\left[n(n-1)(2n+5) - \sum_{k=1}^{g} t_k(t_k-1)(2t_k+5)\right]$$

Where n is the number of data points, g is the number of tied groups (a tied group is a set of data having the same value), and t_k is the number of data points in the kth group. The standard test statistics Z is calculated as follows:

$$Z_s = \begin{cases} \dfrac{S-1}{\sqrt{\mathrm{Var}(S)}}, & S > 0 \\ 0, & S = 0 \\ \dfrac{S+1}{\sqrt{\mathrm{Var}(S)}}, & S < 0 \end{cases}$$

The statistical significance level of the trend variation was evaluated using Zs value. A positive Zs value indicates an increasing trend, while a negative Zs value shows a decreasing trend. Two-sided test under a significant α level, if |Zs| <Z(1−α/2), the hypothesis that the sequence Xi has no trend or Ho is accepted, but if |Zs| >Z(1−α/2), the

null hypothesis (Ho) is rejected, and the alternative hypothesis (H_1) is accepted, then the sequence has either increasing or decreasing monotonic trend. p-value is used to test the hypotheses: H_o: no trend and H_a: monotonic trend (upward or downward).

Sen's Slope Estimator: Sen's estimator (Kocsis et al., 2017) has been widely used to detect the trend direction and determine the time series' magnitude (Amrender et al., 2015; Nury et al., 2017). It is a nonparametric method that can calculate the change per unit time. This method assumes a linear trend in the time series. In this method, the slopes T_i of all data pairs are calculated as follows (Pal et al., 2017).

$$T_i = \frac{x_j - x_i}{j - i}$$

For i = 1, 2, N, where xj and Xi are data values at a time j and i(j>i), respectively. If there are n values x_j in the time series and obtained N=n (n-1)/2, slope estimates Si. The median of these N values of T_i is Sen's estimator of the slope, which is obtained as;

$$T_{Med} = \begin{cases} T_{N+1/2}, & N \text{ is odd} \\ \frac{1}{2}\left(\frac{T_N}{2} + \frac{T_{N+2}}{2}\right), & N \text{ is even} \end{cases}$$

A positive value indicates an increasing trend, and a negative value indicates a decreasing trend in the time series. Finally, the median tested with a two-sided test at the 100 (1- α) % confidence in the true slope may be obtained with the nonparametric test (Mondal et al., 2012). The frequency of drought incidences was computed by considering the number of SPEI values ≤ −1.

$$F = \frac{n}{N} * 100$$

where n is the number of months' drought events (SPEI ≤ −1) that an index value meets a set of drought criteria, divided by the number of months in the entire series (N). Drought frequency (F) helps to assess the drought prevalence during the study period.

Aridity Index (AI): is a numerical indicator of the degree of dryness at a given location, which is a convenient but straightforward numerical indicator of aridity-supported long-

term climatic water deficits. It is calculated as a ratio P/PET, which is of rainfall and evapotranspiration (Bereket et al., 2022). Potential evapotranspiration (PET) measures the "drying power" of the atmosphere to remove water from land surfaces through evaporation and transpiration. Consequently, the climate is considered arid if PET is more significant than P (Angearu et al., 2020). AI is classified as hyper-arid (<0.05), Arid (0.05 to 0.20), Semiarid (0.20 to 0.50), Dry subhumid (0.50 to 0.65), and Humid (>0.65) (Middleton & Thomas, 1997).

$$\mathrm{AI} = \frac{\mathrm{P}}{\mathrm{PET}}$$

6.3. Results

6.3.1. Potential evapotranspiration and climatic water balance

The PET has shown an upward trend over the period from 1981 to 2022, spanning 42 years, using gridded satellite data for all four study districts – Delanta, Dessie Zuria, Kalu, and Worebabo – in South Wollo, which highlights an increase in temperature. However, the increase in PET is not statistically significant. The PET plot and the trend line are indicated in Figure 6.1, which shows a stagnated trend line when observed visually. Although an upward trend was observed, as indicated by positive Sen's slope estimates, the p-value for all districts was greater than 0.05, denoting the absence of a statistically significant trend.

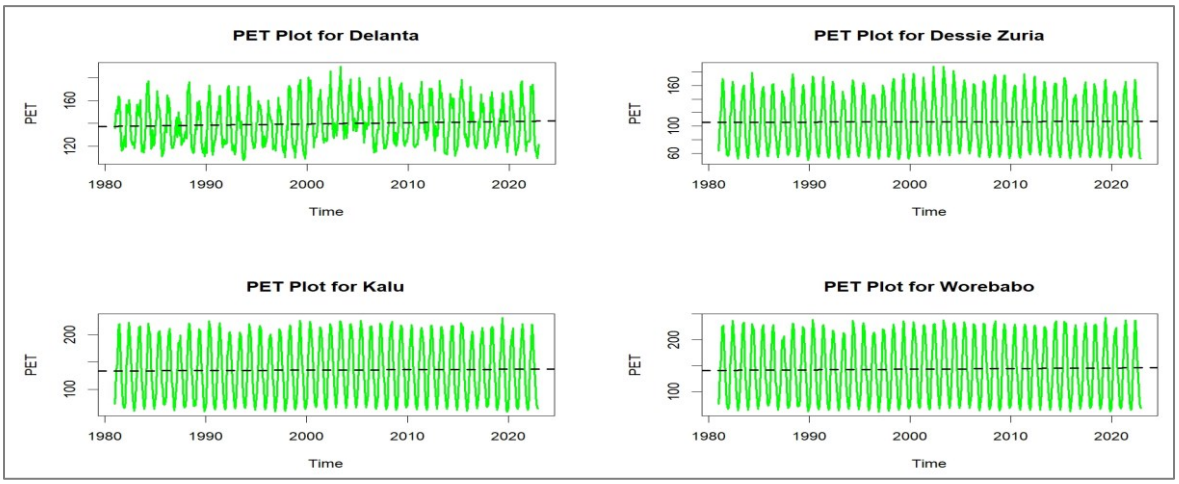


Figure 6.1: Potential evapotranspiration plots
Source: authors' own construction

As indicated in Figure 6.2, the Climatic Water Balance (CWBAL) shows a consistent decreasing trend, demonstrating a deficit of climatic water over the 42-year period. The Sen's slope estimates indicated a negative value, confirming a decrease in climatic water over time. However, the MK test revealed that there is no statistically significant decrease in the CWBAL trend across all districts, with a p-value greater than 0.05.

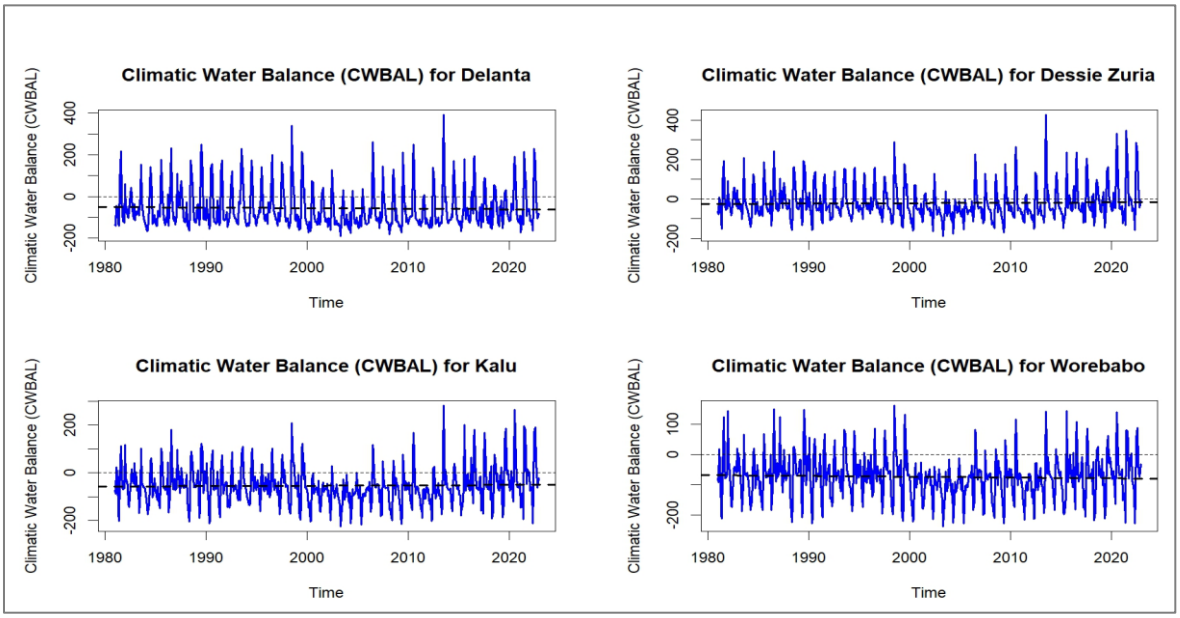


Figure 6.2: Climatic water balance plots
Source: authors' own construction

6.3.2. Aridity index

Based on the classification of the aridity index, the study districts were categorized into different aridity classes. Several months within the study period were categorized as hyper-arid, arid, and semi-arid as shown in Figure 6.3. However, the MK test and Sen's slope estimates indicate that there was no statistically significant trend in aridity index for the study area between 1981 – 2022. This suggests that, while there may be a tendency toward increased dryness, the variability in the data prevents us from drawing firm conclusions. Further monitoring over a longer time frame may be needed to detect significant changes.

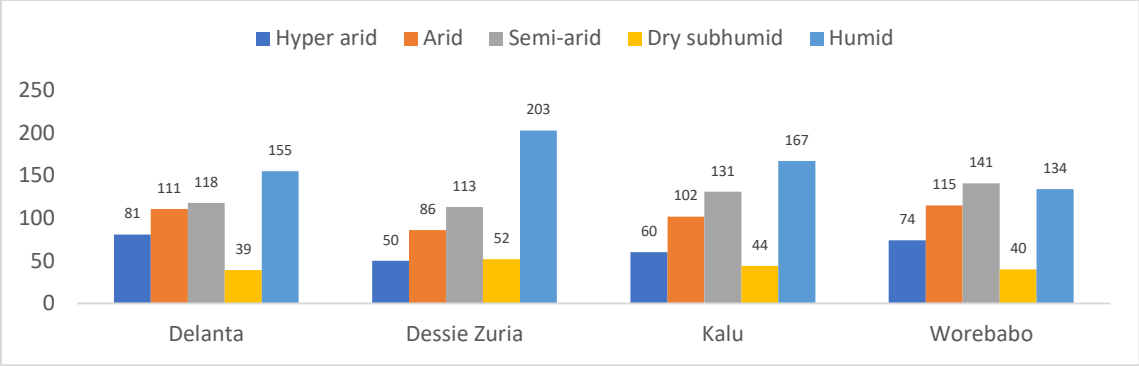


Figure 6.3: Aridity classifications of the study area
Source: authors' own construction

Figure 6.4 indicates the aridity index for the four districts. The figure shows a decreasing pattern of the aridity index, indicating that drier periods are becoming more frequent over time. However, the MK test and Sen's slope estimates indicate the absence of a statistically significant trend.

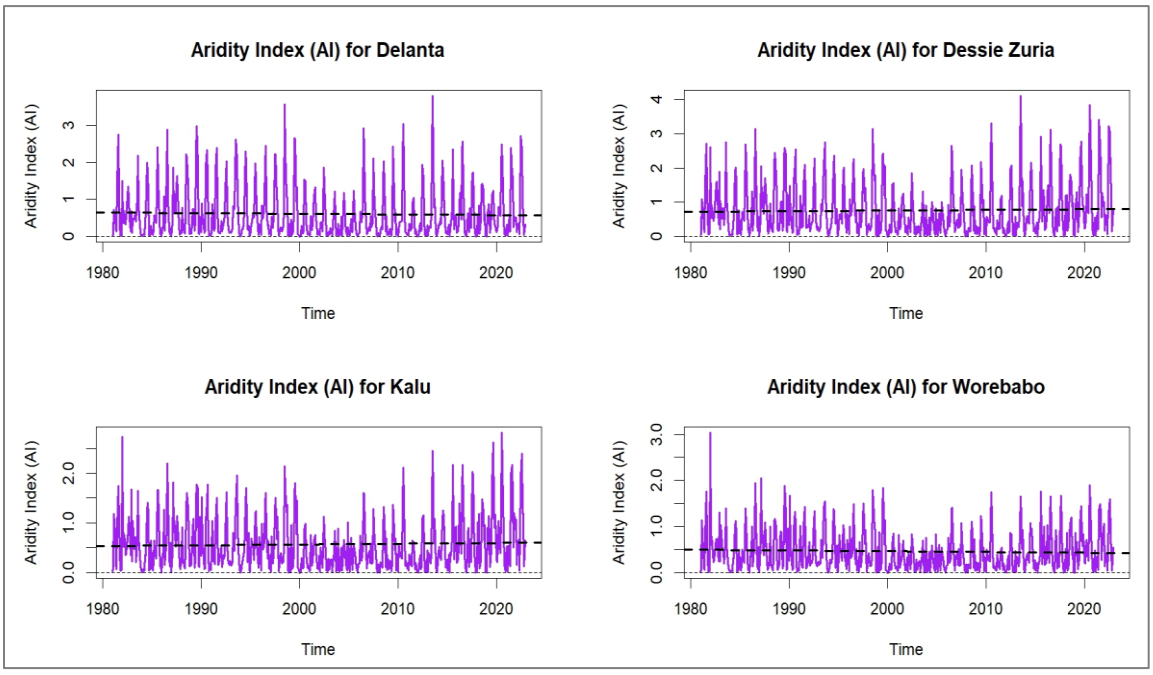


Figure 6.4: Aridity index for the four districts with trend line
Source: authors' own construction

6.3.3. Pattern of droughts at multiple timescales

6.3.3.1. Short-term droughts

The short-term drought conditions were analyzed based on the 3-month and 6-month timescales. As indicated in Figure 18, the frequency of drought occurrence at the 3-month and 6-month timescales has increased since 2000. Between 1981 and 2022, dry periods account for 17%, near-normal periods for 65%, and wet periods for 18% of the time. The number of months, along with the severity of drought conditions, is reported for all districts at 3-month and 6-month time scales in Table 6.1.

Table 6.1: Drought categories at short-term timescale

Timescale	District	Extremely dry	Severely dry	Moderately dry	Near normal	Moderately wet	Severely wet	Extremely wet
SPEI - 3	Delanta	3	36	42	332	57	23	9
	Dessie Zuria	3	36	42	332	57	23	9
	Kalu	3	36	42	332	57	23	9
	Worebabo	3	36	42	332	57	23	9
SPEI - 6	Delanta	0	41	48	319	55	28	8
	Dessie Zuria	0	41	48	319	55	28	8
	Kalu	0	41	48	319	55	28	8
	Worebabo	0	41	48	319	55	28	8

Figure 6.5 illustrates the short-term drought frequencies and trends over the period from 1981 to 2022 for the four districts, including trend lines based on SPEI–3 and SPEI–6. The plots clearly indicate an increase in the frequency and severity of drought conditions throughout the data period, with a more pronounced increase since 2000 and 2015.

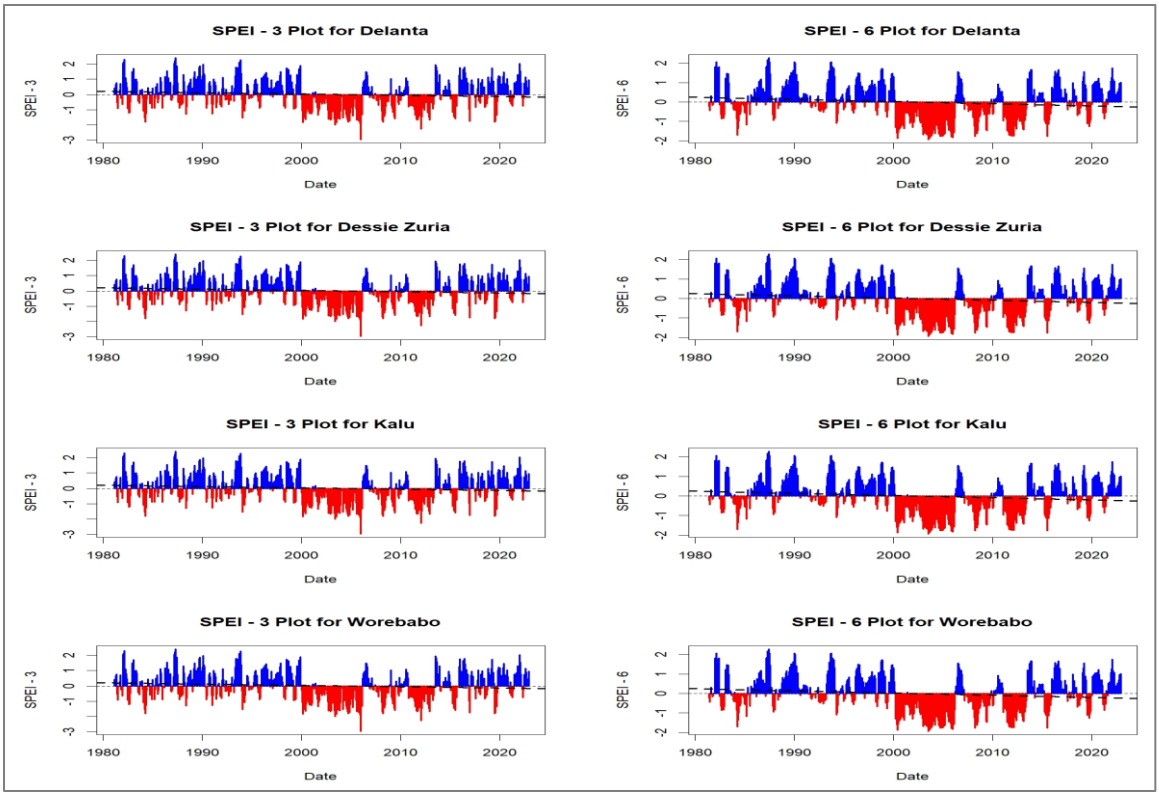


Figure 6.5: Short-timescale drought trends

Source: authors' own construction

6.3.3.2. Long-term droughts

On average, over a long-term timescale, dry periods account for 20%, near-normal periods for 62%, and wet periods for 18% between 1981 and 2022 in the study areas. The number of months along with the severity of drought conditions is reported for all districts at 9-month and 12-month timescales in Table 6.2.

Table 6.2: Drought categories at long-term timescale

Timescale	District	Extremely dry	Severely dry	Moderately dry	Near normal	Moderately wet	Severely wet	Extremely wet
SPEI – 9	Delanta	1	41	53	309	65	21	6
	Dessie Zuria	1	41	53	309	65	21	6
	Kalu	1	41	53	309	65	21	6
	Worebabo	1	41	53	309	65	21	6
SPEI - 12	Delanta	0	46	55	304	62	21	5
	Dessie Zuria	0	46	55	304	62	21	5
	Kalu	0	46	55	304	62	21	5
	Worebabo	0	46	55	304	62	21	5

Source: authors' own construction

Even at long-term timescales (SPEI–9 and SPEI–12), an increase in the frequency of drought periods is observed, as shown in Figure 6.6. For all districts, the period between 2000 and 2015 shows an increased frequency of drought periods on the long-term timescale, as observed in the plots.

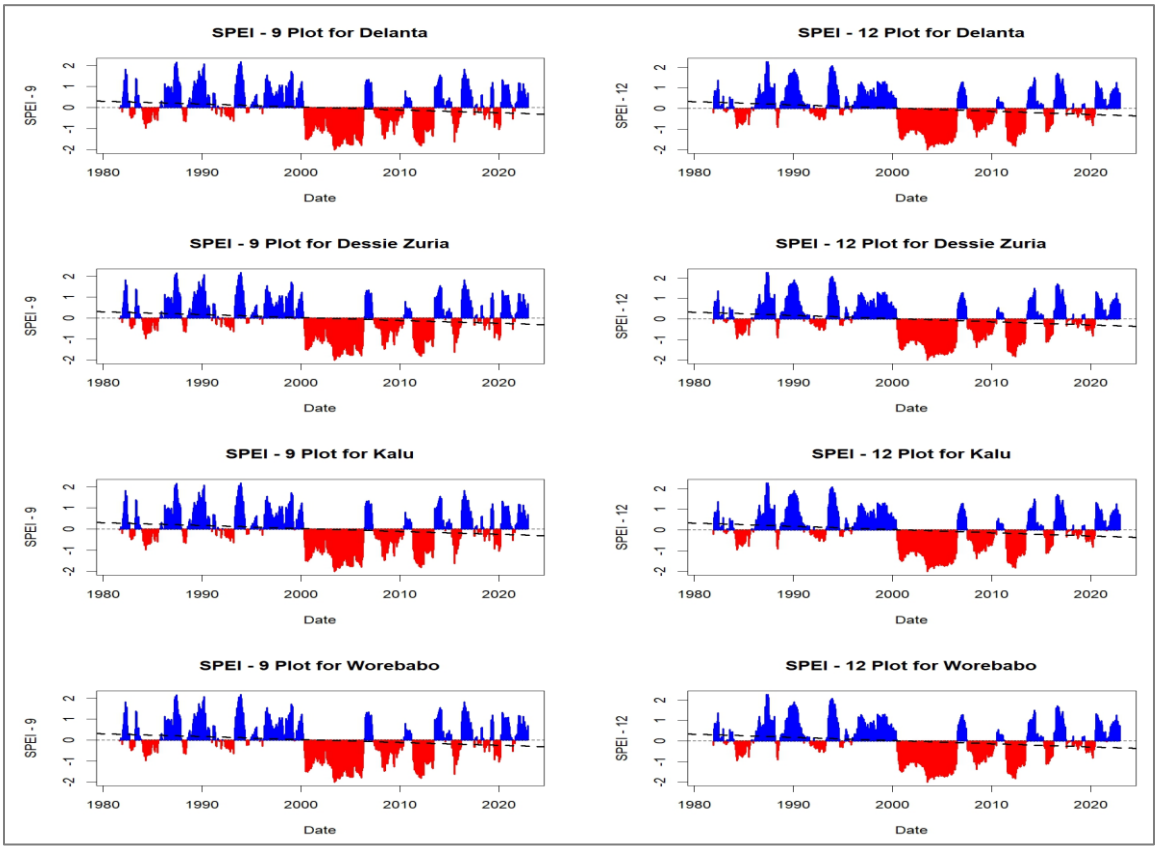


Figure 6.6: Long-timescale drought trends

Source: authors' own construction

6.3.4. Trend analysis

Table 6.3 summarizes the MK test and Sen's slope for PET and CWBAL across the four districts, indicating no statistical significance despite an increasing and decreasing pattern, respectively.

Table 6.3: Sen's slope and trend analysis for potential evapotranspiration and climatic water balance

Variable	Districts	z-value	p-value	Sen's slope	Trend	Significance
PET	Delanta	1.4659	0.1427	0.0082	Increasing	No
	Dessie Zuria	0.2481	0.8041	0.0024	Increasing	No
	Kalu	0.2084	0.8350	0.0024	Increasing	No
	Worebabo	0.4900	0.6241	0.0057	Increasing	No
CWBAL	Delanta	-1.0434	0.2968	-0.0182	Decreasing	No
	Dessie Zuria	-0.2698	0.7873	-0.0046	Decreasing	No
	Kalu	-0.3286	0.7425	-0.0056	Decreasing	No
	Worebabo	-1.0550	0.2914	-0.0202	Decreasing	No

As shown in Table 6.4, the PET trend is not statistically significant. However, the Sen's slope estimate indicates an upward trend for PET for all districts. In all of the districts under the study, the trends in Climatic Water Balance show a decreasing trend. However, the decrease in trend in CWBAL is not statistically significant, as the p-value is greater than 0.05.

Table 6.4: Sen's slope and trend analysis for short-timescale droughts

Timescale	Districts	*z-value*	*p-value*	Sen's slope	Trend	Significance
SPEI - 3	Delanta	-1.7631	0.0779	-0.0006	Decreasing	No
	Dessie Zuria	-1.7631	0.0779	-0.0006	Decreasing	No
	Kalu	-1.7631	0.0779	-0.0006	Decreasing	No
	Worebabo	1.7631	0.0779	-0.0006	Decreasing	No
SPEI – 6	Delanta	-2.5363	0.0112	-0.0009	Decreasing	Yes
	Dessie Zuria	-2.5363	0.0112	-0.0009	Decreasing	Yes
	Kalu	-2.5363	0.0112	-0.0009	Decreasing	Yes
	Worebabo	-2.5363	0.0112	-0.0009	Decreasing	Yes

The MK test and Sen's slope estimates indicate that there is a decrease in the SPEI-3 drought index over a period of time. However, the decrease in trend is not statistically significant as the p-value is slightly above 0.05 for SPEI-3 timescales for all districts. A

statistically significant trend is observed for SPEI-6 for the four districts at p-value <0.05. The SPEI-6 analysis yields similar p-values and Sen's slope estimates for all districts. The decreasing trend highlights an increase in drought conditions in the study area that affects the geological aspect of water. The decrease in the SPEI trend is at a rate of 0.009 units/month as reported in Table 6.5.

Table 6.5: Sen's slope and trend analysis for long-timescale droughts

Timescale	Districts	*z-value*	*p-value*	Sen's slope	Trend	Significance
SPEI – 9	Delanta	-2.9745	0.0029	-0.0010	Decreasing	Yes
	Dessie Zuria	-2.9745	0.0029	-0.0010	Decreasing	Yes
	Kalu	-2.9745	0.0029	-0.0010	Decreasing	Yes
	Worebabo	-2.9745	0.0029	-0.0010	Decreasing	Yes
SPEI – 12	Delanta	-3.2917	0.0010	-0.0011	Decreasing	Yes
	Dessie Zuria	-3.2917	0.0010	-0.0011	Decreasing	Yes
	Kalu	-3.2917	0.0010	-0.0011	Decreasing	Yes
	Worebabo	3.2917	0.0010	-0.0011	Decreasing	Yes

At a *p-value* < 0.0001, the SPEI-9 and SPEI-12 timescales show a statistically significant decreasing trend over the period of 1981 to 2022. The Sen's slope estimate for all districts was similar, and the MK test shows a statistically significant trend at a p-value <0.01 was observed and a decrease in Sen's slope estimates of 0.0010 units/month for SPEI-9 and 0.0011 units/month reduction for SPEI-12, both highlighting an increase in long-timescale drought conditions over the research periods. Figure 6.7 shows the trends in SPEI at different timescales for all study districts.

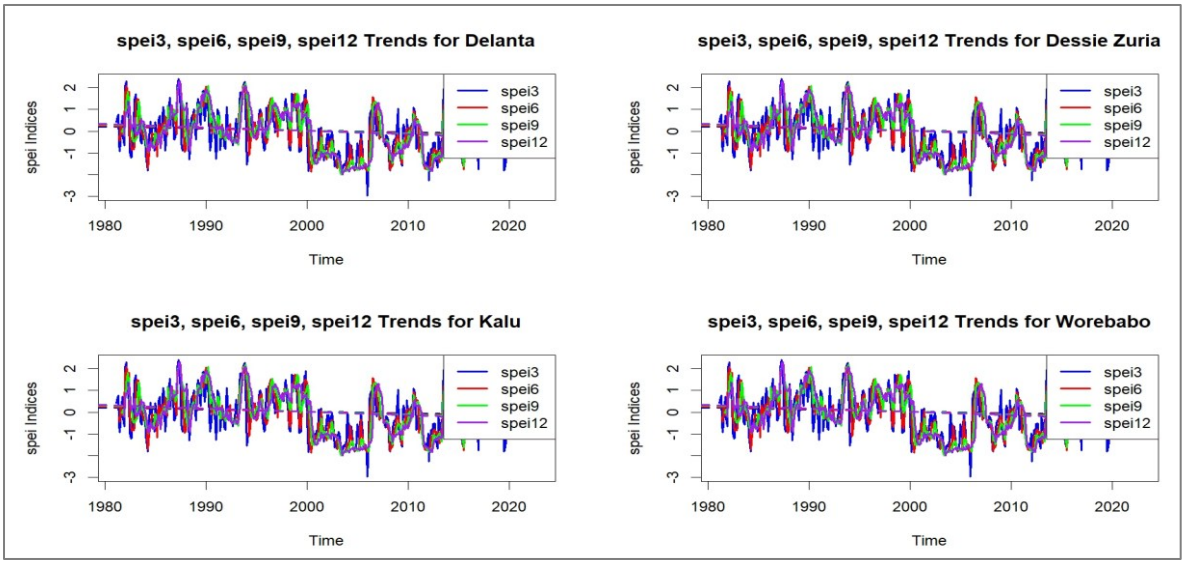


Figure 6.7: Aggregated drought trend estimates at different timescales
Source: authors' own construction

6.4. Discussion

6.4.1. Interpretation of drought dynamics

The upward trend in Potential Evapotranspiration (PET) in the four districts suggests a heightened atmospheric demand for moisture. This increase potentially exacerbates drought conditions. At the same time, the decreasing trend in the climatic water balance, although not statistically significant, indicates a growing deficit between precipitation and evapotranspiration. While moisture availability is declining, the change in the aridity index does not present statistically significant trends, indicating that the overall climatic classification remains relatively stable. The downward trend in all SPEI-3 (only significant at p-value < 0.1), SPEI-6 (at p-value < 0.05), SPEI-9 (at p-value < 0.01), and SPEI-12 (at p-value < 0.01) timescales for the Standardized Precipitation Evapotranspiration Index (SPEI) highlights increasing drought severity and frequency. Notably, all SPEI timescales underscore drought events predominantly from 2000 onwards, with severe drought conditions between 2000 and 2015.

These findings are consistent with earlier studies from the South Wollo Zone. A rise in both the frequency and severity of meteorological droughts, attributed to ongoing climate variability and shifts, was reported by Mohammed et al. (2022). Likewise, Wassie et al. (2022) highlighted major drought years: 2002, 2004, 2009, 2011, 2014, 2015, and 2019.

These years closely match the drought periods identified in this study. In another related study, Gebre et al. (2017) used SPEI and Landsat Normalized Difference Vegetation Index (NDVI) to assess agricultural drought in the North Wollo Zone and pointed out severe droughts in 2005 and 2015. This study identified an increasing severity and frequency of drought periods since 2000 on a short timescale, as well as a few years before 2010 and onwards for long-term analysis. Altogether, these parallels strengthen the credibility of the present study and highlight the ongoing challenge of drought in the region.

6.4.2. Drivers and processes

The upward trend in PET indicates rising temperatures, which increase evapotranspiration and exacerbate drought conditions in the South Wollo Zone. Mohammed et al. (2022) emphasized that increasing temperatures are a key driver of more severe droughts in South Wollo. Furthermore, land degradation and deforestation exacerbate the issue by accelerating moisture loss and reducing the soil's ability to retain water (Climate Investment Funds, 2024). Rainfall patterns are also shifting. Wassie et al. (2022) observed that rainfall has declined during critical growing seasons, exacerbating the area's water shortages. These climate changes and human activities paint a complex picture of how droughts develop and intensify.

6.4.3. Implications for household food security

Drought conditions are intensifying, significantly affecting household food security in the study areas. The reliance of South Wollo on rain-fed agriculture makes it particularly vulnerable to moisture deficits. Gebre et al. (2017) reported a strong correlation between SPEI values and crop yield anomalies, suggesting that drought has a direct impact on agricultural productivity. Access to rainfall and supplementary irrigation negatively affect agricultural activities, in addition to unexpected seasonal fluctuations that increase the unpredictability of the seasonal calendar, leading to poor farming decisions related to planting timelines. Zeru (2020) also highlighted the importance of small-scale irrigation in improving food security.

The analysis of meteorological droughts in the South Wollo Zone from 1981 to 2022, based on SPEI, reveals a region prone to periodic droughts, with some of the most severe events occurring more frequently in recent years. With short-term SPEI, drought frequencies have increased since 2000, while the long-term SPEI shows a persistent increase in drought conditions, particularly from 2010 onwards throughout the data reference period.

Households in South Wollo are highly vulnerable to drought due to a combination of climatic and socioeconomic factors. KII and FGD participants consistently highlighted that the zone's dependency on rain-fed agriculture makes it particularly susceptible to fluctuations in rainfall, which is often exacerbated by rising temperatures. Research participants reported a recurring cycle of drought exposure, with particular emphasis on the period from 2015 to 2016, which is linked to the El Niño event and had long-lasting effects on household food security. Many respondents indicated that their crops failed during these years, forcing them to rely on purchasing food from markets where inflated prices increase existing vulnerability. These droughts created a cycle of vulnerability, as households were forced to sell off their livestock and other assets to purchase food. This coping mechanism limited their ability to withstand future shocks.

Even outside the data period (1981 - 2022), research participants highlighted the ongoing exposure to drought incidents, coupled with the impact of the northern Ethiopia conflict crisis. This indicates the persistent nature of the drought's consequences over an extended period, where the severity and frequency of drought conditions fluctuate over time. Similar studies, including those by Tesfaye and Alemayehu (2021) and Mekonnen et al. (2021), have reported that households in drought-affected areas continue to face challenges in accessing food due to depleted household assets and decreased agricultural productivity.

In South Wollo, households often could not meet their nutritional needs years after the drought. An unprecedented proportion of households failed to meet the daily energy requirement before the Northern Ethiopia conflict. The situation was even worse during and after the conflict, as it added additional strain to households' ability to meet household food requirements due to challenges affecting agricultural production, inability to engage

in meaningful livelihood activities, interruptions in basic services, and mobility restrictions that further limited coping mechanisms. This finding aligns with previous studies that have noted the profound impact of droughts on dietary diversity in drought-prone areas, exacerbating malnutrition (Bethelhem et al., 2024; Gebre et al., 2024).

In terms of adaptation, households in South Wollo have developed various strategies to cope with recurring droughts; however, these strategies are often short-term and unsustainable. Key informants indicated that many households rely heavily on food aid provided by the PSNP, which helps mitigate the immediate impacts of food insecurity. However, the PSNP often faces challenges such as delays and insufficient coverage, so many households are still left without sufficient food during droughts. Focus group participants also described how some households have resorted to migration, particularly to urban centers or areas with better access to food, as a coping strategy, even though this was constrained during the conflict, thereby furthering their vulnerabilities. Households opt for various consumption-related coping strategies, including dietary changes, reducing the number of people, short-term increases in food availability, and rationing, in addition to other strategies such as the sale of livestock, which are also common. As livestock is a critical asset in rural Ethiopia, the sale of animals is often a last resort to meet immediate food needs during droughts. However, as households deplete their assets, they become even more vulnerable in the long term, as livestock serves as a form of savings and a source of income during non-drought periods.

Although some coping strategies exist, the resilience of households in South Wollo is severely limited. A significant barrier to building resilience is the lack of access to alternative livelihoods and limited agricultural diversification. The reliance on rainfed agriculture and limited livelihood diversification, with little or no access to irrigation or drought-resistant crop varieties, coupled with a lack of investment in water harvesting technologies, such as small-scale irrigation systems and climate-smart agricultural practices, has left many households unable to adapt to the changing climate. Similar studies, such as those by Odongo et al. (2025) and Mukasa et al. (2020), argue that drought exacerbates vulnerability by limiting adaptation capacity due to inadequate infrastructure,

knowledge, and financial resources, which is consistent with the study's findings. There is a need for more long-term adaptation strategies, such as investing in agricultural diversification, introducing drought-tolerant crops, and promoting climate-smart agricultural techniques. According to Abate et al. (2023), enhancing local capacity to adapt to climate change through such measures can significantly improve food security outcomes in regions like South Wollo, where climate variability is a major driver of food insecurity.

Drought conditions are intensifying, significantly affecting household food security in the study areas. The reliance of South Wollo on rain-fed agriculture makes it particularly vulnerable to moisture deficits. Gebre et al. (2017) reported a strong correlation between SPEI values and crop yield anomalies, suggesting that drought has a direct impact on agricultural productivity. Lack of access to rainfall and supplementary irrigation negatively affects agricultural activities, in addition to unexpected seasonal fluctuations that increase the unpredictability of the seasonal calendar, leading to poor farming decisions related to planting timelines. Zeru (2020) also highlighted the importance of small-scale irrigation in improving food security.

Access to irrigation improves food consumption at the household level in South Wollo, indicating that irrigation can play a significant role in mitigating the adverse effects of drought on food security. However, the adoption of irrigation technologies remains limited, leaving many households vulnerable to food insecurity during periods of drought. Beshir (2018) found that households involved in irrigation programs experienced noticeable improvements in their food security. Building on this, Kebede (2024) highlighted that access to irrigated water increased household income and played a crucial role in enhancing food security. These findings underscore the importance of expanding irrigation infrastructure and access to support food security in drought-prone areas of South Wollo.

6.4.4. Limitations of the study

This study has some limitations, particularly related to a lack of sufficient station data for precipitation and temperature from EMI, which affects the corroboration of the drought indices, both from satellite and station data. As a result, drought index analysis was based

on gridded satellite data that may not capture local-level differences in drought characteristics between the study districts, as they are relatively close to each other.

6.4.5. Implications for policy and future interventions

The study underscores the critical need for integrated drought early warning systems that can help predict meteorological droughts and their socioeconomic impacts on food security. While drought indices like SPEI are valuable tools for characterizing drought severity, integrating early food security monitoring systems, such as household-level food insecurity assessments, could improve early responses and preparedness. The northern Ethiopia conflict was a devastating experience for households in the study area, highlighting the importance of strengthening resilience to climatic shocks and social and political instability, which can further exacerbate vulnerabilities. Moreover, investing in disaster risk reduction (DRR) and climate adaptation programs irrigation and drought-resistant farming, should be prioritized to enhance the long-term resilience of vulnerable communities in South Wollo, including local-level interventions integrating climate information with food security monitoring to mitigate future risks and reduce the cycle of vulnerability that households face in the aftermath of droughts.

CHAPTER 7: A POST-CONFLICT ASSESSMENT OF HOUSEHOLD FOOD SECURITY AND COPING STRATEGIES IN THE SOUTH WOLLO ZONE, ETHIOPIA[9]

This chapter presents a cross-sectional analysis of household food security and its determinant factors. It considers the Household Food Insecurity Access Scale (HFIAS) and the Coping Strategy Index (CSI) as key indicators of food security to provide an understanding of household food security and coping strategies in the aftermath of the conflict in northern Ethiopia.

Abstract

Violent conflict exacerbates food insecurity by disrupting agricultural production, markets, and mobility. South Wollo Zone, already vulnerable to climate shocks, suffered severe destruction and loss of life during the northern Ethiopia conflict. This study assessed post-conflict household food security using the Household Food Insecurity Access Scale (HFIAS) in selected districts of South Wollo Zone, Ethiopia. It also identified determinant factors of food security and examined consumption-related coping strategies during and after the conflict. This study used a mixed cross-sectional research design. Data were collected from 422 randomly selected households, key informant interviews, and focus group discussions which was complemented by review of related literature. A Household Food Insecurity Access Scale was analyzed by running ordered logistic regression to identify determinant factors using the Stata software. The result reveals that 45% of households severely food insecure, 39% moderately insecure, 7% mildly insecure, and only 9% food secure in conflict-affected districts of South Wollo Zone. Households with more livestock and larger landholdings were more food secure, while conflict-related losses increased vulnerability. Besides, wealth index and off-farm participation positively associated with household food security. Exposure to drought worsened food shortages, while the contribution of humanitarian aid was dependent on sufficiency and timeliness of assistance. Households adopted coping strategies such as dietary changes (89%),

[9] This chapter is based an article that is currently under consideration by Journal of Nutrition and Food Security which is currently at peer review stage.

rationing (79%), short-term food acquisition (59%), and reducing household size (15%). Violent conflict disrupts food systems and deepens vulnerabilities, forcing negative coping strategies. Conflict-sensitive interventions, off-farm livelihood support, and livestock restocking, are crucial for recovery.

Keywords: Coping strategies, Conflict, Food security, Violent conflict, Determinants of food security

7.1. Introduction and Justification

Violent conflict involves social, economic, environmental, and political factors that cumulatively exacerbate food insecurity. In addition to the direct damage caused by conflict on agricultural produce and activities, it also affects the supporting functions of agriculture, such as irrigation systems, market disruptions, and the mobility of people from one place to another for labor activities. Food security encompasses not only the mere availability of food but also the concept of both physical and economic access to sufficient, safe, and nutritious food (Righettini & Bordin, 2023).

Food insecurity and conflict are interrelated, with one often being a cause of the other. Countries that experience conflict also experience food insecurity (Martin-Shields & Stojetz, 2019). It was reported that 60% of undernourished people and 79% of stunted children live in conflict-affected countries globally, while 80% of acutely food-insecure individuals live in conflict-affected countries in Africa (ACSS).

Violent conflict has a profound effect on household food security. Conflict can exacerbate existing vulnerabilities by creating barriers to access to food. The destruction of vital infrastructures in the agriculture and health sectors, as well as insufficient humanitarian assistance, further exacerbate food insecurity in the context of violent conflict (Shishay & Dawit, 2018; Woldegebriel et al., 2024).

Hunger and food insecurity remain high for three consecutive years due to multiple factors, including the COVID-19 pandemic, conflict, climate variability, inequality, slow economic

growth, and other factors globally. This makes achieving the Sustainable Development Goals (SDGs) of zero hunger at the same level without significant improvement. FAO et al. (2024) reported that approximately 733 million people faced hunger in 2023, in addition to 2.33 billion people who might have experienced food insecurity. Given that inequalities play a significant role in accessing food, poor countries have the highest proportion of people who cannot access a healthy diet.

Sub-Saharan Africa is among the regions most affected by protracted conflict worldwide. conflict undermines progress toward sustainable development goals and leaves people in extreme poverty. Several studies, including the GRFC (2022), have indicated that conflict is a major driver of food insecurity (Tranchant et al., 2021). Conflict undermines household food security by reducing calorie availability at the household level and compromising dietary diversity.

Agriculture is crucial to Ethiopia's economy, but it suffers greatly from conflict and other crises. Agricultural lands are damaged due to conflict, which destroys crops, disrupts markets and veterinary services, constrains labor movement, and distorts local governance, leading to economic losses and worsening food insecurity (Rohwerder, 2017). Beyond its direct effects on food security, the conflict also has social and economic consequences due to the disruption of the entire food system, from production to consumption, which limits production and essential services, and compromises food availability, accessibility, utilization, and stability.

The study is conducted in four districts of the South Wollo Zone, located in the Amhara region, which was heavily affected by the conflict in northern Ethiopia and frequently impacted by drought and other disasters that hinder agricultural production. The conflict caused significant damage to lives and livelihoods, worsening existing vulnerabilities in the zone. It assessed Household Food Insecurity Access Scales (HFIAS) and coping strategies to highlight the conflict's consequences on food security. It aims to offer new insights into how violent conflict interacts with food insecurity, identifying key factors and

coping strategies in the post-conflict context. This research also provides valuable recommendations for improving food security in areas recovering from conflict.

7.2. Materials and Methods

7.2.1. Research design and approach

A mixed cross-sectional design was employed to assess the links between variables affecting household food security following violent conflict in the South Wollo Zone, Amhara Region. This approach incorporated both quantitative and qualitative data from various groups. The post-conflict period spans June 2021 to May 2022, during which HFIAS data was gathered for a four-week reference period.

7.2.2. Sampling techniques and sample size determination

Four districts were selected purposively based on their exposure to conflict. Within them, villages were stratified by agroecological zones, and 38 were selected via a lottery approach. From these, 422 households were randomly sampled, including a 10% contingency. The sample size was determined using a formula for cross-sectional studies with categorical variables (Bolarinwa, 2020).

$$n = \frac{z^2 pq}{d^2} = 384 + 10\% = 422$$

where z is the corresponding z score for the 95% confidence interval, p is the percentage of occurrence, q is 1-p, and d is the percentage of precision described as the margin of error. KII and FGD participants were selected based on purposive sampling to provide a broader context and in-depth understanding. The 15 KIIs included local leaders, experts, and officials, while the 10 FGDs comprised 12 participants each from mixed demographics, offering insights into food security and coping strategies.

7.2.3. Data sources and collection tools

Data were collected using household surveys, KIIs, FGDs, and literature review. Quantitative data from 422 households were collected to assess socioeconomic status, food security, conflict impacts, and coping mechanisms. Qualitative insights were derived from the FGDs and KIIs to deepen understanding of local conditions.

7.2.4. Techniques of data analysis

The HFIAS was used to analyze household food security by examining HFIAS-related conditions (c), HFIAS-related domains (d), HFIAS scores (s), and HFIAS prevalence (p), as outlined in Coates et al. (2007). These parameters were calculated based on the nine HFIAS questions.

$$c = \frac{X_i}{N_i} * 100$$

where c represents the HFIAS-related conditions, X represents the affirmative response (yes) for the HFIAS question, and N represents the number of respondents answering HFIAS question i.

$$d_1 = \frac{X_1}{N_1} * 100$$

$$d_2 = \frac{X_2\ or X_3\ or\ X_4}{N_2 or\ N_3\ or\ N_4} * 100$$

$$d_3 = \frac{X_5\ or X_6\ or\ X_7\ or\ X_8\ or\ X_9}{N_5\ or\ N_6\ or\ N_7\ or\ N_8\ or\ N_9} * 100$$

where d is the HFIAS-related domain (d1 is anxiety and uncertainty, d2 is insufficient quality, and d3 is insufficient food intake and its physical consequences), Xs are the affirmative responses to the specific HFIAS questions, and N is the total number of respondents who answered either of the specified HFIAS questions for each domain.

The HFIAS score for each household was computed by summing the frequency of occurrence for each HFIAS question. Once the household-level HFIAS score was computed, the average HFIAS score for the research participants was computed as follows:

$$S = \frac{\sum_{s=1}^{n} s}{N} * 100$$

where S is the average HFIAS score, s is the household-level HFIAS score, and N is the total number of households surveyed.

Household food security status was categorized into four groups: food-secure, mildly food-insecure, moderately food-insecure, and severely food-insecure. Each HFIAS question was rated on a scale of 0 (no), 1 (rarely), 2 (sometimes), and 3 (often), based on a four-week recall. This classification followed the FAO recommendation as in Coates et al. (2007)[10]. After the HFIAS categories were determined, an ordered logistic regression model was used to identify determinants of household food security according to food security categories on the HFIAS scale.

$$logit(P(Y \leq j)) = \beta_{j0} + \beta_1 x_1 + \cdots + \beta_p x_p$$

for j=1, ⋯, J−1 are the food security categories of the outcome variable, and X_1, …, X_p are predictors.

A thematic method was used to analyze and organize data that were collected from related literature, FGDs, and KII.

7.3. Results

7.3.1. Sociodemographic information of respondents

The 422 respondents came from villages across various agroecological zones in four districts. The average household size in the study is five. Table 7.1 presents respondent numbers and impacts from non-drought events. A chi-square test showed a significant link between food security and disaster exposure severity ($p < 0.01$).

[10] The HFIAS categorization was calculated based on the FAO indicator guideline (Coates et al., 2007) using the Stata software after labelling 1 = Food Secure, 2=Mildly Food Insecure Access, 3=Moderately Food Insecure Access, 4=Severely Food Insecure Access
HFIA category = 1 if [(Q1a=0 or Q1a=1) and Q2=0 and Q3=0 and Q4=0 and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0]
HFIA category = 2 if [(Q1a=2 or Q1a=3 or Q2a=1 or Q2a=2 or Q2a=3 or Q3a=1 or Q4a=1) and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0]
HFIA category = 3 if [(Q3a=2 or Q3a=3 or Q4a=2 or Q4a=3 or Q5a=1 or Q5a=2 or Q6a=1 or Q6a=2) and Q7=0 and Q8=0 and Q9=0]
HFIA category = 4 if [Q5a=3 or Q6a=3 or Q7a=1 or Q7a=2 or Q7a=3 or Q8a=1 or Q8a=2 or Q8a=3 or Q9a=1 or Q9a=2 or Q9a=3]

Table 7.1: Exposure to non-drought climate disasters and food security status.

Food security category	Number of respondents	Exposure to non-drought disasters			
		No	Low	Medium	High
Food secure	36	0	10	23	3
Mildly food insecure	31	1	14	10	6
Moderately food insecure	165	2	70	73	20
Severely food insecure	190	3	25	130	32
Total	422	6	119	236	61

p value=0.000; Source: Survey data

Drought exposure has a significant impact on household food security. A Pearson Chi-square test confirmed an association between drought exposure and food security status ($p < 0.01$). As drought exposure rises, so does the likelihood of food insecurity. Table 7.2 displays the proportion of households by food security category, based on drought exposure.

Table 7.2: Exposure to drought and food security status.

Food security category	Number of respondents	Exposure to drought	
		No	Yes
Food secure	36	9	27
Mildly food insecure	31	12	19
Moderately food insecure	165	62	103
Severely food insecure	190	34	156
Total	422	117	305

p value=0.000; Source: Survey data

Food security levels vary across the four districts, with high rates of severe and moderate food insecurity: 94% in Delanta, 74% in Dessie Zuria, 81% in Kalu, and 92% in Worebabo. Figure 7.1 shows the breakdown of food security categories by district.

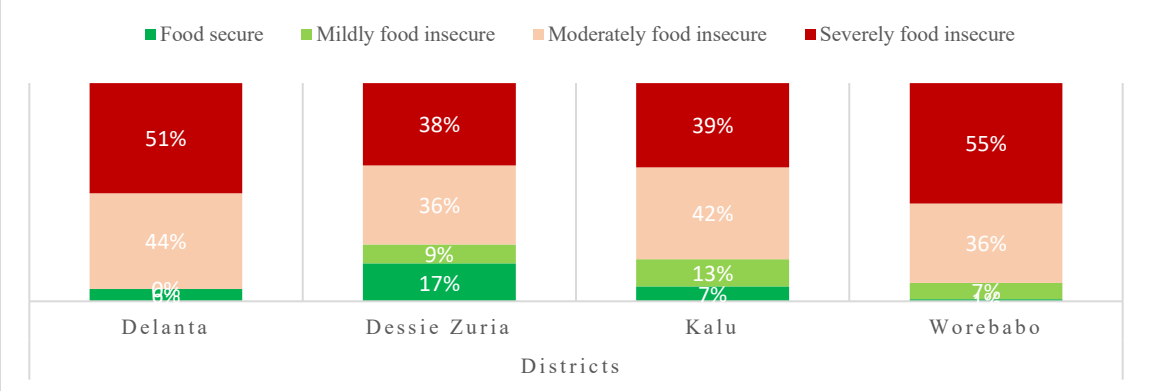


Figure 7.1: Food security categories per district
Source: survey data

Approximately 15% of respondents were from female-headed households, while 85% were from male-headed households. Figure 7.2 presents food security status by sex of the household heads.

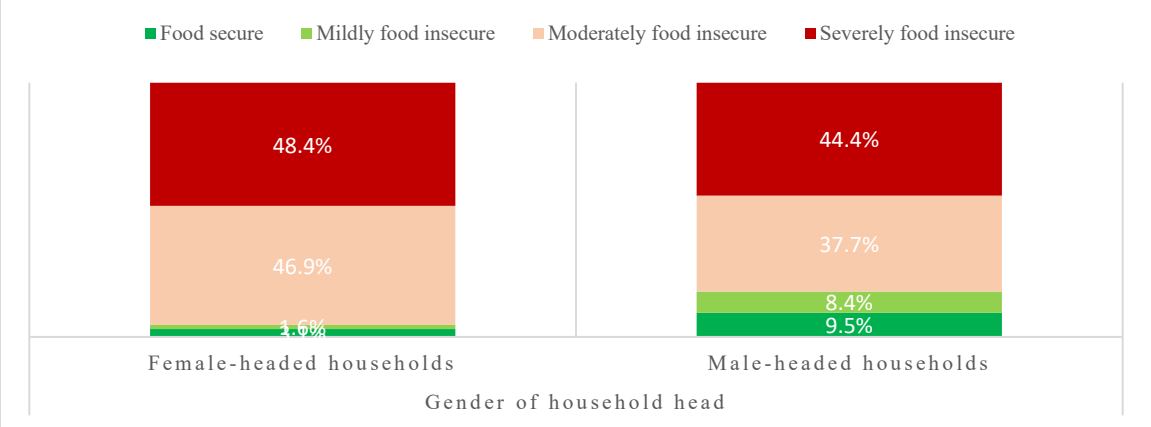


Figure 7.2: Food security categories per sex of the household heads
Source: survey data

Livelihood diversification is vital in the area, with 30% of respondents engaged in both agricultural and non-agricultural work, such as tailoring, salons, carpentry, and small trades. Off-farm activities help improve food security. A chi-square test ($p = 0.002$) showed

a strong link between HFIAS and off-farm participation. Table 7.3 shows this association with Chi-square results.

Table 7.3: Food security status and off-farm participation.

Food security category	Number of respondents	Off farm participation	
		No	Yes
Food secure	36	16	20
Mildly food insecure	31	19	12
Moderately food insecure	165	125	40
Severely food insecure	190	136	54

p-value = 0.002; Source: Survey data

7.3.2. Household food insecurity access scale

Post-conflict data provided affirmative responses to different food insecurity situations and frequencies of occurrence against the nine HFIAS questions to assess household food insecurity access-related conditions, food insecurity access-related domains, HFIAS scores, and HFIAS prevalence. The affirmative response of households for the nine HFIAS-related conditions is indicated in Table 7.4.

Table 7.4: Affirmative responses for the household food insecurity access scale

		Affirmative responses		Frequency of responses (%)		
S/N	HFIAS Questions	Number of responses*	% (Yes)**	Rarely	Sometimes	Often
1	Worry about food	327	77.5	60.2	29.4	10.4
2	Unable to eat preferred food	347	82.2	55.6	32.9	11.5
3	Eat a limited variety of foods	348	82.5	49.4	35.9	14.7
4	Eat food that you did not want to eat	309	73.2	55.7	29.1	15.2
5	Eat a smaller portion of meal	322	76.3	56.5	28.0	15.5
6	Eat fewer meals in a day	297	70.4	60.0	18.5	21.5
7	No food of any kind to eat	133	31.5	72.2	25.6	2.2
8	Go to sleep at night hungry	67	15.9	76.1	20.9	3.0
9	Go a whole day and night without eating	75	17.8	77.3	20.0	2.7

*Note: * The total number of respondents (n) who answer all nine HFIA questions, where 422 is the sample size of the study. ** percentage of respondents who affirmatively answered the HFIAS questions, n/422;* Source: Survey data

HFIAS conditions are grouped into domains: question #1 reflects anxiety and uncertainty; questions #2–4 relate to food quality; and questions #5–9 address inadequate intake and

physical effects. About 77% of respondents faced anxiety over food access, 90% reported poor food quality, and 83% experienced insufficient intake during the post-conflict period. Figure 7.3 shows the share of households affected in each HFIAS domain.

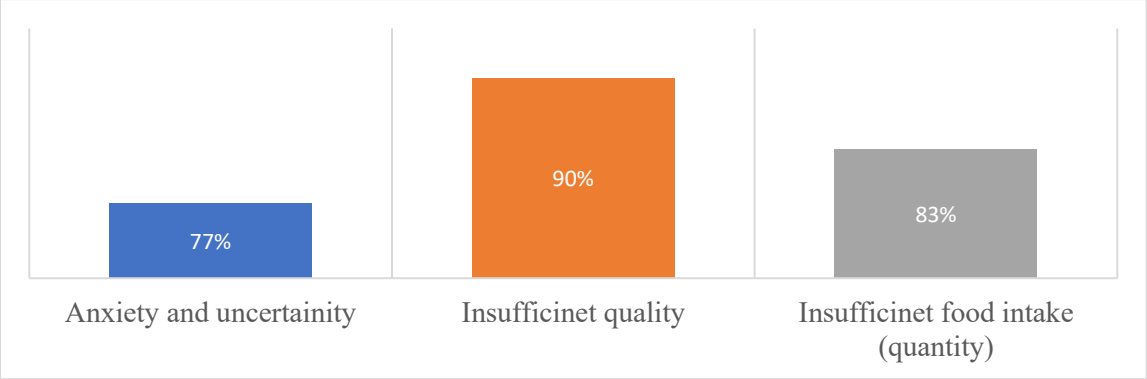


Figure 7.3: Household food insecurity access scale - related domains
Source: source data

The mean HFIAS score was 8.16, with a minimum value of 0 and a maximum value of 25. The HFIAS prevalence, a categorical indicator of the Food Insecurity Access Scale, was computed for the study target groups according to the method recommended by Coates et al. (2007), as used in the FAO indicator guide.

7.3.3. Household food insecurity access scale prevalence

As indicated under Figure 7.4, 45% of the respondent households were severely food insecure, 39% were moderately food insecure, 7% were mildly food insecure, and only 9% food secure in the post-conflict reference period. This indicated that the vast majority of respondents experienced food insecurity to varying degrees.

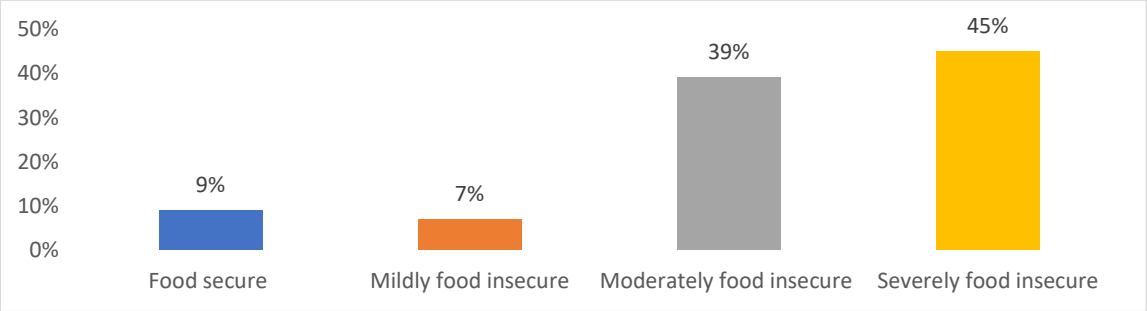


Figure 7.4: Prevalence of household food insecurity access scale
Source: survey data

7.3.4. Determinants of household food security

Ordered logistic regression was applied using HFIAS prevalence, categorized into food secure, mildly food insecure, moderately food insecure, and severely food insecure, as the dependent variable. Table 7.5 presents the regression results and key factors.

Table 7.5: Ordered logistic regression of the HFIAS prevalence categories during post-conflict reference.

Independent variables	Coefficient	Standard Error	Z	P>|z|	Confidence Interval - 95%	
					Lower Bound	Upper Bound
Age	0.011	0.011	1.00	0.319	-0.010	0.031
Sex	0.237	0.444	0.53	0.593	-0.634	1.108
Literacy	-0.041	0.227	-0.18	0.856	-0.486	0.403
Total livestock unit	-0.342	0.112	-2.98	0.003***	-0.567	-0.117
Ecology	-0.410	0.174	-2.35	0.019**	-0.752	-0.069
Distance to livestock market	-0.007	0.002	-3.78	0.000***	-0.010	-0.003
Total land size	-0.222	0.056	-3.97	0.000***	-0.332	-0.113
Wealth index	-1.822	0.890	-2.05	0.041**	-3.567	-0.077
Off farm participation	-0.528	0.245	-2.15	0.031**	-1.008	-0.047
Use of fertilizer	-0.487	0.226	-2.15	0.031**	-0.930	-0.044
Family support	0.000	0.000	3.16	0.002***	0.000	0.000
Aid	0.839	0.243	3.46	0.001***	0.363	1.314
Family size	0.139	0.061	2.27	0.023**	0.019	0.259
Exposure to drought	0.504	0.219	2.30	0.021**	0.075	0.932
Marital status	-0.098	0.160	-0.62	0.538	-0.412	0.215
Amount of off farm income	-0.00003	0.000	-1.92	0.055*	-0.0001	0.000
/cut1	-4.057	0.880			-5.782	-2.332
/cut2	-3.229	0.873			-4.940	-1.517
/cut3	-0.862	0.858			-2.545	0.820

Note: Number of observations=422, LR chi2 (16) =134.74, p value=0.0000, Pseudo R2=0.1415, * significant variables at p values less than 0.1, ** significant variables at p values less than 0.05, *** significant at p-value less than 0.01; Source: Survey data

The ordered logistic regression model was significant (p = 0.0000). Key factors affecting food security included livestock units, ecological variability, walking distance to livestock market, land size, wealth index, off-farm participation, fertilizer use, family support, aid,

family size, drought exposure, and off-farm income. Family support, aid, larger family size, and exposure to drought were associated with higher food insecurity.

Livestock ownership, measured by total livestock unit (TLU), positively affects household food security. As TLU increases by one unit, the odds of the household being in a higher category of food insecurity decrease by 0.34 percent at a p-value less than 0.01. In the study area, focus group discussants indicated that livestock were used as a source of food during drought and conflict periods where market systems were interrupted. In addition, livestock were used as collateral to access loans from local moneylenders as a coping strategy during difficult periods, in addition to the income generated through the sale of livestock at local markets, although prices were not competitive. Agroecology plays a key role in determining household food security in the study area, where, from the highlands (Dega) to the midlands (Weyna Dega) and lowlands (Kolla), there is a reduction in the probability of being in a higher category of food insecurity by 0.41.

The walking distance to livestock markets has a significant impact on food security. The regression analysis indicates that longer distance is associated with increased household food security. As land sizes increase by one unit and households use improved fertilizers, the probability of being in a severe food insecurity situation decreases by 0.22 and 0.49 at p-values less than 0.01 and 0.05, respectively. The wealth index, based on household assets, reduces the likelihood of severe food insecurity. Greater assets are linked to improved food security. Off-farm participation diversifies livelihoods, reducing the risks associated with agriculture and conflict. Increased off-farm income increases the probability of being in the food secure category by 0.52 at a p-value of < 0.05.

Even though humanitarian aid and family support are crucial for household food security, their impact was negative in the study areas. Aid contributes to deteriorated household food security due to its negative association. Family size influences food security, with larger households experiencing higher levels of food insecurity. Though more family members can contribute to production or off-farm labor, they also increase food demands. Exposure to drought, alongside conflict, has a negative association with household food security,

which was also aggravated by the conflict. The combined effects of drought and conflict significantly contributed to reduced food security in the region.

7.3.5. Coping strategies for food insecurity

The coping strategies related to consumption in the research area were identified using twelve questions (Table 7.6), grouped into four major strategies: dietary change, short-term measures to increase food availability, reducing household numbers, and rationing. Respondents indicated their household's experience and frequency of these strategies over a seven-day recall period. The mean CSI was 22.4, with a range from 0 to 127. The CSI varied across different food security categories and by the sex of the household head. The mean CSI for female-headed households (26.7) was higher than for male-headed households (21.6). A two-way sample t-test revealed a significant difference in the mean CSI, highlighting the greater vulnerability of female-headed households and their use of more negative coping strategies.

Table 7.6: Coping strategy questions

Question code	Description of the questions
A.	Rely on less preferred and less expensive foods
B.	Borrow food, or rely on help from a friend or relative
C.	Purchase food on credit
D.	Gather food from garbage or collect from leftovers or wild foods
E.	Do labor work for friends, relatives, neighbors in exchange for food
F.	Send household members to eat elsewhere
G.	Send household members to beg
H.	Limit portion size at mealtimes
I.	Restrict consumption by adults for children to eat
J.	Feed working members at the expense of nonworking members
K.	Reduce number of meals eaten in a day
L.	Skip entire days without eating

Source: Maxwell et al. (2003)

The coping strategies were classified into three broad categories by grouping related questions. These strategies include dietary change (question A), short-term strategies to increase the availability of food at the household level (questions B, C, D, and E), decreasing the number of people (questions F and G), and rationing strategies (questions H, I, J, K, and L).

About 89% of respondents reported relying on less preferred, cheaper food during food insecurity. Conflict forced many to consume food they would normally avoid in times of better harvests and market access. To cope, households sought help from relatives, bought food on credit, or worked for food. Only 5% mentioned eating leftovers. Initially, these strategies were common in South Wollo, but as the conflict deepened, aid delays, market breakdowns, and widespread hardship weakened credit, labor, and support options. Sending household members elsewhere to eat (12%) or beg (6%) was rare. Since the crisis affected nearly everyone, community support systems broke down, making this option largely not viable. Rationing was the second most used strategy after dietary change. It included reducing meal portions, prioritizing children, feeding only working members, or skipping meals altogether. Figure 7.5 illustrates the frequency of use for each strategy.

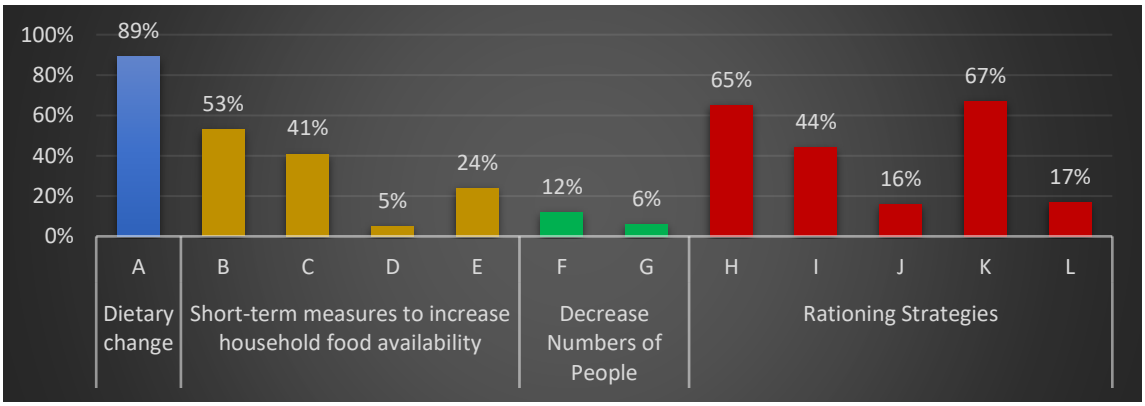


Figure 7.5: Coping strategies for food insecurity: affirmative responses
Source: survey data

Further to the consumption-related coping strategies, focus group discussants indicated that households also consider other strategies during drought and conflict crises. These include gathering of wild foods, selling of productive assets such as livestock, selling of firewood, and making of charcoal, and relying on external assistance, including family, friends, the Government, and non-governmental organizations. Some of these strategies compromise long-term resilience by compounding vulnerability at the household level and due to the negative impact on the environment. Furthermore, in cases of severe drought and conflict consequences, migration and livelihood diversification were mentioned as some of the long-term strategies adopted to cope with the negative consequences of such disasters.

7.4. Discussion

The northern Ethiopia conflict had complex and far-reaching consequences for household food security in the study area, which is already vulnerable to recurring droughts, pests, and flooding. The conflict impacted lives and livelihoods by disrupting economic activities and essential services. Food insecurity was widespread, cutting across sex and household types. While more male-headed households were food secure, the rates of severe food insecurity were nearly the same for both groups, indicating the widespread nature of the conflict.

The analysis identified several factors determining household food security. Access to livestock, land for cultivation, household assets, and alternative income sources played key roles. Households with more livestock were better able to cushion the shock despite some losses due to looting and displacement. This reflects livestock's dual role as a source of food and income, consistent with other findings (Adesogan et al., 2020; Getaneh et al., 2022; Acosta et al., 2024).

According to Akukwe (2020), longer distances to livestock markets hinder livestock health and reduce market access, contributing to household food insecurity. However, longer travel distances to well-established markets result in better prices for livestock, though mobility challenges constrained travel to these markets during the conflict period. This might be a result of poorly developed local markets that do not offer competitive prices. Therefore, it was confirmed that the more livestock owners manage to travel long distances, the more they reach well-developed, structured markets that provide competitive prices for livestock.

Land size was also tied to better outcomes, echoing previous work that emphasizes land as a vital productive asset (Mekonnen et al., 2021). A higher wealth index, expressed in terms of ownership of farm tools, durable, and productive assets, was linked to better food security, as seen in studies such as Hjelm et al. (2016). Off-farm income also helped reduce vulnerability, reinforcing evidence from Endiris et al. (2021) and Kuwornu et al. (2018).

However, the support systems that might have mitigated the challenges due to the conflict did not perform reliably. Delayed aid and interruptions in productive safety net programs left many households to manage on their own. Where support existed, it was often insufficient to offset the growing demand, particularly in large households. As noted by Akbar et al. (2023) and Mengistu and Kassie (2022), larger families face more severe food security challenges, particularly when conflict restricts access to income and mobility. Surprisingly, the education level of the household head did not show a strong link to food security. While education is often viewed as a protective factor, in the context of the study, physical access to resources and income proved more decisive than formal education or literacy level.

Coping responses followed a clear pattern: as food insecurity worsened, households increasingly resorted to short-term, often damaging strategies. Those in the most insecure categories reported the highest Coping Strategy Index (CSI) scores, highlighting the severity of the food security situation.

Generally, these findings indicate that food insecurity in conflict-affected areas is influenced by a combination of environmental exposure, market conditions, asset ownership, and the reliability of humanitarian and family support mechanisms. Responses must consider these factors to rebuild food systems and household resilience effectively.

7.5. Conclusion and Recommendations

7.5.1. Conclusion

The South Wollo zone has already been exposed to climatic shocks such as drought and landslides, and has faced compounded devastation due to the northern Ethiopia conflict. The conflict disrupted every layer of the food system, from production to consumption, endangering all four pillars of food security: availability, access, utilization, and stability. Basic services, social institutions, and market mechanisms were negatively affected, deepening vulnerability and inequality, which led to a significant share of households experiencing food insecurity. With only a small proportion of households in the study area classified as food secure, this situation has been exacerbated. The conflict affected

households across the board, regardless of the sex, age, or educational level of the household head. However, families with more diverse ways of earning a living, particularly those involved in off-farm work, were better able to maintain their food security.

The ordered logistic regression identified several factors influencing food security: land size, livestock holdings, ecological zone, market access, wealth index, and support systems. Family support and humanitarian aid were not strongly linked to improved food security due to widespread need, delayed assistance, and disrupted social networks. The positive association between greater distance to livestock markets and food security, attributed to better-developed, higher-priced distant markets, requires further investigation.

Households in the study area deployed different coping strategies, ranging from dietary changes to rationing and seeking food through informal means. As food insecurity deepened, more negative coping strategies were adopted, reflected in a higher Coping Strategy Index (CSI), especially among the severely food insecure compared to the other categories.

7.5.2. Recommendations

In addition to inclusive peace dialogue to prevent future conflicts, it is recommended for reconstruction and rehabilitation efforts to enhance the functionality of markets and social services that play a key role in household food security. Rebuilding livelihoods is essential: livestock restocking, small business revival, and support for off-farm activities can help households recover and diversify income.

Food security interventions must consider all food system components such as production, processing, retail and marketing, distribution, and consumption, and recognize conflicts' distinct characteristics. Humanitarian responses should be timely and coordinated, involving local community leaders and leveraging international influence, to ensure fighting groups adhere to humanitarian principles and adapt to dynamic conflict conditions. Additionally, the link between market access and food security deserves further study for future programming.

CHAPTER 8: CONCLUSION AND RECOMMENDATIONS

In Chapter Eight, conclusive remarks derived from various aspects of this research are presented. It highlights the key findings on food security and resilience assessments for households affected by multiple disasters, specifically violent conflict and drought. This chapter provides essential recommendations for policymakers and the academic community. Given the complexity and depth of the research, these conclusive remarks and recommendations offer valuable insights for policy formulation and further academic investigations.

8.1. Synthesis of the Dissertation

This dissertation examines the impacts of drought and conflict on household food security and resilience in the South Wollo zone, Amhara region, Ethiopia. Grounded in a mixed-methods approach, the study examines the patterns and intensification of drought in conjunction with the recent conflict in Northern Ethiopia to understand how these intertwined shocks have impacted food security and resilience outcomes.

The research reveals that the South Wollo zone has faced recurrent drought episodes with high frequency and increasing severity over recent decades. The reliance on rain-fed agriculture and the limited adoption of irrigation by households in the study area have exacerbated the situation. The northern Ethiopia conflict further disrupted agricultural production and market access, affecting the functioning of social institutions and leading to worsening food availability, access, utilization, and stability. These combined shocks have eroded household resilience, with only a minority remaining food-secure in the aftermath of the conflict.

The research identified key determinants of food security, including livestock ownership, agricultural engagement, and household demographics. Larger family sizes, exposure to shocks, and reliance on humanitarian aid were associated with poorer outcomes. Humanitarian aid programs were constrained by security challenges that limited access due to resource looting and blockages. The delay in timeliness and insufficient coverage of food

distributions limited the effectiveness of aid in strengthening household resilience to food insecurity. Households employ a combination of multiple coping and adaptation strategies, ranging from adjustments in consumption to the sale of assets. Although many of these measures are short-term and undermine long-term stability, social networks and community-based institutions remain crucial for effective crisis management.

The study underscores the need for coordinated, context-sensitive interventions that prioritize asset-building, livelihood diversification, and restoration of basic infrastructure. In addition, humanitarian responses must be timely, neutral, and integrated with long-term development and peacebuilding efforts to effectively address food insecurity in fragile settings.

Moreover, the study contributes methodologically by validating the use of retrospective recall data through robust statistical tests by deploying the Flashbulb memory test and Common Method Bias (CMB) to validate the reliability of retrospective data for statistical inference; the study addresses a key challenge in conflict-affected research environments. The research forwards some relevant policy insights and program options into the complex interplay of drought and conflict on household food security. These options enhance household resilience to food insecurity and support sustainable recovery in conflict-affected and drought-prone areas.

8.2. Theoretical and Methodological Perspective

Food security and resilience were analyzed from the perspectives of sustainable food systems, sustainable livelihoods, and disaster risk reduction in the study. Shocks and stresses related to drought and armed conflict interact with socioeconomic, demographic, political, and cultural drivers, as well as inherent or existing vulnerabilities within communities. Drought and conflict can affect communities and individuals at varying intensities, depending on pre-existing conditions prior to disaster exposure, even though they have a more generalized impact on lives and livelihoods.

Drought and conflict impact the food system, compromising the pillars of food security, including availability, accessibility, utilization, and stability. Drought primarily affects the production side of the food system, and in severe and prolonged scenarios, it continues to impact the entire food system. However, conflict has a drastic, often acute impact on production, storage, distribution, processing, packaging, retail, marketing, and consumption.

The impact of drought and conflict on the food system is dependent on the adaptive capacity of individuals, households, and communities. The ability of livelihood assets to respond to shocks and stresses is a critical component in assessing the impact of drought and conflict on food security and resilience. When households have strong asset bases that can be converted into economic value, they will be able to withstand the short-term consequences of drought and conflict. Depending on the types of assets used to mitigate the impact of such a crisis, long-term adaptive capacity and resilience could be compromised, and it would affect future recovery efforts.

The ability of structures and processes that comprise local institutions, government services, market systems, the rule of law, the private sector, and humanitarian actors to deliver services, facilitate access to services in affected areas, manage cultural norms and policies, allocate resources, and maintain infrastructure is constrained during crises. Particularly, drought and conflict compromise the ability of these institutional structures and processes. Hence, food security and resilience outcomes are at stake, which leads to insufficient support mechanisms in the context of drought and conflict.

At times when the food systems such as production, storage and distribution, processing and packaging, retail and marketing, and consumption are affected either individually or in a more generalized exposure to drought and conflict impacts, the ultimate consequence on food security and resilience outcomes is different depending on the availability of assets, feasibility of different livelihood strategies, and the ability of systems and process to function at times of crisis coupled with the enabling environment that share the interaction of these systems. Drought and conflict result in the loss of livelihoods, as well as assets

such as human, physical, natural, financial, and social capital. In the event of conflict, migration as a livelihood strategy was compromised due to restricted mobility and fear of persecution. All basic services crucial for food security and resilience, such as healthcare, education, justice, market systems, transportation, local institutions, water systems, veterinary services, and research institutions, were critically affected, leading to compromised food security and resilience at the household level.

When households are exposed to low-intensity crises, if local structures and processes continue to function, coupled with feasible livelihood strategy options and a stronger asset base, households tend to bounce back even stronger, and their adaptive capacity is enhanced, which leads to better food security outcomes or at least less impact on household food security. Whereas, when households are exposed to high-intensity crises, such as drought and conflict, and their asset base is not strong, livelihood strategies are compromised. Local structures and processes are not functioning to the expected level, households and individuals tend to adopt dangerous coping strategies that compromise resilience and lead to malnutrition and overall poor food security outcomes.

In this research, based on the theoretical foundation of the study, several statistical approaches and measurement models were used to analyze the impact of drought and conflict on household resilience to food insecurity. Longitudinal precipitation and temperature data, covering the period 1981–2022, were utilized to characterize drought conditions using the SPEI index at different timescales. The longitudinal drought analysis was complemented with a food security assessment to identify the implications of drought on household food security in the South Wollo zone.

The food security analysis utilized the Household Food Balance Model during the pre- and post-conflict periods, assessing per capita calorie availability. While HFBM assesses the availability pillar of food security, the HFIAS model was deployed to characterize the food security situation from an accessibility perspective. The Coping Strategy Index was used to identify the various coping strategies and pathways that households employ during periods of crisis, resulting in food shortages and accessibility constraints.

The resilience component of the research was founded on a resilience index measurement and analysis model that integrates livelihood assets, access to basic services, adaptive capacity, and social safety nets as foundational pillars of resilience. The RIMA approach was utilized to examine the stability pillar of food security, as it encompasses critical socioeconomic functions of the study population. It was also assessed in terms of the pre-post references, providing a comparison of short-term and long-term resilience capacities and food security outcomes.

The study used multiple linear regression and logistic regression integrated with the Difference-in-Difference statistical model to identify determinants of food security, factors determining food security loss linked with household resilience capacity, and provide the individual and combined impact of drought and conflict on household food security and resilience by controlling for confounding variables aligned with a quasi-experimental design.

Finally, as the research utilized retrospective data to establish the pre-conflict scenario, a novel statistical model was integrated to assess the presence of recall bias in the retrospective food security and resilience study. The Flashbulb memory test method was utilized as a complementary study within the food security and resilience study by integrating a well-known event that occurred in the past, specifically the pre-conflict period. The event that was used for the study was the official announcement of the death of the late Prime Minister of Ethiopia, Mr. Meles Zenawi. A questionnaire related to this event was integrated into the study, and respondents were asked to recall the month and year of the announcement. Then, a recall error variable was identified as the outcome variable, and a regression analysis was conducted to determine if conflict exposure and socioeconomic characteristics affected the recall ability of respondents. Including such statistical methods helps identify the presence of recall bias and confirms the reliability of retrospective data for statistical inference.

8.3. Conclusion

The South Wollo zone has already been exposed to recurrent climatic shocks, such as drought and landslides, and has faced compounded devastation due to the conflict in northern Ethiopia. The conflict disrupted every layer of the food system, from production to consumption, endangering all four pillars of food security: availability, accessibility, utilization, and stability. Basic services, social institutions, and market mechanisms were negatively affected, deepening vulnerability and inequality. This led to a significant share of households experiencing food insecurity, with only a small proportion of households in the study area classified as food secure. The conflict affected households across the board, regardless of the sex, age, or educational level of the household head. However, families with more diverse ways of earning a living from off-farm work were better able to maintain their food security.

The damage also results in a breakdown of the community's social assets, such as trust, cooperation, and interaction. This has deteriorated the social dynamics that communities in Ethiopia used to live together peacefully. Given the conflict and drought-related disasters Ethiopia is facing, the government's capacity was too limited to provide sufficient support. Moreover, the limited recognition and attention paid by aid agencies and the international community to the conflict crisis contributed to its severity.

This study investigated the impact of conflict and drought on household food security and resilience capacity using a mixed-methods approach, including descriptive and quasi-experimental designs, particularly a difference-in-differences (DiD) approach, complemented by longitudinal drought analysis and various regression methods to identify key socioeconomic and demographic determinants of household food security and resilience. It also assesses the different consumption-related coping strategies that households employ to manage food shortages during crisis periods. The results reveal that both conflict and drought significantly reduced household food security, as measured by per capita calorie availability. The combined exposure to both shocks in the post-conflict period had the most severe impact, suggesting a compounding and mutually reinforcing relationship between these crises.

Livestock ownership is expressed in terms of total livestock units (TLU), and the agricultural index is expressed in terms of participation in agricultural activities, with a focus on improved agronomic practices, work ratio, and the age of the household head, which positively influences household food security. In contrast, larger family size, disaster exposure, and aid were negatively associated with food security. The negative relationship between aid and food security suggests that while aid targets vulnerable populations, its structure and delivery may not be sufficient to improve resilience or ensure long-term food access. Besides, during the conflict, humanitarian aid, including the productive safety net program, was interrupted, untimely, and insufficient, which could have reduced the effectiveness of aid for the particular context of the study.

The study highlights the important interaction between household assets, demographic characteristics, and exposure to shocks in determining per capita calorie availability in conflict-affected settings. Households with stronger asset bases managed better, while those exposed to large-scale shocks like conflict and drought experienced heightened vulnerability.

The SPEI-based drought analysis in the South Wollo Zone, which takes longitudinal precipitation and temperature data from 1981 to 2022, reveals a region prone to periodic droughts, with some of the most severe events occurring more frequently in recent years. With short-term SPEI, drought frequencies have increased since 2000, while the long-term SPEI shows a persistent increase in drought conditions, particularly from 2010 onwards throughout the data reference period.

Households in South Wollo are highly vulnerable to drought due to climatic and socioeconomic factors. The zone's dependency on rain-fed agriculture makes it particularly susceptible to fluctuations in rainfall, which is often exacerbated by rising temperatures. Many respondents reported that their crops failed during drought years, forcing them to rely on purchasing food from markets where inflated prices exacerbated their existing vulnerability. These droughts created a cycle of vulnerability, as households were forced to

sell off their livestock and other assets to purchase food. These coping mechanisms limited the households' ability to withstand future shocks.

In South Wollo, households often could not meet their nutritional needs years after the drought. An unprecedented proportion of households failed to meet the daily energy requirement before the northern Ethiopia conflict. The situation was even worse during and after the conflict, as it added additional strain to households' ability to meet household food requirements due to challenges affecting agricultural production, inability to engage in meaningful livelihood activities, interruptions in basic services, and mobility restrictions that further limited coping mechanisms.

In terms of adaptation, households in South Wollo have developed various strategies to cope with recurring droughts; however, these strategies are often short-term and unsustainable. Key informants indicated that many households rely heavily on food aid provided by the PSNP, which helps mitigate the immediate impacts of food insecurity. However, the PSNP often faces delays and insufficient coverage, so many households still lack sufficient food during droughts. Households opt for various consumption-related coping strategies, including dietary changes, reducing the number of people, short-term increases in food availability, and rationing, in addition to other strategies such as the sale of livestock, which are also common. As livestock is a critical asset in rural Ethiopia, the sale of animals is often a last resort to meet immediate food needs during droughts. However, as households deplete their assets, they become even more vulnerable in the long term, as livestock serves as a form of savings and a source of income during non-drought periods.

The ordered logistic regression identified several factors influencing food security: land size, livestock holdings, ecological variability, market access, wealth index, and support systems. Family support and humanitarian aid were not strongly linked to improved food security due to widespread need, delayed assistance, and disrupted social networks. The positive association between greater distance to livestock markets and food security, attributed to better-developed, higher-priced distant markets, requires further investigation.

8.4. Recommendations

Addressing food insecurity caused by conflict is a matter of fundamental human rights. Given the adversities that the Amhara region faced from 2020 to 2022 and the complex impact of armed conflict on livelihoods, food security, and the social dynamics of the affected communities, both short- and long-term responses are required.

Government and humanitarian organizations should recognize the enormous consequences of the armed conflict in the Amhara region and participate in providing life-saving and recovery measures. While it is important to meet basic needs, investments in long-term adaptation and resilience measures to strengthen systems and build resilience are recommended. Humanitarian assistance should be based on a thorough understanding of the damage and the specific needs of the affected communities. Small farmers should be supported to restore their productivity in agricultural activities. It is also important to restore basic infrastructure through post-war reconstruction efforts.

The government should take the lead in coordinating recovery and rehabilitation initiatives by mobilizing non-governmental organizations, the donor community, and community-based institutions to play a crucial role in building community resilience and supporting post-conflict reconstruction efforts as a matter of priority.

Policies should recognize the key role that assets play in household resilience, and investments should be made to increase households' asset bases. In the context of violent conflict, the contribution of livestock ownership and agricultural assets plays a significant role in maintaining household resilience, and policy, development, and humanitarian programming should focus on building these components. Investments in asset-building programs, particularly in productive assets, will help households cope with calamities and quickly return to normalcy after a drought and conflict crisis.

Strengthening livelihood diversification through participation in off-farm activities and the growth of various crops should be prioritized as a pathway to increase household resilience. This increases the ability of households to diversify risks and provides opportunities for

them to ensure that their basic needs, including food, are met during periods of conflict and drought. Due to the unique nature of violent conflict, which disrupts the agricultural sector through the destruction of crops, loss of livestock, and displacement, diversification of livelihoods in the off-farm sector can help distribute risk and expand the income-generating potential for conflict-affected communities. Particularly when off-farm livelihoods include marketable skills, displaced communities can have the opportunity to establish their lives by providing labor or skill services in exchange for money.

The susceptibility of the agricultural sector to drought could be mitigated by supporting household income through livelihood diversification. Livelihood diversification reduces heavy dependence on single income sources in the agricultural sector, which are vulnerable to drought. Diversifying livelihoods can bring sustainable and lasting results when considering the diverse needs of different sexes and ages to develop women- and youth-friendly activities that align with individual aspirations, technical and economic capabilities, and other societal factors, thereby enhancing productivity, food security, and resilience. These livelihood options can be considered mostly non-farm activities that help mitigate the severe impacts of climate change in the agricultural sector and provide marketable skills that can be adapted during times of displacement, when productive agricultural resources are unavailable.

In addition to inclusive peace dialogue to prevent future conflicts through the grassroots participation of all actors with different political standpoints, including civic society organizations, reconstruction and rehabilitation efforts are recommended to enhance the functionality of markets and social services, which play a crucial role in household food security. Rebuilding livelihoods is essential: livestock restocking, small business revival, and support for off-farm activities can help households recover and diversify income.

Food security interventions must consider all components of the food system and recognize the unique characteristics of conflict. Humanitarian responses should be timely and coordinated, involving local community leaders and leveraging international influence to ensure that fighting groups adhere to humanitarian principles, negotiate to address root

causes, and prevent current and future conflicts. This approach also facilitates efficient and uninterrupted access to humanitarian aid that is adapted to dynamic conflict conditions. The resilience of many households depends heavily on such assistance. It is essential that the government, local authorities, military groups, humanitarian organizations, and the United Nations collaborate to negotiate access in line with humanitarian principles.

While aid must be provided purely from a humanitarian perspective, non-governmental organizations should uphold these principles, particularly neutrality and independence, and avoid politicizing aid. They must ensure the equitable and ethical distribution of assistance and prevent potential aid diversion, which could pose a primary threat to uninterrupted access. Ultimately, the continuous delivery of humanitarian aid must be integrated into a broader strategy that connects relief with long-term development and peacebuilding efforts.

Access to affordable credit and loan services is crucial for supporting recovery and reconstruction efforts in post-conflict periods. Affordable loan and credit services include reasonable interest rates, more lenient collateral requirements, the integration of financial literacy, and extended repayment periods. This could help households build productive assets, establish off-farm businesses to diversify their livelihoods, and enhance other essential services, such as education, healthcare, and water, among others, that are crucial for building resilience and ensuring household food security. In addition, creating public awareness to address grievances and alleviate public distress caused by conflicts between conflict-affected communities and financial service institutions, due to these institutions' inability to provide the required services during the conflict, is necessary. This should be implemented as a priority during the post-conflict recovery period by mobilizing financial service providers, such as banks, microfinance institutions, and rural associations, for a joint effort to address the gap.

A food systems perspective is necessary in food security and resilience programming, with due attention to the four pillars of food security: availability, accessibility, utilization, and stability. Therefore, integrating a resilience perspective into food security programming is crucial to ensure the long-term functionality of these systems. Investments in improving

one will result in positive outcomes for the other. Food security programming should aim to build resilience instead of focusing solely on short-term food security outcomes.

To build household resilience, it is crucial to enhance individual and community-level coping mechanisms. Policymakers and development actors should invest in transforming short-term, erosive strategies into adaptive practices that build resilience over time. This includes expanding access to livelihood assets, supporting livelihood diversification, and reinforcing traditional support systems, such as *Equb* and *Edir*, which are vital in mobilizing community resources. Furthermore, recovery and resilience programs should integrate responses to conflict and drought, acknowledging the compounding nature of these shocks. Targeted support to livestock and agricultural sectors will improve household food access and stability.

In the context of conflict, making comparisons before, during, and after the conflict is crucial for developing effective policies that address the needs of conflict-affected communities. The challenges of access and safety concerns make data collection during conflict periods very difficult. As a result, recalling information was the most appropriate option, but it suffers from limitations related to recall bias, which compromises the reliability of statistical inference linked to retrospective data. Considering that the research was based on retrospective data collection for the pre-conflict reference period, recall bias was a potential problem that required thorough investigation. The reliability of data collected based on recall is questionable, as memory decay and the impact of conflict can affect respondents' ability to accurately recall past events. This could potentially affect the reliability of recall data for statistical inference. This study integrates the Flashbulb Memory and Common Method Bias methods to statistically verify the reliability of recall data by including a complementary questionnaire on food security and resilience in the survey. This complementary study offers a scientific approach to addressing recall bias in retrospective food security and resilience studies, thereby enhancing confidence in the reliability of retrospective data for statistical inference. Therefore, this study provides guidance on how to check for recall bias using statistical methods, and it is recommended

that similar methods be applied in future studies, thereby increasing confidence in the statistical reliability of retrospective data.

Future research should investigate the long-term effects of various coping strategies, distinguishing between those that are adaptive and those that may further exacerbate existing vulnerabilities. A further exploration into the structure, delivery mechanisms, and outcomes of aid programs, particularly in the context of violent conflict, will provide valuable insights for designing more effective food security interventions in complex emergencies. Additionally, distance to market and food security outcomes require further investigation.

This study contributes to the growing body of evidence on the intersection of conflict, drought, and household food security and resilience, particularly in a fragile context. By combining a difference-in-differences (DiD) impact evaluation with a determinants-based regression framework, it provides an excellent understanding of both the causal impacts of shocks and the underlying household-level factors shaping food security outcomes. Moreover, the inclusion of coping strategies offers important insights into the behavioral and social responses to compound crises, which is an area often overlooked in quantitative food security research. The findings enrich the scientific dialogue on resilience and vulnerability by emphasizing the compounded effects of conflict and drought, the limitations of current aid modalities, and the critical role of local institutions. These insights are intended to inform not only academic discourse but also the design of more responsive and context-sensitive policies and programs in humanitarian and development settings. This research also provides an understanding of the Flashbulb memory test method for utilizing retrospective data in a post-conflict food security study, highlighting key steps in addressing recall bias to determine the reliability of retrospective data for statistical inference.

REFERENCES

Abate, D., Tesfaye, H., Kassaw, M., Addis, Y., & Mossie, H. (2023). Impact of adopting the climate-smart crop varieties on food security in southwestern Ethiopia. *African Journal of Science, Technology, Innovation and Development*, *15*(5), 590-598.

Abramowitz, M., & Stegun, I. A. (1965). With formulas, graphs, and mathematical tables. *National Bureau of Standards Applied Mathematics Series. e*, *55*, 953.

Acosta, A., Nicolli, F., & Tirkaso, W. (2024). Cattle ownership and households' welfare: Evidence from Southern Africa. *Global Food Security*, *42, 100772.*

ACSS. (2024). *Famine Takes Grip in Africa's Prolonged Conflict Zones*. https://africacenter.org/spotlight/famine-takes-grip-in-africas-prolonged-conflict-zones/

Adamu M.K. (2020). Determinants of agricultural output in Ethiopia: ARDL approach to co-integration. Int J Bus Soc Res 10:1–10

Adesete, A. A., Olanubi, O. E., & Dauda, R. O. (2023). Climate change and food security in selected Sub-Saharan African Countries. *Environment, Development and Sustainability*, *25*(12), 14623-14641.

Adesogan, A. T., Havelaar, A. H., McKune, S. L., Eilittä, M., & Dahl, G. E. (2020). Animal source foods: sustainability problem or malnutrition and sustainability solution? Perspective matters. *Global Food Security*, *25, 100325.*

Ado AM, Savadogo P, & Abdoul-Azize HT (2022) Livelihood strategies and household resilience to food insecurity: insight from a farming community in Aguie district of Niger. In: Rethinking food system transformation. Springer, Cham, pp 97–111

Africa Centre for Strategic Studies. (2023). Unresolved conflicts continue to Drive Africa's Food Crisis Africa Centre for Strategic Studies.

Agidew, A. M. A., & Singh, K. N. (2018). Determinants of food insecurity in the rural farm households in South Wollo Zone of Ethiopia: the case of the Teleyayen sub-watershed. *Agricultural and food economics*, *6*(1), 1-23.

Agwu G.A. (2023). The Boko Haram conflict and food insecurity: does resilience capacity matter? J Afr Econ 32:352–382. https://doi.org/10.1093/jae/ejac015

Ahmed, M., Asim, M., Ahmad, S., & Aslam, M. (2023). Climate change, agricultural productivity, and food security. In *Global agricultural production: Resilience to climate change* (pp. 31-72). Cham: Springer International Publishing.

Akbar, A., Darma, R., Fahmid, I. M., & Irawan, A. (2023). Determinants of household food security during the COVID-19 pandemic in Indonesia. *Sustainability*, *15(5), 4131*.

Aklilu Amsalu & Alebachew Adem. (2009). Assessment of climate change-induced hazards impacts and responses in the southern lowlands of Ethiopia. FSS research report no. 4. Forum for Social Studies (FSS) and Cordaid.

Akpa, A. F. (2024). The effects of climate extreme events on selected food crop yields in Sub-Saharan Africa. *Heliyon*, *10*(9).

Akukwe, T. I. (2020). Household food security and its determinants in agrarian communities of southeastern Nigeria. *Agro-Science*, *19(1), 54-60*.

Allen, F., & Okeke-Uzodike, U. (2010). Oil, Politics and Conflict in the Niger Delta: A Nonkilling Analysis. *Africa Peace and Conflict Journal*, *3*(2), 32-42.

Alozieuwa, S. H. (2010). Beyond the ethno-religious theory of the Jos conflict. *Africa Peace and Conflict Journal*, *3*(2), 18-31.

Amrender, K., Singh, K. N., Chattopadhyay, C., Vennila, S., & Rao, V. U. M. (2015). Non-parametric analysis of long-term rainfall and temperature trends in India. *Journal of the Indian Society of Agricultural Statistics*, *69*(2), 135-147.

Amungwa, F. A. (2011). The evolution of conflicts related to natural resource management in Cameroon. *Journal of Human Ecology*, *35*(1), 53-60.

Anbes Tenaye. (2020). Technical efficiency of smallholder agriculture in developing countries: The case of Ethiopia. *Economies*, *8*(2), 34.

Angearu, C. V., Ontel, I., Boldeanu, G., Mihailescu, D., Nertan, A., Craciunescu, V., ... & Irimescu, A. (2020). Multi-temporal analysis and trends of the drought based on MODIS data in agricultural areas, Romania. *Remote Sensing*, *12*(23), 3940.

Arage, M. W., Kumsa, H., Asfaw, M. S., Kassaw, A. T., Dagnew, E. M., Tunta, A., ... & Tenaw, L. A. (2023). Exploring the health consequences of armed conflict: the perspective of Northeast Ethiopia, 2022: a qualitative study. *BMC public health*, *23*(1), 2078.

Aragie, T., & Genanu, S. (2017). Level and determinants of food security in north wollo zone (Amhara region–Ethiopia). Journal of Food Security, 5(6), 232-247.

Arega Bazezew. (2015). Coping strategies and household food security in drought-prone areas in Ethiopia: the case of lay Gayint District. *Ghana Journal of Development Studies*, *12*(1-2), 1-18.

Asong, Z. E., Wheater, H. S., Bonsal, B., Razavi, S., & Kurkute, S. (2018). Historical drought patterns over Canada and their teleconnections with large-scale climate signals. *Hydrology and Earth System Sciences*, *22*(6), 3105-3124.

Awoke, W., Eniyew, K., Agitew, G., & Meseret, B. (2022). Determinants of food security status of household in Central and North Gondar Zone, Ethiopia. *Cogent Social Sciences*, *8*(1), 2040138.

Bahadur A., & Pichon F. (2016). Analysis of resilience measurement frameworks and approaches. Working paper. Overseas Development Institute, London

Barnett, J., & Adger, W. N. (2007). Climate change, human security and violent conflict. *Political geography*, *26*(6), 639-655.

Bartlett, J.E., Kotrlik, J. & Higgins, C. (2001). Organizational Research: Determining Appropriate Sample Size in Survey Research. *Information technology, learning, and performance journal, 19(1), 43*.

Bedasa, Y., & Bedemo, A. (2023). The effect of climate change on food insecurity in the Horn of Africa. *GeoJournal*, *88*(2), 1829-1839.

Bedasa, Y., & Deksisa, K. (2024). Food insecurity in East Africa: An integrated strategy to address climate change impact and violence conflict. *Journal of Agriculture and Food Research*, *15*, 100978.

Belew, A. K., Awoke, T., Gelaye, K. A., Atnafu, A., Guadu, T., Azale, T., ... & Molla, A. (2023). Determinants of Malnutrition and its associated factors among pregnant and lactating women under armed conflict areas in North Gondar Zone, Northwest Ethiopia: a community-based study. *BMC nutrition*, *9*(1), 102.

Béné, C., Prager, S. D., Achicanoy, H. A., Toro, P. A., Lamotte, L., Cedrez, C. B., & Mapes, B. R. (2019). Understanding food systems drivers: A critical review of the literature. *Global Food Security*, *23*, 149-159.

Bere, M. (2011). Managing Intra-State Conflicts: Promises and Failures of Peace Agreements in Cote d‟ Ivore. *African Peace and Conflict Journal*, *4*(2), 17-28.

Bereket Tesfaye, Kassahun Ture, Tadesse Terefe, Desalegn Yayeh, Gudina Legese, & Fikiru Abiko. (2022). Drought analysis using standardized evapotranspiration and aridity index at Bilate watershed: sub-basins of Ethiopian Rift Valley. *The Scientific World Journal*, *2022*. https://doi.org/10.1155/2022/1181198

Berhane, G., Gilligan, D. O., Hoddinott, J., Kumar, N., & Taffesse, A. S. (2014). Can social protection work in Africa? The impact of Ethiopia's productive safety net programme. *Economic Development and Cultural Change*, *63*(1), 1-26.

Berhanu Nega & Samuel Gebreselassie. (2002). Land tenure and agricultural development in Ethiopia. In *Research Report, Ethiopian Economic Association/Ethiopian Economic Policy Research Institute*.

Berhanu Nega, Berhanu Adenew & Samuel Gebreselassie. (2003). Current land policy issues in Ethiopia. Affiliation: Ethiopian Economic Policy Research Institute, Addis Ababa, Ethiopia, *Journal of Land Reform, Land Settlement and Cooperatives*, 2003, No.3, 103-124 ref. 41.

Berhanu, M., & Wolde, A. O. (2019). Review on climate change impacts and its adaptation strategies on food security in Sub-Saharan Africa. *Agricultural Socio-Economics Journal*, *19*(3), 145-154.

Berti, A., Tardivo, G., Chiaudani, A., Rech, F., & Borin, M. (2014). Assessing reference evapotranspiration by the Hargreaves method in north-eastern Italy. *Agricultural Water Management*, *140*, 20-25.

Beshir, H. (2018). The impact of irrigation on poverty reduction and food security at the household level in South Wollo, Ethiopia. Eastern Africa Social Science Research Review, 34(1), 65-107.

Bethelhem Mezgebe, Taye Gari, Mehretu Belayneh, & Bernt Lindtjørn. (2024). Seasonal variations in household food security and consumption affect women's nutritional status in rural South Ethiopia. *PLOS Global Public Health*, *4*(8), e0003294.

Beyene F. & Senapathy M. (2023). Household resilience to food insecurity in Southern Ethiopia: monograph. Primedia eLaunch LLC, Dallas

Beyene F., Senapathy M., Bojago E. & Tadiwos T. (2023). Rural household resilience to food insecurity and its determinants: Damot Pulasa district, Southern Ethiopia. J Agric Food Res 11:100500. https://doi.org/10.1016/j.jafr.2023.100500

Bhandari, A., & Wagner, T. (2006). Self-reported utilization of health care services: improving measurement and accuracy. *Medical Care Research and Review*, *63*(2), 217-235.

Birara E, Mequanent M, & Tadesse S. (2015). Assessment of food security situation in Ethiopia: a review. Asian J Agric Res 9:55–68. https://doi.org/10.3923/ajar.2015.55.68

Birkmann, J., Jamshed, A., McMillan, J. M., Feldmeyer, D., Totin, E., Solecki, W., ... & Garschagen, M. (2022). *Poverty, Livelihoods and Sustainable Development*. In H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, ... & B. Rama (Eds.), Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 1171–1274). Cambridge University Press.

Blattman, C., & Miguel, E. (2010). Civil war. *Journal of Economic literature*, *48*(1), 3-57.

BoA. (2013). South Wollo Zone annual plan July 2023 – June 2024, unpublished copy from Bureau of Agriculture, South Wollo zone, October 2023, Dessie, Ethiopia

Bogale A, & Shimelis A. (2009). Household level determinants of food insecurity in rural areas of Dire Dawa, Eastern Ethiopia. Afr J Food Agric Nutr Dev 9:1914–1926. https://doi.org/10.18697/ajfand.30.3740

Bolarinwa, O. A. (2020). Sample size estimation for health and social science researchers: The principles and considerations for different study designs. *Nigerian Postgraduate Medical Journal*, *27(2)*, 67–75.

Brown, R., & Kulik, J. (1977). Flashbulb memories. *Cognition*, *5*(1), 73-99.

Brück T, D'Errico M, & Pietrelli R. (2019). The effects of violent conflict on household resilience and food security: evidence from the 2014 Gaza conflict. World Dev 119:203–223. https://doi.org/10.1016/j.worlddev.2018.05.008

Brück, T., Justino, P., Verwimp, P., Avdeenko, A., & Tedesco, A. (2016). Measuring violent conflict in micro-level surveys: current practices and methodological challenges. *The World Bank Research Observer*, *31*(1), 29-58.

Brusco, N. K., & Watts, J. J. (2015). Empirical evidence of recall bias for primary health care visits. *BMC health services research*, *15*, 1-8.

Buehn A, & Schneider F. (2008). MIMIC models, cointegration and error correction: an application to the French shadow economy. Working paper. No. 2200. CESifo working paper

Bundervoet, T., Verwimp, P., & Akresh, R. (2009). Health and civil war in rural Burundi. *Journal of human Resources*, *44*(2), 536-563.

Calloway, E. E., Carpenter, L. R., Gargano, T., Sharp, J. L., & Yaroch, A. L. (2023). New measures to assess the "Other" three pillars of food security–availability, utilization, and stability. *International Journal of Behavioral Nutrition and Physical Activity*, *20*(1), 51.

Cerdà-Bautista J, Tárraga JM, Sitokonstantinou V, & Camps-Valls G. (2023). Evaluating the impact of humanitarian aid on food security. arXiv preprint arXiv:231011287

Chambers, R., & Conway, G. (1992). *Sustainable rural livelihoods: practical concepts for the 21st century*. Institute of Development Studies (UK).

Christakis, T. (2013). The Emperor Has No Clothes? The Secondary Role of African Regional Organizations in Recent Armed Conflicts in Africa. In *Proceedings of the ASIL Annual Meeting* (Vol. 107, pp. 327-330). Cambridge University Press.

Clarke, P. M., Fiebig, D. G., & Gerdtham, U. G. (2008). Optimal recall length in survey design. *Journal of health economics*, *27*(5), 1275-1284.

Climate Investment Funds. (2024). Climate Investment Funds board backs $500 mln Ethiopia nature plan. Reuters. Retrieved from https://www.reuters.com/sustainability/sustainable-finance-reporting/climate-investment-funds-board-backs-500-mln-ethiopia-nature-plan-2024-12-04/, accessed on 02 May 2025.

Coates, J., Swindale, A., & Bilinsky, P. (2007). Household Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide (v. 3).

Constas, M., Frankenberger, T., Hoddinott, J., Mock, N., Romano, D., Béné, C., & Maxwell, D. (2014). A proposed common analytical model for resilience measurement: A general causal framework and some methodological options. *Resilience Measurement Technical Working Group. Technical Series*, (2).

D'Errico M, Romano D, & Pietrelli R. (2018). Household resilience to food insecurity: evidence from Tanzania and Uganda. Food Secur 10:1033–1054. https://doi.org/10.1007/s12571-018-0820-5

De Waal, A. (1997). *Famine crimes: Politics & the disaster relief industry in Africa*. Indiana University Press.

Debebe C. (2018). A review of factors affecting food security situation of Ethiopia: from the perspectives of FAD, economic and political economy theories. Int J Agric Innov Res 6:2319–2473

Debela, B. L., Shively, G. E., & Holden, S. T. (2021). Implications of food-for-work programs for consumption and production diversity: Evidence from the Tigray Region of Ethiopia. *Agricultural and Food Economics*, *9*, 1-24.

Degefa Tolossa. (1996). Belg Crop Production as a Strategy of Households' Food Security: A Comparative Study of Belg Grower and Non Belg Grower Farmers in Munessa district, Arssi Region. *Unpublished MA Thesis. Dep. Geogr., Addis Ababa University*.

Delgado, C., Tschunkert, K., & Smith, D. (2023). *Food Insecurity in Africa: Drivers and Solutions*. Stockholm International Peace Research Institute. https://www.sipri.org/publications/2023/policy-reports/food-insecurity-africa-drivers-and-solutions

Dereje D, Tilahun T & Yirgu T. (2024). Determinants of household resilience to food insecurity for comparison: the case of Chencha district, Southern Ethiopia. F1000Research 13:693. https://doi.org/10.12688/f1000research.145482.1

Dethier, J. J., & Effenberger, A. (2012). Agriculture and development: A brief review of the literature. *Economic systems*, *36*(2), 175-205.

DfID, U. K. (2011). Defining disaster resilience. *London: Retrieved from [left angle bracket] https://assets. publishing. service. gov. uk/government/uploads/system/uploads/attachment_data/file/186874/defining-*

disaster-resilience-approach-paper. pdf [right angle bracket] (accessed 16 August 2021).

DFID. (2002). Sustainable Livelihoods: Building on Strengths. http://www.livelihoods.org/info/docs/SLBoS.pdf

Dinda S. (2015). A survey on adaptation to climate change. https://mpra.ub.uni-muenchen.de/66259/. Accessed 11 November 2024

Dorward, A., & Kydd, J. (2004). The Malawi 2002 food crisis: the rural development challenge. *The Journal of Modern African Studies*, *42*(3), 343-361.

El Tayeb, S., Abdalla, S., & Linnan, M. (2014). Respondents' recall of injury events: an investigation of recall bias in cross-sectional injury data from the Sudan Household Health Survey 2010. *International Journal of Injury Control and Safety Promotion*, 21(3), 213–222. https://doi.org/10.1080/17457300.2013.833943

Endiris, A., Brehanie, Z., & Ayalew, Z. (2021). The impact of off-farm activities on rural households' food security status in Western Ethiopia: The case of Dibatie district. *Cogent Food & Agriculture*, *7(1), 1879425*.

ESS. (2007). National Population Statistics. Federal Democratic Republic of Ethiopia, Central Statistical Authority, Addis Ababa.

ESS. (2012). Map of the study area South Wollo, North Wollo and North Shewa zones of Amhara region, Ethiopia. https://www.statsethiopia.gov.et/

ESS. (2021). Population Size by Sex, Region, Zone and Wereda: July 2021. ESS: Addis Ababa, Ethiopia. 2021.

ESS. (2024). Ethiopia Demographic Health Survey Report-2014: Population Size by Sex, Area and Density by Region, Zone and Wereda.

Famine Early Warning Systems Network. (2021). Ethiopia food security outlook update. https://reliefweb.int/report/ethiopia/ethiopia-food-security-outlook-june-2021-january-2022. Accessed on 19 April 2025.

Fang, X., Kothari, S., McLoughlin, C., and Yenice, M. (2020). The economic consequences of conflict in Sub-Saharan Africa. IMF Working Paper, WP/20/221.

FAO & WFP. (2018). Monitoring food security in countries with conflict situations: A joint FAO/WFP update for the United Nations Security Council. *New York: Food and Agriculture Organization of the United Nations, World Food Programme*.

FAO, IFAD, UNICEF, WFP, & WHO. (2024). *The State of Food Security and Nutrition in the World 2024 – Financing to end hunger, food insecurity and malnutrition in all its forms*.

FAO. (1996). Rome declaration on world food security and world food summit plan of action: world food summit 13-–17 November 1996, Rome, Italy. Food and Agriculture Organization, Rome

FAO. (2002). Food security: concepts and measurement. https://www.fao.org/4/y4671e/y4671e06.htm

FAO. (2003). Ethiopia: Humanitarian Response Plan. Rome.

FAO. (2016). RIMA-II: resilience index measurement and analysis—II. Food and Agriculture Organization, Rome

FAO. (2021). GIEWS Update - The Federal Democratic Republic of Ethiopia, 11 November 2021 Dire food insecurity situation in northern areas due to conflict. FAO.

FAO. (2021). Northern Ethiopia: Tigray, Afar, Amhara. Urgent call for assistance. Food and Agriculture Organization, Rome

FAO. (2023). Resilience strategies for food security in conflict-affected areas. https://www.fao.org/resilience. Accessed 15 April 2025

FAO. (2023). The impact of conflict on food security in Ethiopia: an assessment of the South Wollo zone. Food and Agriculture Organization, Rome

FEWS NET. (2021). Ethiopia Food Security Outlook Update.

Fiedler, C., & Rohles, C. (2021). *Social cohesion after armed conflict: A literature review* (No. 7/2021). Discussion Paper.

Francis, A. C., & Vincent, E. E. (2021). Peace And Conflict Resolution in Africa: A Study of Selected Countries. *African Journal of Politics and Administrative Studies (AJPAS) Volume*, *14*(1), 115 - 127.

Fyles, H., & Madramootoo, C. (2016). Key drivers of food insecurity. In *Emerging technologies for promoting food security* (pp. 1-19). Woodhead Publishing.

Gatdet, C. (2021). The review on the smallholder farmers' food security and conflict in Ethiopia: https://doi. org/10.52152/spr/2021.122. *Science Progress and Research (SPR)*, *1*(3), 191-196.

Gebre, E., Berhan, G., & Lelago, A. (2017). Application of remote sensing and GIS to characterize agricultural drought conditions in North Wollo Zone, Amhara region, Ethiopia. *J. Nat. Sci. Res*, *7*.

Gebre, G. G., Isoda, H., Rahut, D. B., Amekawa, Y., & Nomura, H. (2021). Gender gaps in market participation among individual and joint decision-making farm households: Evidence from Southern Ethiopia. *The European Journal of Development Research*, *33*, 649-683.

Gebre, T., Abraha, Z., Zenebe, A., & Zeweld, W. (2024). A comprehensive analysis of food insecurity in the drought–prone rural areas of Tigray. *Journal of Health, Population and Nutrition*, *43*(1), 66.

GEOGLAM. (2022). Northern Ethiopia: Conflict and Food Insecurity. Retrieved on 11 December 2024. https://reliefweb.int/report/ethiopia/northern-ethiopia-conflict-and-food-insecurity-updated-september-27th-2022

George, J., & Adelaja, A. (2022). Armed conflicts, forced displacement and food security in host communities. *World Development*, *158*, 105991.

George, J., Adelaja, A., & Weatherspoon, D. (2020). Armed conflicts and food insecurity: evidence from Boko Haram's attacks. *American Journal of Agricultural Economics*, *102*(1), 114-131.

Getaneh, Y., Alemu, A., Ganewo, Z., & Haile, A. (2022). Food security status and determinants in North-Eastern rift valley of Ethiopia. *Journal of Agriculture and Food Research*, *8, 100290*.

Gluhbegovic, R. (2016). *Types of Conflict in Africa: How Do the APRM Reports Address Conflict?* Electoral Institute for Sustainable Democracy in Africa.

GRFC. (2022). *Global report on food crises: Joint analysis for better decisions*.

Group on Earth Observations Global Agricultural Monitoring (2022) Northern Ethiopia: conflict and food insecurity. https://reliefweb.int/report/ethiopia/northern-ethiopia-conflict-and-food-insecurity-updated-september-27th-2022. Accessed 14 December 2024

Guiné, R. D. P. F., Pato, M. L. D. J., Costa, C. A. D., Costa, D. D. V. T. A. D., Silva, P. B. C. D., & Martinho, V. J. P. D. (2021). Food security and sustainability: discussing the four pillars to encompass other dimensions. *Foods*, *10*(11), 2732.

Guyu D.F., & Muluneh W.T., (2015). Wild foods (plants and animals) in the green famine belt of Ethiopia: do they contribute to household resilience to seasonal food insecurity? For Ecosyst 2:1–12. https://doi.org/10.1186/s40663-015-0058-z

Haile, G. G., Tang, Q., Sun, S., Huang, Z., Zhang, X., & Liu, X. (2019). Droughts in East Africa: Causes, impacts and resilience. *Earth-science reviews*, *193*, 146-161.

Hall, C., Dawson, T. P., Macdiarmid, J. I., Matthews, R. B., & Smith, P. (2017). The impact of population growth and climate change on food security in Africa: looking ahead to 2050. *International Journal of Agricultural Sustainability*, *15*(2), 124-135.

Hargreaves, G. H., & Allen, R. G. (2003). History and evaluation of Hargreaves evapotranspiration equation. *Journal of irrigation and drainage engineering*, *129*(1), 53-63.

Hawkes, C., Parsons, K., & Wells, R. (2019). Brief 2: Understanding the food system: Why it matters for food policy.

Headey, D., & Taffesse, A. S. (2014). Rural wages in Asia. In A. Gulati, R. M. Joshi, & A. Cummings (Eds.), *The Future of Indian Agriculture* (pp. 157–174). Academic Foundation.

Hilemelekot, F., Ayal, D. Y., Ture, K., & Zeleke, T. T. (2021). Climate change and variability adaptation strategies and their implications for household food Security: the case of Basona Worena District, North Shewa zone, Ethiopia. *Climate services*, *24*, 100269.

Hirst, W., & Phelps, E. A. (2016). Flashbulb memories. In *Learning and Memory: A Comprehensive Reference* (2nd ed., pp. 283-298). Elsevier. https://doi.org/10.1016/B978-0-12-809324-5.21045-4

Hjelm, L., Mathiassen, A., & Wadhwa, A. (2016). Measuring poverty for food security analysis: consumption-versus asset-based approaches. *Food and nutrition bulletin*, *37(3)*, 275–289.

HLPE. (2014). Food losses and waste in the context of sustainable food systems. A report by the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. Rome. http://www.fao.org/3/a-i3901e.pdf

HLPE. (2017). Nutrition and food systems. A report by the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.

Holleman, C., Jackson, J., Sánchez, M. V., & Vos, R. (2017). Sowing the seeds of peace for food security. Disentangling the nexus between conflict, food security and peace.

Hurni, H., Berhe, W. A., Chadhokar, P., Daniel, D., Gete, Z., Grunder, M., & Kassaye, G. (2016). Soil and water conservation in Ethiopia: guidelines for development agents.

ICRC. (2021). Emergency Plan of Action (EPoA) Ethiopia: Food Security DREF, August 2021.

IFAD. (2017). *The state of food security and nutrition in the world 2017*.

IFRC & ICRC. (2021). Emergency Plan of Action (EPoA) Ethiopia: Food Security DREF

Integrated Drought Management Programme (IDMP). (n.d.). Standardized Precipitation Evapotranspiration Index (SPEI). Retrieved May 3, 2025, from https://www.droughtmanagement.info/standardized-precipitation-evapotranspiration-index-spei/

International Labour Organization. (2021). Estimating the needs of workers and their families in Ethiopia. International Labour Organization, Geneva

IPCC. (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp., doi:10.1017/9781009325844.

Justino, P. (2006). On the links between violent conflict and chronic poverty: How much do we really know? *Chronic Poverty Research Centre Working Paper*, (61).

Justino, P. (2011). Violent conflict and human capital accumulation. *IDS Working Papers*, *2011*(379), 1-17.

Kafando, W. A., & Sakurai, T. (2024). Armed conflicts and household food insecurity: Effects and mechanisms. *Agricultural Economics*, *55*(2), 313-328.

Kasie, T., Agrandio, A., Adgo, E., & Garcia, I. (2017). *Household resilience to food insecurity: Shock exposure, livelihood strategies and risk response options: The case of Tach-Gayint District, Amhara Region, Ethiopia* (PhD dissertation).

Kebede, T. E. (2024). Impacts of Irrigated Water Use on Household's Income in South Wollo Zone, Amhara region, Ethiopia. *Journal of World Economic Research*, *13*(2), 33-43.

Kendall, K. (1975). Thin-film peeling-the elastic term. *Journal of Physics D: Applied Physics*, *8*(13), 1449.

Kidane, W., Maetz, M., & Dardel, P. (2006). Food security and agricultural development in sub-Saharan Africa. *FAO, Subregional Office for Southern and East Africa, Rom*.

Kogan, F. N. (1995). Droughts of the late 1980s in the United States as derived from NOAA polar-orbiting satellite data. *Bulletin of the American Meteorological Society*, *76*(5), 655-668.

Kogan, F. N. (1997). Global drought watch from space. *Bulletin of the American Meteorological Society*, *78*(4), 621-636.

Kogan, F., Goldberg, M., Schott, T., & Guo, W. (2015). Suomi NPP/VIIRS: improving drought watch, crop loss prediction, and food security. *International Journal of Remote Sensing*, *36*(21), 5373-5383.

Kruk, M. E., Myers, M., Varpilah, S. T., & Dahn, B. T. (2015). What is a resilient health system? Lessons from Ebola. *The Lancet*, *385*(9980), 1910-1912.

Kuwornu, J. K., Osei, E., Osei-Asare, Y. B., & Porgo, M. (2018). Off-farm work and food security status of farming households in Ghana. *Development in practice*, *28(6)*, 724–740.

Lautze, S., & Raven-Roberts, A. (2006). Violence and complex humanitarian emergencies: Implications for livelihoods models. *Disasters*, *30*(4), 383-401.

Le, T. H., Bui, M. T., & Uddin, G. S. (2022). Economic and social impacts of conflict: A cross-country analysis. *Economic Modelling*, *115*, 105980.

Lee, J., Lim, H., Allen, J., & Choi, G. (2021). Multiple mediating effects of conflicts with parents and self-esteem on the relationship between economic status and depression among middle school students since COVID-19. *Frontiers in psychology*, *12*, 712219.

Lemma, Y., Beyene, F., & Hundie, B. (2013). Climate change and variability: implications for household food security in agro-pastoral areas of Jigjiga District, Eastern Ethiopia. *Ethiopian Journal of Economics*, *22*(1), 71-106.

Lindell, M. K., & Whitney, D. J. (2001). Accounting for common method variance in cross-sectional research designs. *Journal of Applied Psychology, 86*(1), 114-121.

Little PD, Stone MP, Mogues T, Castro AP & Negatu W. (2006). Moving in place: drought and poverty dynamics in South Wollo, Ethiopia. J Dev Stud 42:200–225. https://doi.org/10.1080/00220380500405287

Little, P. D. (1992). *The elusive granary: Herder, farmer, and state in northern Kenya* (No. 73). Cambridge University Press.

Little, P. D. (2008). Food aid dependency in northeastern Ethiopia: myth or reality?. *World Development*, *36*(5), 860-874.

Little, P. D., Stone, M. P., Mogues, T., Castro, A. P., & Negatu, W. (2006). 'Moving in place': drought and poverty dynamics in South Wollo, Ethiopia. *The Journal of Development Studies*, *42*(2), 200-225.

MacKenzie, S. B., & Podsakoff, P. M. (2012). Common method bias in marketing: Causes, mechanisms, and procedural remedies. *Journal of Retailing, 88*(4), 542-555.

Mangaliso, M., & Dlamini, T. (2018). Predictors of food insecurity in Eswatini: Lessons from the 2015/16 El Niño induced drought. *African Review of Economics and Finance*, *10*(2), 69-96.

Martin-Shields, C. P., & Stojetz, W. (2019). Food security and conflict: Empirical challenges and future opportunities for research and policy making on food security and conflict. *World development*, *119*, 150–164.

Masih, I., Maskey, S., Mussá, F. E. F., & Trambauer, P. (2014). A review of droughts on the African continent: a geospatial and long-term perspective. *Hydrology and Earth System Sciences*, *18*(9), 3635-3649.

Maxwell D, Vaitla B & Coates J. (2017). How do indicators of household food insecurity measure up? An empirical comparison from Ethiopia. Food Policy 68:28–40

Maxwell, D., Watkins, B., Wheeler, R., & Collins, G. (2003). *The coping strategies index: A tool for rapidly measuring food security and the impact of food aid programs in emergencies* Nairobi: CARE Eastern and Central Africa Regional Management Unit and the World Food Programme Vulnerability Assessment and Mapping Unit.

Maxwell, D., Watkins, B., Wheeler, R., & Collins, G. (2003). The coping strategies index: A tool for rapidly measuring food security and the impact of food aid programs in

emergencies. *Nairobi: CARE Eastern and Central Africa Regional Management Unit and the World Food Programme Vulnerability Assessment and Mapping Unit*.

McKee, T. B., Doesken, N. J., & Kleist, J. (1993). The relationship of drought frequency and duration to time scales. In *Proceedings of the 8th Conference on Applied Climatology* (Vol. 17, No. 22, pp. 179-183).

McLeod S. (2024). Narrative analysis in qualitative research. https://doi.org/10.13140/RG.2.2.30491.07200

Mekonen, A. A., Berlie, A. B., & Ferede, M. B. (2020). Spatial and temporal drought incidence analysis in the northeastern highlands of Ethiopia. *Geoenvironmental Disasters*, *7*, 1-17.

Mekonnen, A., Tessema, A., Ganewo, Z., & Haile, A. (2021). Climate change impacts on household food security and adaptation strategies in southern Ethiopia. *Food and Energy Security*, *10*(1), e266.

Mengistu, S. W., & Kassie, A. W. (2022). Household level determinants of food insecurity in rural Ethiopia. *Journal of Food Quality*, *2022(1), 3569950*.

Mesfin Woldemariam. (1984). Rural vulnerability to famine in Ethiopia 1958–1977. *Vicas: New Delhi, India*.

Meskerem Abi & Degefa Tolossa. (2015). Household food security status and its determinants in girar jarso district, north Shewa zone of oromia region, Ethiopia. *Journal of Sustainable development in Africa*, *17*(7), 118-137.

Middleton, N., & Thomas, D. (1997). *World atlas of desertification. ed. 2*. Arnold, Hodder Headline, PLC.

Mihrete, T. B., & Mihretu, F. B. (2025). Crop Diversification for Ensuring Sustainable Agriculture, Risk Management and Food Security. *Global Challenges*, 2400267.

Mitchell T, Jones L, Lovell E & Comba E. (2013). Disaster risk management in post-2015 development goals: potential targets and indicators. Overseas Development Institute, London

MoA. (2021). Annual National Agricultural Production Report, Addis Ababa, Ethiopia. Ministry of Agriculture.

MoH. (2022). Ethiopia: Food-Based Dietary Guidelines–2022

Mohamed, A. A. (2017). Food security situation in Ethiopia: a review study. *International journal of health economics and policy*, *2*(3), 86-96.

Mohammed, S. A., Mengesha, H. Y., Andualem, A., Seid, E., & Assefa, G. M. (2024). Availability, price, and affordability of diabetes mellitus and thyroid dysfunction medicines in South Wollo zone, Northeast Ethiopia. *BMC Health Services Research*, *24(1)*, 1–13.

Mohammed, U. D., Legesse, S. A., Berlie, A. B., & Ehsan, M. A. (2022). Climate change repercussions on meteorological drought frequency and intensity in South Wollo, Ethiopia. *Earth Systems and Environment*, *6*(3), 645-655.

Mohammed, Y., Yimer, F., Tadesse, M., & Tesfaye, K. (2018). Meteorological drought assessment in northeast highlands of Ethiopia. *International Journal of Climate Change Strategies and Management*, *10*(1), 142-160.

Mondal, A., Kundu, S., & Mukhopadhyay, A. (2012). Rainfall trend analysis by Mann-Kendall test: A case study of north-eastern part of Cuttack district, Orissa. *International Journal of Geology, Earth and Environmental Sciences*, *2*(1), 70-78.

Moreno-Serra, R., Anaya-Montes, M., León-Giraldo, S., & Bernal, O. (2022). Addressing recall bias in (post-) conflict data collection and analysis: lessons from a large-scale health survey in Colombia. *Conflict and health*, *16*(1), 1-14.

Mossie H, Asfaw T, Abebe A & Fekete-Farkas M. (2024). Determinants of household resilience to food insecurity: a case of rural Northern Ethiopia by using the RIMA approach. J Agric Food Res 18:101351. https://doi.org/10.1016/j.jafr.2024.101351

Motbainor A, Worku A & Kumie A. (2016). Level and determinants of food insecurity in East and West Gojjam zones of Amhara Region, Ethiopia: a community based comparative cross-sectional study. BMC Public Health 16:503. https://doi.org/10.1186/s12889-016-3186-7

Muhyie J.H., Yayeh D.A. & Teshome T.T. (2025b) Analysis of household food security and determinants in the face of drought and conflict in South Wollo zone, Ethiopia. *Ethiopian Journal of Development Research*. 47 (2).

Muhyie, J. H., Ayal, D. Y., & Teshome, T. T. (2025a). Assessing Recall Bias in Post-conflict Food Security and Resilience Study in South Wollo Zone, Ethiopia. *MethodsX*, 103321.

Muhyie, J. H., Yayeh, D., Kidanie, S. A., Metekia, W. A., & Tilahun, T. (2025c). Synthesizing the impact of armed conflicts on food security, livelihoods and social dynamics in Amhara region, Ethiopia. *BMC nutrition*, *11*(1), 29.

Mukasa, J., Olaka, L., & Yahya Said, M. (2020). Drought and households' adaptive capacity to water scarcity in Kasali, Uganda. *Journal of Water and Climate Change*, *11*(S1), 217-232.

Mulat, D., Wolday, A., Ehui, S., & Zegeye, T. (1995). Food Security, Nutrition, and Poverty Alleviation in Ethiopia: Problems and Prospects. *Proceedings of the Inaugural and First Annual Conferencce of the Agricultural Economics Society of Ethiopia, Addis Ababa, Ethiopia*, 8-9.

Muriuki, J., Hudson, D., & Fuad, S. (2023). The impact of conflict on food security: evidence from household data in Ethiopia and Malawi. *Agriculture & Food Security*, *12*(1), 41.

Naeem M, Ozuem W, Howell K & Ranfagni S. (2023). A step-by-step process of thematic analysis to develop a conceptual model in qualitative research. Int J Qual Methods 22:16094069231205789. https://doi.org/10.1177/16094069231205789

Nega, B., & Gebreselassie, S. (2002). Land tenure and agricultural development in Ethiopia. *Ethiopian Economic Association/Ethiopian Economic Policy Research Institute.*

Negatu, W. (2004). Reasons for food insecurity of farm households in South Wollo, Ethiopia: explanations at grassroots.

Nury, A. H., Hasan, K., & Alam, M. J. B. (2017). Comparative study of wavelet-ARIMA and wavelet-ANN models for temperature time series data in northeastern Bangladesh. *Journal of King Saud University-Science*, *29*(1), 47-61.

OCHA. (2023). Discussion Paper: Gendered drivers, risks and impacts of food insecurity in the Sahel and the Horn of Africa.https://reliefweb.int/report/world/ocha-discussion-paper-gendered-drivers-risks-and-impacts-food-insecurity-sahel-and-horn-africa

Odongo Rhoda, Teun Schrieks, Ileen Streefkerk, Hans de Moel, Tim Busker, Toon Haer, David MacLeod, Katerina Michaelides, Michael Singer, Mohammed Assen, George Otieno, Anne F., & Van Loon. (2025). Drought impacts and community adaptation: Perspectives on the 2020–2023 drought in East Africa, *International Journal of Disaster Risk Reduction*, Volume 119, 105309, ISSN 2212-4209, https://doi.org/10.1016/j.ijdrr.2025.105309.

Office for the Coordination of Humanitarian Affairs. (2018). Ethiopia: escalating inter-communal violence displaces close to 1 million people, 27 June 2018. OCHA, Geneva

Office for the Coordination of Humanitarian Affairs. (2024). Global humanitarian overview 2024: Ethiopia. OCHA, Geneva

Oxford Policy Management. (2024). *Building Resilience in Ethiopia – Technical Assistance Final Report*. https://www.opml.co.uk/sites/default/files/2024-05/bre-final-report-main.pdf.

Pacillo, G., Carneiro, B., Resce, G., Ruscica, G., Craparo, A. C. W., Basel, A. M., ... & Läderach, P. R. (2021). Assessing the relationship between climate, food security and conflict in Ethiopia and in the Central American Dry Corridor (CADC). Quantitative analysis on the impact of climate variability on conflict in Ethiopia and in the CADC countries. Appendix.

Pal, A. B., Khare, D., Mishra, P. K., & Singh, L. (2017). Trend analysis of rainfall, temperature and runoff data: a case study of Rangoon watershed in Nepal. *Int. J. Stud. Res. Technol. Manag*, *5*, 21-38.

Parry ML, Canziani O, Palutikof J, Van Der Linden P & Hanson C. (2007). Climate change 2007—impacts, adaptation and vulnerability: working group II contribution to the fourth assessment report of the IPCC. Cambridge University Press, Cambridge

Pasteur, K. (2011). *From Vulnerability to Resilience, a framework for analysis and action to build community resilience*. Practical Action Publishing.

Pate, Amy. (2014). Boko Haram: An Assessment of Strengths, Vulnerabilities, and Policy Options. Report to the Strategic Multilayer Assessment Office, Department of Defense, and the of University Programs, Department of Homeland Security. College Park MD

Pérez-Escamilla, R., & Segall-Corrêa, A. M. (2008). Food insecurity measurement and indicators. *Revista de Nutrição*, *21*, 15s-26s.

Pickson, R. B., & Boateng, E. (2022). Climate change: a friend or foe to food security in Africa? *Environment, Development and Sustainability*, 1-26.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*(5), 879-903.

Policinski, E., & Kuzmanovic, J. (2019). Protracted Conflicts: The enduring legacy of endless war. *International Review of the Red Cross*, *101*(912), 965-976.

Post, R., Hudson, D., Mitchell, D., Bell, P., Perliger, A., & Williams, R. (2016). Rethinking the Water-Food-Climate Nexus and Conflict: An Opportunity Cost Approach. *Applied Economic Perspectives and Policy*, *38*(4), 563-577.

Puechguirbal, N. (2010). Discourses on gender, patriarchy and Resolution 1325: a textual analysis of UN documents. *International Peacekeeping*, *17*(2), 172-187.

Rahmato, D. (1986). Hunger and destitution in rural Ethiopia, IDR Discussion Paper, Institute for Development Research, Addis Ababa University.

Rahmato, D. (1991). *Famine and survival strategies: A case study from Northeast Ethiopia*. Nordic Africa Institute.

Raleigh C & Kniveton D. (2012). Come rain or shine: an analysis of conflict and climate variability in East Africa. J Peace Res 49:51–64. https://doi.org/10.1177/0022343311427754

Regassa, N., Makombe, G., Fitsum, H., & Seleshi, B. (2010). Rural poverty and inequality in Ethiopia: Does access to small-scale irrigation make a difference? *Ethiopian Journal of Development Research*, *32*(2), 1-31.

Reporter. (2021). Counting agricultural costs of the war. The Ethiopian Reporter Magazine. https://www.thereporterethiopia.com/12342/, accessed on 15 November 2022.

Righettini, M. S., & Bordin, E. (2023). Exploring food security as a multidimensional topic: twenty years of scientific publications and recent developments. *Quality & Quantity*, *57(3)*, 2739–2758.

Rohwerder, B. (2017). *Supporting agriculture in protracted crises and rebuilding agriculture after conflict and disasters. K4D helpdesk report.*

Saad R. (2014). Food security: at what cost? Dietary and behavioral coping strategies of low-income households in Cairo and implications on children's food security. Master's Thesis, American University in Cairo

Sanginga, P. C., Kamugisha, R. N., & Martin, A. M. (2007). The dynamics of social capital and conflict management in multiple resource regimes: a case of the southwestern highlands of Uganda. *Ecology and Society*, *12*(1).

Seid, A., Asresie, A., Muhie, S. H., & Hassen, S. (2024). Some Impacts of Armed Conflict on Agriculture: A Case Study from South Wollo, Northeastern Ethiopia. *Chilean journal of agricultural & animal sciences*, *40*(3), 563-575.

Seid, A., Asresie, A., Muhie, S. H., & Hassen, S. (2024). Some Impacts of Armed Conflict on Agriculture: A Case Study from South Wollo, Northeastern Ethiopia. *Chilean journal of agricultural & animal sciences*, *40*(3), 563-575.

Sharmake, M. A., Sultan, K., Zaman, Q. U., Rehman, R., & Hussain, A. (2022). Decadal impacts of climate change on rainfed agriculture community in Western Somaliland, Africa. *Sustainability*, *15*(1), 421.

Shishay, K., & Dawit, G. (2018). Impact of climate variability on household food availability in Tigray, Ethiopia. *Agriculture & Food Security*, *7*, 1–9.

Smakhtin, V. U., & Hughes, D. A. (2004). *Review, automated estimation and analyses of drought indices in South Asia*. Working Paper 83. Colombo, Sri Lanka: International Water Management Institute.

Suryabhagavan, K. V. (2017). GIS-based climate variability and drought characterization in Ethiopia over three decades. *Weather and climate extremes*, *15*, 11-23.

Taherdoost H. (2016) Sampling methods in research methodology; how to choose a sampling technique for research. Int J Acad Res Manag 5:18–27. https://doi.org/10.2139/ssrn.3205035

Takeuchi, J. (1974). A necessary condition for the well-posedness of the Cauchy problem for a certain class of evolution equations. *Proceedings of the Japan Academy*, *50*(2), 133-137.

TANGO International. (2007). Ethiopia: The Path to Self-Resiliency. Prepared for CHF – Partners in Rural Development. July 2007.

TANGO International. (2012). Secure the Future: Enhancing resilience of drought-affected nations, communities, and households in the Horn of Africa.

Tesafa F, Mulugeta M & Tsehay S. (2023). Impact of agricultural diversification and off-farm income on food security of rural households in Northwest Ethiopia: a dose-response analysis. Ethiop J Dev Res 45:1–30

Tesfaye, A., & Alemayehu, A. (2021). Climate Change and variability on food security of rural household: central Highlands, Ethiopia. In *African handbook of climate change adaptation* (pp. 379-395). Cham: Springer International Publishing.

Tesfaye, B., Lengoiboni, M., Zevenbergen, J., & Simane, B. (2023). A Holistic Analysis of Food Security Situation of Households Engaged in Land Certification and Sustainable Land Management Programs: South Wello, Ethiopia. *Foods*, *12*(18), 3341.

Tesfaye, B., Lengoiboni, M., Zevenbergen, J., & Simane, B. (2023). A Holistic Analysis of Food Security Situation of Households Engaged in Land Certification and Sustainable Land Management Programs: South Wello, Ethiopia. *Foods*, *12*(18), 3341.

Tesfaye, B., Ture, K., Terefe, T., Yayeh, D., Legese, G., & Abiko, F. (2022). Drought analysis using standardized evapotranspiration and aridity index at Bilate watershed: subbasins of Ethiopian Rift Valley. *The Scientific World Journal*, *2022(1), 1181198*.

Tesfaye, T., & Nayak, D. (2022). Does participation in non-farm activities provide food security? Evidence from rural Ethiopia. *Cogent Social Sciences*, *8*(1), 2108230.

Thomas D, & Zubkov P (2020) Quantitative research designs. In: Quantitative research for practical theology. Andrews University, Michigan, pp 103–114

Thomas K, Hardy RD, Lazrus H, Mendez M, Orlove B, Rivera-Collazo I, Roberts JT, Rockman M, Warner BP & Winthrop R. (2019). Explaining differential vulnerability to climate change: a social science review. Wiley Interdiscip Rev Clim Change 10:e565. https://doi.org/10.1002/wcc.565

Tontisirin, K., MacLean, W. C., Warwick, P., & FAO. (2003). Technical workshop on food energy: methods of analysis and conversion factors.

Tranchant, J. P., Gelli, A., & Masset, E. (2021). Impact of conflict-related violence and presence of armed groups on food security: Evidence from longitudinal analysis in Mali. *Intl Food Policy Res Inst.*, *2095*.

Ugwu, C. N., & Eze, V. H. U. (2023). *Qualitative Research. IDOSR JOURNAL OF COMPUTER AND APPLIED SCIENCES, 8 (1), 20–35*.

UN OCHA. (2018). Ethiopia: Escalating inter-communal violence displaces close to 1 million people, 27 June 2018.

UN OCHA. (2023). Ethiopia: Humanitarian Needs Overview 2023. United Nations Office for the Coordination of Humanitarian Affairs.

UNHCR. (2021). Factsheet, Sudan, September. https://data-dev.unhcr.org/en/documents/details/889032021

UNHCR. (2022). FACTSHEET: Northern Ethiopia Situation. Retrieved on 11 December 2024. https://reliefweb.int/report/ethiopia/unhcr-northern-ethiopia-situation-factsheet-march-2022

UNICEF. Ethiopia Humanitarian Situation Report, July 2021. 2021.

USDA. (2017). Food security. https://www.usda.gov/topics/food-and-nutrition/food-security. Accessed 06 February 2023.

Vaitla, B., Cissé, J. D., Upton, J., Tesfay, G., Abadi, N., & Maxwell, D. (2020). How the choice of food security indicators affects the assessment of resilience—an example from northern Ethiopia. *Food Security*, *12*, 137-150.

Vicente-Serrano, S. M., Beguería, S., & López-Moreno, J. I. (2010). A multiscalar drought index sensitive to global warming: the standardized precipitation evapotranspiration index. *Journal of climate*, *23*(7), 1696-1718.

Vicente-Serrano, S. M., McVicar, T. R., Miralles, D. G., Yang, Y., & Tomas-Burguera, M. (2020). Unraveling the influence of atmospheric evaporative demand on drought and its response to climate change. *Wiley Interdisciplinary Reviews: Climate Change*, *11*(2), e632.

Wahbeh S, Anastasiadis F, Sundarakani B & Manikas I. (2022). Exploration of food security challenges towards more sustainable food production: a systematic literature review of the major drivers and policies. Foods (Basel, Switzerland) 11:3804. https://doi.org/10.3390/foods11233804

Wassie, S. B., Mengistu, D. A., & Berlie, A. B. (2022). Trends and spatiotemporal patterns of meteorological drought incidence in North Wollo, northeastern highlands of Ethiopia. *Arabian Journal of Geosciences*, *15*(12), 1158.

Weldegiargis, A. W., Abebe, H. T., Abraha, H. E., Abrha, M. M., Tesfay, T. B., Belay, R. E., ... & Mulugeta, A. (2023). Armed conflict and household food insecurity: evidence from war-torn Tigray, Ethiopia. *Conflict and Health*, *17*(1), 22.

WFP. (2021). Ethiopia food security outlook update. August 2021. FEWS NET.

WFP. (2023). *WFP resilience programmes in Sahel act as buffer against instability, build peace and social cohesion – study finds*. World Food Programme.

Wilhite, D. A., & Glantz, M. H. (1985). Understanding: the drought phenomenon: the role of definitions. *Water international*, *10*(3), 111-120.

Wilhite, Donald A. (2000). Chapter 1 Drought as a Natural Hazard: Concepts and Definitions. *Drought Mitigation Center Faculty* Publications. 69. http://digitalcommons.unl.edu/droughtfacpub/69

Winderl T. (2014). Disaster resilience measurements: stocktaking of ongoing efforts in developing systems for measuring resilience. https://www.preventionweb.net/publication/disaster-resilience-measurements-stocktaking-ongoing-efforts-developing-systems. Accessed 27 July 2023

Winograd, E., & Neisser, U. (Eds.). (1992). *Affect and accuracy in recall: Studies of "flashbulb" memories*. Cambridge University Press. https://doi.org/10.1017/CBO9780511664069

Woldegebriel, A. G., Gebrehiwot, G. G., Teka, A. G., Gebreyesus, H. A., Weldeslassie, T. T., Desta, A. A., Yigzaw, H. K., Bezabih, N. M., Baryau, H. K., Haileselassie, M., & Gebregziabiher, M. B. (2024). High manifestations of food insecurity and hunger among pregnant and lactating women during post-conflict in Tigray, Ethiopia: a community-based study. *BMC Pregnancy and Childbirth*, *24(1), 385*.

Woldehanna, T., Endale, K., Das, S., Yadete, W., Vintges, J., Baird, S., ... & Hamory, J. (2024). Armed conflict and adolescent social capital in Ethiopia. *International Journal of Disaster Risk Reduction*, *103*, 104299.

World Bank. (2023). Ethiopia: impact of conflict on productive safety net programme implementation. World Bank Report, Washington

WSP (2017) Socio-economic assessment—Amhara IAIP and RTC. https://www.afdb.org/sites/default/files/48920_amhara_appendix_c12_socio-economic.pdf. Accessed 14 December 2024

Yagaso, Z. S., Bayu, T. Y., & Bedane, M. D. (2024). Assessing the current status of food security under climate variability and the role of household-level adaption strategies near Ghibe III hydroelectric dam, Ethiopia. *Discover Food*, *4*(1), 77.

Yeleliere, E., Antwi-Agyei, P., & Guodaar, L. (2023). Farmers response to climate variability and change in rainfed farming systems: Insight from lived experiences of farmers. *Heliyon*, *9*(9).

Yifru GS & Miheretu BA. (2022). Farmers' adoption of soil and water conservation practices: The case of Lege-Lafto Watershed, Dessie Zuria District, South Wollo, Ethiopia. PLoS ONE 17(4): e0265071. https://doi.org/10.1371/journal.pone.0265071

Yifru, G. S., & Miheretu, B. A. (2022). Farmers' adoption of soil and water conservation practices: the case of lege-lafto watershed, dessie zuria district, south wollo, Ethiopia. *PloS one*, *17(4), e0265071*.

Yigezu Wendimu, G. (2021). The challenges and prospects of Ethiopian agriculture. *Cogent Food & Agriculture*, *7*(1), 1923619.

Zelalem Fikire & Abate Bekele. (2014). *Determinants of food security in the rural households of Meskan District, Gurage Zone, SNNPR, Ethiopia* (Doctoral dissertation, St. Mary's University).

Zeru, H. (2020). Impact of Small-Scale Irrigation on Household Food Security in Mehal Sayint Worda, South Wollo Zone, Amhara region, Ethiopia. Addis Ababa University. Retrieved from https://etd.aau.edu.et/items/a86fe021-8eb6-48a9-bf4d-57ff354ed647

Zhang, H., Zhang, M., Jin, J., Fei, K., Ji, D., Wu, C., ... & Zhu, J. (2020). Description and Climate Simulation Performance of CAS-ESM Version 2. *Journal of Advances in Modeling Earth Systems*, *12*(12), e2020MS002210.

Zhang, W., Persoz, L., Hakiza, S., Biru, L., & Girmatsion, L. (2022). Impact of COVID-19 on food security in Ethiopia. *Epidemiologia*, *3*(2), 161-178.

APPENDICES

Appendix 1: Household Questionnaire

Part 1: General Information

Purpose of the research and Consent note:

Introduction and Purpose of the Research: Dear Respondent, Good morning/afternoon. My name is _____ working as a data collector for the study being conducted by Jemal Hassen Muhyie (PhD student) who is studying his PhD in Food Security and Development at Addis Ababa University. The research is not sponsored by any individual or organization. It is fully supported by the researcher. I kindly request you to participate in this study by responding to some questions about your experience of the impact of drought and conflict on food security and resilience. I will be asking about some demographic related household information, socio-economic, social and cultural, trends, variability and severity of drought and conflict with a perspective of food security and resilience. The research title: Households Food Security and Resilience to Drought and Conflict in South Wollo Zone, Ethiopia. Purpose of the study: The research aims to analyze the impact of drought and conflict on household resilience to food insecurity in South Wollo zone of the Amhara region of Ethiopia. It will further envision to provide evidence-based on trends and variability of drought over a long period of time, explore the impact of conflict on food security and livelihoods, examine food security situation, and the interplay between conflict and drought on peoples' resilience to impacts of drought and conflict on food security. In addition, the questionnaire has an integral part of the PhD research to assess recall bias using Flashbulb memory test. The data on food security and resilience of drought and conflict affected households will be collected on the basis of recall - taking into account one-year before the northern Ethiopia conflict and one-year after the conflict ended. This poses a risk of recall bias as few respondents may find it difficult to remember past events which could result in inappropriate inference. Therefore, these questions are included as a benchmark to assess if recall bias affects the collected data on food security and resilience so that corrective measure is taken during data analysis. A known event is selected which you will know during the interview and there are about 5 questions related to the event. These questions are neither political nor have any hidden purpose. The researcher identifies them to understand and assess recall bias using a Flashbulb memory test. The ultimate purpose of the research is to complete the dissertation which is a requirement as a fulfilment for the Doctor of Philosophy (PhD) degree in Food Security and Development for the principal investigator, Jemal Hassen.

Do you consent to participate in this study? ☐ Yes ☐ No

S.N.	Description of the question	Answer Options	
1.1.	Do you give your consent to participate in this research?	(0) No (1) Yes	
1.2.	Name of enumerator		
1.3.	Region	(1) Amhara	
1.4.	Zone	(1) South Wollo	
1.5.	District	(1) Delanta	

		(2) Dessie Zuria (3) Kalu (4) Worebabo		
1.6.	Kebele			
1.7.	Village (*gott*)			
1.8.	What is the Sex of household head?	(1) Male (2) Female		
1.9.	What is the Age of household head?			
1.10.	What is the educational level of household head in years *(Count number of years spent in formal education and indicate the total number of school years)*			
1.11.	Marital status of the household head?	(1) Single (2) Married (3) Divorced (4) Separated (5) Widow		
1.12.	What is the Family size by age and sex including the father and mother? *(Indicate the number of family members by age category and sex)*		Male	Female
	0-5 years			
	6-14 years			
	15-35 years			
	36-64 years			
	65 and above years			
1.13.	How many family members have DISABILITY?			
1.14.	How many family members are CHRONICALLY ILL?			
1.15.	How many family members are PREGNANT?			
1.16.	How many family members are LACTATING (have babies under 2 years of age)?			
1.17.	How many children are under the age of 7 years?			
1.18.	How many children are attending school in the reference period?			
1.19.	How many children dropped out of school in the reference period?			
1.20.	Is there sex difference for school dropout and for children that are of school age but not attending school during the reference period?	(0) No (1) Yes		
1.21.	If yes to the above question, who are mostly dropping out and not going to school during the reference period?	(1) Boys (2) Girls		

1.22.	Types of housing	(1) Own - Corrugated Galvanized Iron (CGI) sheet (2) Own - Grass thatched. (3) Rented - Corrugated Galvanized Iron (CGI) sheet. (4) Rented - Grass thatched. (5) Living with family or friends (shared without rent) (6) Other type (specify)
1.23.	Do you have access to off-farm income generating activities?	(0) No (1) Yes

Part 2: Off-farm Income Sources and Amount of Annual Income

Type of off-farm income sources and amount of annual income in the reference year?	**One year period before the northern Ethiopia conflict** June 2019 to May 2020 (Annual income in birr)	**One year period During & after the northern Ethiopia conflict** June 2021 to May 2022 (Annual income in birr)
Tailoring		
Hair dressing and beautification		
Carpentry		
Electrical installation		
Computer writing service		
Computer and mobile maintenance		
Auto mechanic		
Painting		
Daily labor		
Othe, please specify _____		

Part 3: Access to Basic Services (ABS)

Access to Basic Services (ABS) related questions	**One year period before the northern Ethiopia conflict** June 2019 to May 2020	**One year period During & after the northern Ethiopia conflict** June 2021 to May 2022
3.1. Is the main source of drinking water for members of the household piped from a household water connection, public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs or rainwater collection?	(0) No (1) Yes	(0) No (1) Yes
3.2. Is the main type of toilet facility used by members of the household a flush/pour flush (to piped sewer	(0) No (1) Yes	(0) No (1) Yes

system, septic tank, or pit latrine), a ventilated improved pit (VIP) latrine, a pit latrine with slab, or a composting toilet?		
3.3. Is electricity the main source of energy used in the household for cooking or lighting?	(0) No (1) Yes	(0) No (1) Yes
3.4. How far (one way) is the household dwelling from the closest accessible/ functioning [**WATER SOURCE**] in minutes?	[_____] minutes	[_____] minutes
3.5. How far (one way) is the household dwelling from the closest accessible/ functioning [**PRIMARY SCHOOL**] in minutes?	[_____] minutes	[_____] minutes
3.6. How far (one way) is the household dwelling from the closest accessible/ functioning [**PUBLIC HOSPITAL/HEALTH FACILITY**] in minutes?	[_____] minutes	[_____] minutes
3.7. How far (one way) is the household dwelling from the closest accessible/ functioning [**LIVESTOCK MARKET**] in minutes?	[_____] minutes	[_____] minutes
3.8. How far (one way) is the household dwelling from the closest accessible/ functioning [**AGRICULTURAL/CROP MARKET**] in minutes?	[_____] minutes	[_____] minutes
3.9. How far (one way) is the household dwelling from the closest accessible/ functioning [**PUBLIC MEANS OF TRANSPORT**] in minutes?	[_____] minutes	[_____] minutes

Part 4: Assets (AST)

Assets (AST) related questions (How many of the following durable assets the household possess? Please indicate the number of assets?)	**One year period before the northern Ethiopia conflict** June 2019 to May 2020	**One year period During & after the northern Ethiopia conflict** June 2021 to May 2022
4.1. How many cars do the household have?		
4.2. How many motor bikes or bicycles do the household have?		
4.3. How many gas/electrical stoves do the family have?		
4.4. How many smart phones do you have in the household?		
4.5. How many modern plows do you have in the household?		
4.6. How many tractors do you have?		
4.7. How many refrigerators do you have?		
4.8. How many electrical washings machine do you have?		

4.9. How many televisions do you have?		
4.10. How many tailoring machine or singer do you have?		
4.11. How many digital cameras do you have?		
4.12. How many computers do you have?		
4.13. Have you used improved seeds?	(0) አልጠቀምም (1) እጠቀማለሁ	(0) አልጠቀምም (1) እጠቀማለሁ
4.14. Have you used chemical pesticides?	(0) አልጠቀምም (1) እጠቀማለሁ	(0) አልጠቀምም (1) እጠቀማለሁ
4.15. Hove you used improved fertilizer?	(0) አልጠቀምም (1) እጠቀማለሁ	(0) አልጠቀምም (1) እጠቀማለሁ
4.16. How many timds of agricultural land the household own?		
4.17. How many timad of agricultural land the family used in renting?		
4.18. Do you use irrigation?	(0) አልጠቀምም (1) እጠቀማለሁ	(0) አልጠቀምም (1) እጠቀማለሁ
4.19. How many Cows/calves/Oxen do you own?		
4.20. How many Sheep and goat do you own?		
4.21. How many Chickens do you own?		
4.22. How many Camels, donkey, mule, horse, do you own?		
4.23. How many Bee colony/hives with bees do you own?		

Part 5: Social Safety Nets (SSN)

Social safety net related questions	**One year period before the northern Ethiopia conflict** June 2019 to May 2020	**One year period During & after the northern Ethiopia conflict** June 2021 to May 2022
5.1. What is the total amount of loan(s) received in the 12 months by the members of the household?	[monetary value in local currency]	[monetary value in local currency]
5.2. What is the total amount of formal transfers (relief food, cash assistance, livestock, safety net programs, pension schemes, etc.) received in the 12 months by the members of the household?	[monetary value in local currency]	[monetary value in local currency]
5.3. What is the total amount of informal transfers (cash, remittances, food or grain gift, seed gift, free use of animals, etc.) received in the 12 months by the members of the household?	[monetary value in local currency]	[monetary value in local currency]

5.4. How many [Associations (farmers groups, women support groups, youth groups, business associations, unions, etc.)] can the members of the household rely on in case of need?	[number]	[number]
5.5. How many [Relatives/friends/family members] can the members of the household rely on in case of need?		

Part 6: Adaptive Capacity (AC)

Adaptive capacity related questions	**One year period before the northern Ethiopia conflict** June 2019 to May 2020	**One year period During & after the northern Ethiopia conflict** June 2021 to May 2022
6.1. Can the head of the household read and write?	(0) No (1) Yes	(0) No (1) Yes
6.2. How many years has the household head attended formal school?		
6.3. How many years has the household head attended Quranic/Biblical school?		
6.4. How many years has the household member with the highest level of education?		
6.5. How many years has the household member with the highest level of education attended Quranic/Biblical school?		
6.6. How many years on average have the household members of working age (>14 and <65 years old) attended formal school?		
6.7. In the past 12 months, was [Agriculture, animal breeding, fishing, bee keeping, poultry] a source of household income?	(0) No (1) Yes	(0) No (1) Yes
6.8. In the past 12 months, was [Family business (other than agriculture)] a source of household income?	(0) No (1) Yes	(0) No (1) Yes
6.9. In the past 12 months, was [Government wage and salary] a source of household income?	(0) No (1) Yes	(0) No (1) Yes
6.10. In the past 12 months, was [Private sector wage and salary] a source of household income?	(0) No (1) Yes	(0) No (1) Yes
6.11. In the past 12 months, was [Transfers and social assistance] a source of household income?	(0) No (1) Yes	(0) No (1) Yes
6.12. In the past 12 months, was there any other source of household income?	(0) No (1) Yes	(0) No (1) Yes

6.13. What is considered as the main income source of the household?	[open answer]	[open answer]
6.14. How many different crops have the household members grown during the last season?		

Part 7: Shocks

Shocks related questions	**One year period before the northern Ethiopia conflict** June 2019 to May 2020	**One year period During & after the northern Ethiopia conflict** June 2021 to May 2022
7.1. Have you been exposed to drought (shortage of rainfall either during belg or meher) in the year?	(0) No (1) Yes	(0) No (1) Yes
7.2. Have you been exposed to frost, flood, pest, etc. in the year at a significant level?	(0) No (1) Yes	(0) No (1) Yes
7.3. How do you rate level of exposure to climate variability (drought, flood, frost, etc.)?	(0) No (1) Low (2) Medium (3) High	(0) No (1) Low (2) Medium (3) High

Part 8: Conflict

Description of questions related to exposure to conflict	One year period before the northern Ethiopia conflict June 2019 to May 2020	One year period During & after the northern Ethiopia conflict June 2021 to May 2022					
8.1. Have you been affected by or exposed to violent conflict in the reference year?		(0) No		(1) Yes			
8.2. Which aspects of the food systems component are affected?		No damage	Mild damage	Moderate damage	High damage	Very high damage	Severe damage
- Production system (including biophysical, environmental, human, infrastructural, technological, institutional, social, governance and political drivers while assessing this system)		0	1	2	3	4	5

- Distribution and storage systems (including biophysical, environmental, human, infrastructural, technological, institutional, social, governance and political drivers while assessing this system)		0 1 2 3 4 5
- Processing and packaging systems (including biophysical, environmental, human, infrastructural, technological, institutional, social, governance and political drivers while assessing this system)		0 1 2 3 4 5
- Retail and market systems (including biophysical, environmental, human, infrastructural, technological, institutional, social, governance and political drivers while assessing this system)		0 1 2 3 4 5
- Consumption (including biophysical, environmental, human, infrastructural, technological, institutional, social, governance and political drivers while assessing this system)		0 1 2 3 4 5
8.3. Was there any damage to matured crops by the conflict?		(0) No (1) Yes
8.4. How many people in the household died in the conflict?		
8.5. How many people in the household were injured in the conflict?		
8.6. What is the estimated monetary value of the damage on agricultural crops, livestock and other properties because of the conflict?		

ክፍል 9፡ Household Food Balance Model (HFBM) - <u>One year period before the northern Ethiopia conflict June 2019 to May 2020</u>

Type of crops	Area Cultivated in (timad)	GP Total grain produced/year/household in kg	GB Total grain bought/year/household in kg	FA Quantity of food aid obtained/year/household in kg	GG Total grain obtained through gift or remittance/year/household	FW Food for work (kg/household/year)	MP Total meat products (kilogram/household/year)	DP Total dairy products (kilogram/household/year)	HL post-harvest losses/year in kg	GU Quantity of grain reserved for seed/year/household in kg	GS Amount of grain sold/year/household in kg	GV Grain given to others with in a year in kg	GSE Grain used for social events /household/year in kg	NGA = (GP + GB + FA + GG + FW + MP + DP) - (HL+ GU+ GS+ GV + GSE)	Kcal content per kg of grains (this is given from Ethiopia Public Health Institution	Total kcal available for the HH	Adult equivalent kcal/day (total kcal/HH size/365)
Maize														0			
Barley														0			
Wheat														0			
Millet														0			
Teff														0			
Rice														0			
Oats														0			
Sorghum														0			
Cow peas														0			
Peas														0			
Chick pea														0			
Beans														0			

Part 10: Household Food Balance Model (HFBM) – One year period During & after the northern Ethiopia conflict June 2021 to May 2022

Type of crops	Area Cultivated in (timad)	GP Total grain produced/year/household in kg	GB Total grain bought/year/household in kg	FA Quantity of food aid obtained/year/household in kg	GG Total grain obtained through gift or remittance/year/household	FW Food for work (kg/household/year)	MP Total meat products (kilogram/household/year)	DP Total dairy products (kilogram/household/year)	HL post-harvest losses/year in kg	GU Quantity of grain reserved for seed/year/household in kg	GS Amount of grain sold/year/household in kg	GV Grain given to others with in a year in kg	GSE Grain used for social events /household/year in kg	NGA = (GP + GB + FA + GG + FW + MP + DP) - (HL+ GU+ GS+ GV + GSE)	Kcal content per kg of grains (this is given from Ethiopia Public Health Institution	Total kcal available for the HH	Adult equivalent kcal/day (total kcal/HH size/365)
Maize														0			
Barley														0			
Wheat														0			
Millet														0			
Teff														0			
Rice														0			
Oats														0			
Sorghum														0			
Cow peas														0			
Peas														0			
Chick pea														0			
Beans														0			

Part 11: Household Dietary Diversity Score (HDDS)

Now I would like to ask you about the types of foods that you or anyone else in your household ate **yesterday (24 hours recall)** during the day and at night. Read the list of foods. Place a one in the box if anyone in the household ate the food in question, place a zero in the box if no one in the household ate the food. IN addition, please try to recall a similar 24 hours before the conflict and provide a comparative response as much as possible?	Please provide the last 24 hours feedback	Could you also recall a similar period before the conflict and provide a comparative response to the current situation?
11.1. Any bread, rice noodles, biscuits, or any other foods made from millet, sorghum, maize, rice, wheat, or [insert any other locally available grain]?	(0) No (1) Yes	(0) No (1) Yes
11.2. Any potatoes, yams, manioc, cassava or any other foods made from roots or tubers?	(0) No (1) Yes	(0) No (1) Yes
11.3. Any vegetables?	(0) No (1) Yes	(0) No (1) Yes
11.4. Any fruits?	(0) No (1) Yes	(0) No (1) Yes
11.5. Any beef, lamb, goat, rabbit wild game, chicken, duck, or other birds, liver, kidney, heart, or other organ meats?	(0) No (1) Yes	(0) No (1) Yes
11.6. Any eggs?	(0) No (1) Yes	(0) No (1) Yes
11.7. Any fresh or dried fish or shellfish?	(0) No (1) Yes	(0) No (1) Yes
11.8. Any foods made from beans, peas, lentils, or nuts?	(0) No (1) Yes	(0) No (1) Yes
11.9. Any cheese, yogurt, milk or other milk products?	(0) No (1) Yes	(0) No (1) Yes
11.10. Any foods made with oil, fat, or butter?	(0) No (1) Yes	(0) No (1) Yes
11.11. Any sugar or honey?	(0) No (1) Yes	(0) No (1) Yes
11.12. Any other foods, such as condiments, coffee, tea?	(0) No (1) Yes	(0) No (1) Yes

Part 12: Household Food Insecurity Access Scale (HFIAS)

S/N	HFIAS questions	Response on frequency or occurrence
12.1.	In the past four weeks, did you worry that your household would not have enough food?	(0) No (1) Rarely (1 – 2 times) (2) Sometimes (3 – 10 times) (3) Often (more than 10 times)

12.2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	(0) No (1) Rarely (1 – 2 times) (2) Sometimes (3 – 10 times) (3) Often (more than 10 times)
12.3.	In the past four weeks, did you or any household members have to eat a limited variety of foods due to a lack of resources?	(0) No (1) Rarely (1 – 2 times) (2) Sometimes (3 – 10 times) (3) Often (more than 10 times)
12.4.	In the past four weeks, did you or any household members have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	(0) No (1) Rarely (1 – 2 times) (2) Sometimes (3 – 10 times) (3) Often (more than 10 times)
12.5.	In the past four weeks, did you or any household members have to eat a smaller meal than you felt you needed because there was not enough food?	(0) No (1) Rarely (1 – 2 times) (2) Sometimes (3 – 10 times) (3) Often (more than 10 times)
12.6.	In the past four weeks, did you or any other household members have to eat fewer meals in a day because there was not enough food?	(0) No (1) Rarely (1 – 2 times) (2) Sometimes (3 – 10 times) (3) Often (more than 10 times)
12.7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	(0) No (1) Rarely (1 – 2 times) (2) Sometimes (3 – 10 times) (3) Often (more than 10 times)
12.8.	In the past four weeks, did you or any household members go to sleep at night hungry because there was not enough food?	(0) No (1) Rarely (1 – 2 times) (2) Sometimes (3 – 10 times) (3) Often (more than 10 times)
12.9.	In the past four weeks, did you or any household members go a whole day and night without eating anything because there was not enough food?	(0) No (1) Rarely (1 – 2 times) (2) Sometimes (3 – 10 times) (3) Often (more than 10 times)

Part 13: Coping Strategy Index (CSI)

S/N	Coping Strategies (In the past 7 days, if there have been times when you did not have enough food and do not have enough money to buy food, how often has your household had to	Frequency (no. of days a household experienced the following coping strategies in the past 7 days)
A	Dietary Change Strategy	

13.1.	Rely on less preferred and less expensive foods?	0 1 2 3 4 5 6 7
B	Increase Short-Term Household Food Availability	
13.2.	Borrow food, or rely on help from a friend or relative?	0 1 2 3 4 5 6 7
13.3.	Purchase food on credit?	0 1 2 3 4 5 6 7
13.4.	Gather food from garbage or collect leftovers from hotels or somewhere	0 1 2 3 4 5 6 7
13.5.	Do labor work for friends, relatives, neighbors etc. in exchange of food	0 1 2 3 4 5 6 7
C	Decrease Numbers of People	
13.6.	Send household members to eat elsewhere?	0 1 2 3 4 5 6 7
13.7.	Send household members to beg?	0 1 2 3 4 5 6 7
D	Rationing Strategies	
13.8.	Limit portion size at mealtimes?	0 1 2 3 4 5 6 7
13.9.	Restrict consumption by adults in order for small children to eat?	0 1 2 3 4 5 6 7
13.10.	Feed working members at the expense of non-working members?	0 1 2 3 4 5 6 7
13.11.	Reduce number of meals eaten in a day?	0 1 2 3 4 5 6 7
13.12.	Skip entire days without eating?	0 1 2 3 4 5 6 7

Part 14: Recall bias questions

Questionnaire ID	Recall questions	Response options
14.1	How clearly you recall the announcement of the death of the late prime minister Mr. Meles Zenawi of Ethiopia?	6. Does not recall it 7. Recalls it vaguely 8. Recalls it more or less clearly 9. Recalls it very clearly 10. Recalls it vividly
14.2	At that time, how much importance did you attach to the event?	1. Not important at all 2. Less important to me 3. Somewhat important 4. Considered it very important 5. Considered it extremely important

14.3	What was the year and month of the announcement of his death?	7. August 2003 E.C 8. August 2004 E.C 9. August 2005 E.C 10. January 2003 E.C 11. January 2004 E.C 12. January 2005 E.C
14.4	On a scale of 1 to 5 (where 1 is not at all confident and 5 is extremely confident), how confident do you feel about this remembrance?	6. Not confident at all 7. Less confident 8. Moderately confident 9. Very confident 10. Extremely confident

Appendix 2: Standardized Precipitation Evapotranspiration Index (SPEI) – 1981 to 2022

Station or District	Year	Month	Date	Rainfall	Minimum Temperature	Maximum Temperature	Latitude	Longitude

Appendix 3: Key Informant Interview (KII) Checklist

Date: _____
To: _____

Subject: Checklist for Key Informant Interview for PhD Research – Jemal Hassen

Dear sir/madam,
My name is Jemal Hassen Muhyie. I am studying my Doctorate degree in Food Security and Development at Addis Ababa University. I am currently conducting my research to assess the impact of the northern Ethiopia conflict and drought on resilience to food security in South Wollo zone. My research is entitled as "***Households Food Security and Resilience to Drought and Conflict in South Wollo Zone, Ethiopia***".
The research method includes collection of data from experts (like yourself) and experienced people in the field of food security, resilience and drought. Therefore, I kindly selected you to provide your expert opinion to few questions in the attached checklist for my PhD research.
I guarantee you that the information that I am collecting from you will be kept confidentially and it will only be used for the purpose of my research. If there are any questions that you do not have the answer or you are not comfortable in answering, you may skip them as needed.
Thank you so much in advance for completing the attached checklist and return back to me as soon as possible. I am grateful for all your support and for being part of my academic career.
Regards,

Jemal Hassen Muhyie
PhD Candidate at Addis Ababa University
WhatsApp: +251912689400
Mobile: +22787370450
Email: jemal.hass@yahoo.com or jemal.muhyie@yahoo.com

Key Informant Interview (KII) Checklist **Jemal Hassen – PhD Candidate at Addis Ababa University – Centre for Food Security**	
1. General Information	
Name of the respondent:	
Profession (Position if applicable):	
Position Category:	☐ Zonal/Regional ☐ District level ☐ Community level
Category of employment:	☐ Governmental ☐ Non-Governmental (NGO) ☐ Community Leader/Influential Person
Mobile Number (if willing):	
Location/Address:	
District:	
Kebele:	

Village:	
Sex of respondent:	☐ Male ☐ Female
Age of respondent (if willing):	
2. Food security	
What are the different crops that are grown in the district?	
What can you say about the food security situation in the district? Current status and changes in trend?	
What is the food security situation from availability of food perspective? Is there sufficient food available all round to feed the people of the district from production and purchase?	
Do you think everybody in the district have equal economic access to food? If not, who do not have access and what are the reasons according to your understanding?	
How much of the food that people consume in the district comes from **production**, **purchase**, **gift** from families and friends, or **external assistance** from government or NGOs? Please indicate the proportion in percentage or order them in priority importance.	
Has there been a change in the way people are accessing food compared to previous years? If yes, how and why? Could you elaborate if there are changes in the way communities access food in the past 3 years? Has this been affected by the recent Northern Ethiopia conflict?	
What are the constraints or challenges that impact food security in the district? Could you elaborate factors related to food production, marketing, distribution, utilization of food, WASH and other social and cultural that affects food security?	
Has the district community been affected by a negative event such as drought, flood, violence, cuts in external support (aid), changes in prices of key commodities, etc. over the past three years? (Sketch a historic trend line showing the increasing or decreasing trends over time)	
Who are the people most affected by the occurrence of the above events? How have they been impacted? How did they cope?	
Do/did these groups receive any type of formal or informal support (aid)? If yes, what type, by whom, for how long and how frequent? Could you compare if support available at all or even sufficient during the northern conflict period?	
3. Livelihoods	
What are the main sources of income in the district or community? (which activities are practiced by men and women)	
Have income opportunities changed over the past three years? How and why?	
Do income opportunities change between farming/cropping seasons? What do people do as income source during kiremt and bega or meher and belg?	
Referring to casual labor opportunities, is it mainly agricultural, non-agricultural, seasonal, monthly, daily?	
When income sources are not sufficient, what do vulnerable people/households in your district/community do to cope?	
Is there access to credit for poor people in the district or community? Do poor people able to borrow money when you need it? If yes, could you list the types of credit and loan services that are available?	
4. Disaster Impact Analysis	

What are the most common hazards the communities in the district are experiencing?

Shocks and stresses could cover a wide range of issues including but not limited to insecurity/violence, death of livestock, loss of employment for HH member, reduced/loss of income of a household member, unusually high food prices, serious illness or accident of HH member, unusually high fuel/transport prices, death of working HH member, theft of productive resources, low/few livestock births, drought/irregular rains, prolonged dry spell and others.

Type of shock/hazard	Type of shock/hazard	Type of shock/hazard	Type of shock/hazard	Type of shock/hazard	Type of shock/hazard
1.					
2.					
3.					
4.					
5.					

Could you explain how drought affected household food security? What key food security and livelihoods activities are affected by drought?

What are the different impacts of the northern conflict in the community? Please elaborate the impact of the northern conflict on food system from production, harvesting, distribution, marketing, processing and consumption perspective? This include any infrastructural damage that might be linked to food security and livelihoods.

Could you compare the difference in the impact of the **northern conflict** and **drought** on food security, livelihoods and resilience? Which one was too severe in its impact on food security?

What are the different coping mechanisms the communities experienced when a disaster happens **before the northern conflict**? Is there any shift in types and frequency of coping mechanism after the northern conflict? What are these differences?

What are the different social structures and mechanism that the community consider to cope with the impact of disaster?

Could you explain the contribution of assets (livestock, fixed assets, etc.) in conflict situation compared to other disasters like drought? Did asset play critical role to mitigate the impact of the northern conflict or increased vulnerability of households unlike during drought situation?

What type of households can easily cope with disaster impacts? Do you think this coping capacity is also different for different people during the northern conflict?

What were the specific gender related impacts of the northern conflict?

5. External assistance (government, local charities, NGOs, UN)

Is your community currently benefitting from any external assistance? If yes, what type, by whom and for how long?

Has your community/district benefitted from any external assistance pre, during and post conflict periods? Provide comparison on the quantity, quality and timeliness of these assistances (aid).

What is the frequency (one off, monthly, bi-monthly quarterly, by season) and has assistance been consistently provided according to plans?

Do beneficiaries share their assistance with others who are also vulnerable but did not get any support? Do they sell assistance? Do they barter assistance? If yes, please explain the reasons why people sell or barter their assistance/aid?

How do you expect the situation in this community/district to evolve from the impact of repeated drought and the recent northern conflict? How do you think people will gain

resilience from the impact of such a devastating conflict? Focus on communities/villages affected by the northern conflict in your response.	
6. Resilience to Food Insecurity	
Which basic social services are available in your village among the following?	
Improved water facility	☐
Hospital/health center/post	☐
School	☐
Electric power	☐
Crop market	☐
Livestock market	☐
Transport facility	☐
What and how drought affects the accessibility and availability of these basic services? Could you compare the access and availability of these services during drought period and when there was no drought?	
What and how conflict affects the accessibility and availability of these basic services? Could you compare the access and availability of these services before, during and after the northern Ethiopia conflict? How these services were affected by conflict?	
What is considered asset in the village? How these assets contribute to household resilience during disasters like drought and conflict? is there a difference in the role of assets at times of drought and the northern conflict?	
How these assets are converted to other resources or directly used to manage difficult time related to food insecurity?	
Is the value of any of the assets reduce during disasters?	
Does asset ownership like cash, livestock or any other asset contribute to further vulnerability during drought or conflict?	
What are the different support mechanisms available for your community during difficult times? How these supports contributed to household resilience during drought and conflict times? Have you observed any difference in availability, accessibility and contribution of these support mechanism during drought and conflict?	
what were the different household characteristics/factors contributed positively to adapt with difficult situations resulted from drought and conflict? (hint: household characteristics may include education of the household head, number of working people in the family, status or respect of the head of the family in the community etc.)	
Which type of households are less affected or can be able to easily bounce back from the impact of disasters particularly drought and conflict?	
What were the sources of loan in your community?	

Appendix 4: Focus Group Discussion (FGD) Checklist

Date: _____
To: _____

Subject: Checklist for Focus Group Discussion for PhD Research – Jemal Hassen

Dear participants,
I am conducting this focus group discussion on behalf of Jemal Hassen who is studying his Doctorate degree in Food Security and Development at Addis Ababa University. The aim of the research to assess the impact of the northern Ethiopia conflict and drought on household resilience to food security in South Wollo zone. The research is entitled as "***Households Food Security and Resilience to Drought and Conflict in South Wollo Zone, Ethiopia***".
The research method includes collection of data from focus group participants like you who experienced the impact of recurrent drought and affected by the northern Ethiopia conflict. Therefore, you are selected based on your suitability to provide your understanding and thoughts in this regard.
I guarantee you that the information that I am collecting from you will be kept confidentially and it will only be used for the purpose of my research. If there are any questions that you do not have the answer or you are not comfortable in answering, you may ask to skip them as needed. However, I appreciate if you could provide genuine feedback to depict the true picture of the situation. I am grateful for all your support and for being part of my academic career and for sharing your life experiences.
Regards,

On behalf of Jemal Hassen
PhD Candidate at Addis Ababa University
WhatsApp: +251912689400
Mobile: +22787370450
Email: jemal.hass@yahoo.com or jemal.muhyie@yahoo.com

Focus Group Discussion (FGD) Checklist **Jemal Hassen – PhD Candidate at Addis Ababa University – Centre for Food Security** (Please provide the purpose of the research, confidentiality of data and confirm verbal consent before starting the discussion)	
1. General Information about FGD Participants	
Location/Address:	
District:	
Kebele:	
Village (location of the FGD):	
Dominant Agro-ecology of the village:	☐ Kolla ☐ Weyna Dega ☐ Dega
Total number of participants:	
Male:	
Female:	
Participants per age category:	

Number of <18 years:	
Number of 19 – 35 years:	
Number of 36 – 65 years:	
Number of >65 years:	
Number of Person with Disability (PWD) participating in the FGD:	
2. Food security	
What are the different crops that are grown in your community/village?	
What can you say about the food security situation in your community? Current status and changes in trend (is it deteriorating or improving)?	
What do you think about availability of sufficient food from production and marketing at all times of the year?	
Are there any household or community members who cannot access the available food because of different reasons like gender, age, disability or social status related factors?	
How much of the food that you consume comes from **production**, **purchase**, **gift** from families and friends, or **external assistance** from government or NGOs? Please indicate the proportion in percentage or order them in priority importance.	
Has there been a change in the way you are accessing food compared to previous years? If yes, how and why? Could you elaborate if there are changes in the way communities access food in the past 3 years? Has this been affected by the recent Northern Ethiopia conflict?	
What are the constraints or challenges that impact food security in the village? Could you elaborate factors related to food production, marketing, distribution, utilization of food, WASH and other social and cultural factors?	
Has your community been affected by a negative event such as drought, flood, violence, cuts in external support (aid), changes in prices of key commodities, etc. over the past three years? (Sketch a historic trend line)	
Who are the people most affected by the occurrence of the above events? How have they been impacted? How did they cope?	
Do/did these groups receive any type of formal or informal support (aid)? If yes, what type, by whom, for how long and how frequent? Could you compare if support available at all or even sufficient during the northern conflict period?	
3. Livelihoods	
What are the main sources of income in your community? (by women/men, sector)	
Have income opportunities changed over the past three years? How and why?	
Do income opportunities change between farming/cropping seasons? What do people do as income source during kiremt and bega or meher and belg?	
Referring to casual labor, is it mainly agricultural, non-agricultural, seasonal, monthly, daily?	
When income sources are not sufficient, what do vulnerable people in your community do to cope?	
Do you have access to credit/ or are able to borrow money when you need it? (Count number of people with access and record %) what are the different sources of credit/loan for poor households in the community?	
4. Disaster Impact Analysis	

What are the most common hazards the communities in the village are experiencing?

Shocks and stresses could cover a wide range of issues including but not limited to insecurity/violence, death of livestock, loss of employment for HH member, reduced/loss of income of a household member, unusually high food prices, serious illness or accident of HH member, unusually high fuel/transport prices, death of working HH member, theft of productive resources, low/few livestock births, drought/irregular rains, prolonged dry spell and others.

Please do not mention the above list of hazards but facilitate the discussion so that FGD participants mention the hazards they are experiencing as much as possible and score the probability of occurrence and impact if they happened.

Type of shock/hazard	Probability (How likely this hazard to happen) - score from 1 to 5	Impact (how much would the impact be if the hazard happen) 1 – 5	Type of shock/hazard	Probability (How likely this hazard to happen) - score from 1 to 5	Impact (how much would the impact be if the hazard happen) 1 – 5

Could you explain how drought affected household food security? What key food security and livelihoods activities are affected by drought?

What are the different impacts of the northern conflict in the community? Please elaborate the impact of the northern conflict on food system from production, harvesting, distribution, marketing, processing and consumption perspective?

Could you compare the difference in the impact of the **northern conflict** and **drought** on food security, livelihoods and resilience? Which one was too severe in its impact on food security?

What are the different coping mechanisms the communities experienced when a disaster happens **before the northern conflict**? Is there any shift in types and frequency of coping mechanism after the northern conflict? What are these differences?

What are the different social structures and mechanism that the community consider to cope with the impact of disaster?

Could you explain the contribution of assets (livestock, fixed assets, etc.) in conflict situation compared to other disasters like drought? Did asset play critical role to mitigate the impact of the northern conflict or increased vulnerability of households unlike during drought situation?

What type of households can easily cope with disaster impacts? Do you think this coping capacity is also different for different people during the northern conflict?

What were the specific gender related impacts of the northern conflict?

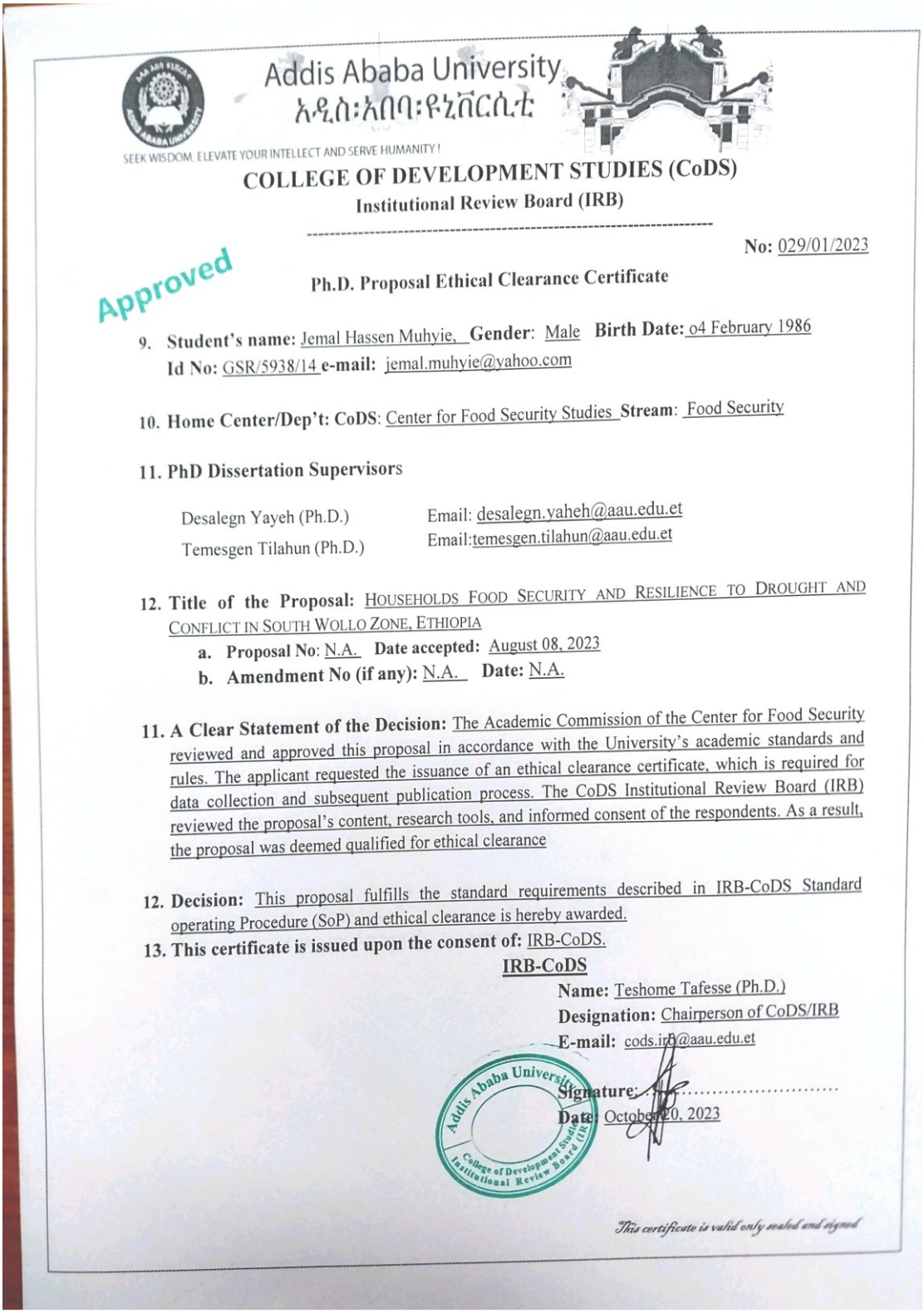
5. External assistance (government, local charities, NGOs, UN)

Is your community currently benefitting from any external assistance? If yes, what type, by whom and for how long?

Has your community benefitted from any external assistance pre, during and post conflict periods? Provide comparison on the quantity, quality and timeliness of these assistances (aid).

What is the frequency (one off, monthly, bi-monthly quarterly, by season) and has assistance been consistently provided according to plans?	
Do beneficiaries share their assistance with others who are also vulnerable but did not get any support? Do they sell assistance? Do they barter assistance? If yes, please explain the reason why people sell their aid?	
How do you expect the situation in this community to evolve from the impact of repeated drought and the recent northern conflict? How do you think people will gain resilience from the impact of such a devastating conflict?	
6. Resilience to Food Insecurity	
Which basic social services are available in your village among the following?	
improved water facility	☐
hospital/health center/post	☐
school	☐
electric power	☐
crop market	☐
livestock market	☐
Transport facility	☐
Veterinary service	☐
What and how drought affects the accessibility and availability of these basic services? Could you compare the access and availability of these services during drought period and when there was no drought? What and how conflict affects the accessibility and availability of these basic services? Could you compare the access and availability of these services before, during and after the northern Ethiopia conflict? How these services were affected by conflict?	
What is considered asset in the village? How these assets contribute to household resilience during disasters like drought and conflict? is there a difference in the role of assets at times of drought and the northern conflict? How these assets are converted to other resources or directly used to manage difficult time related to food insecurity? Is the value of any of the assets reduce during disasters? Does asset ownership like cash, livestock or any other asset contribute to further vulnerability during drought or conflict?	
What are the different support mechanisms available for your community during difficult times? How these supports contributed to household resilience during drought and conflict times? Have you observed any difference in availability, accessibility and contribution of these support mechanism during drought and conflict?	
What were the different household characteristics/factors contributed positively to adapt with difficult situations resulted from drought and conflict? (hint: household characteristics may include education of the household head, number of working people in the family, status or respect of the head of the family in the community etc.) Which type of households were less affected or can be able to easily bounce back from the impact of disasters particularly drought and conflict?	
What were the sources of loan in your community?	

Appendix 5: Institutional Review Board Approval



Addis Ababa University
አዲስ፡አበባ፡ዩኒቨርሲቲ

SEEK WISDOM, ELEVATE YOUR INTELLECT AND SERVE HUMANITY !

COLLEGE OF DEVELOPMENT STUDIES (CoDS)

Institutional Review Board (IRB)

No: 029/01/2023

Approved

Ph.D. Proposal Ethical Clearance Certificate

9. **Student's name:** Jemal Hassen Muhyie, **Gender**: Male **Birth Date:** 04 February 1986
   Id No: GSR/5938/14 **e-mail:** jemal.muhyie@yahoo.com

10. **Home Center/Dep't: CoDS**: Center for Food Security Studies **Stream**: Food Security

11. **PhD Dissertation Supervisors**

Desalegn Yayeh (Ph.D.)	Email: desalegn.yaheh@aau.edu.et
Temesgen Tilahun (Ph.D.)	Email:temesgen.tilahun@aau.edu.et

12. **Title of the Proposal:** HOUSEHOLDS FOOD SECURITY AND RESILIENCE TO DROUGHT AND CONFLICT IN SOUTH WOLLO ZONE, ETHIOPIA
    a. **Proposal No**: N.A. **Date accepted:** August 08, 2023
    b. **Amendment No (if any):** N.A. **Date:** N.A.

11. **A Clear Statement of the Decision:** The Academic Commission of the Center for Food Security reviewed and approved this proposal in accordance with the University's academic standards and rules. The applicant requested the issuance of an ethical clearance certificate, which is required for data collection and subsequent publication process. The CoDS Institutional Review Board (IRB) reviewed the proposal's content, research tools, and informed consent of the respondents. As a result, the proposal was deemed qualified for ethical clearance

12. **Decision:** This proposal fulfills the standard requirements described in IRB-CoDS Standard operating Procedure (SoP) and ethical clearance is hereby awarded.

13. **This certificate is issued upon the consent of:** IRB-CoDS.

IRB-CoDS

Name: Teshome Tafesse (Ph.D.)
Designation: Chairperson of CoDS/IRB
E-mail: cods.irb@aau.edu.et

Addis Ababa University College of Development Studies Institutional Review Board (IRB)

Signature: .....
Date: October 20, 2023

This certificate is valid only sealed and signed

Appendix 6: Statistical Tests for Assumptions of Linear Regression

Several statistical tests were conducted to determine validity of data and model specification for multiple linear regression. Among these statistical tests, testing for linear regression assumptions was conducted.

Linearity: the assumption of linearity requires a linear relationship between the dependent variable (per capita calorie availability) and each independent variable. This statistical test includes identification and correction of outliers using *extreme* Stata command and by winsorization of the data using the *wonsor2* command on Stata.

Augmented component-plus-residual plot (*acprplot)* which provides another graphical way to examine the relationship between variables was used as one option to graphically check the linearity of relationship of each independent variable with the dependent variable. Another way to check linearity of the relationship between the dependent and independent variables was using the two-way scatterplot graphical representation where linear and quadratic fit was used to visualize the relationship of the dependent variable with each independent variable separately (refer to Appendix 7). The graphical representation indicated that there was no linear relationship between per capita calorie availability (dependent variable) and few independent variables. Following these statistical tests, independent variables with non-linear relationship with the dependent variable were transformed into exponential form.

Multicollinearity: the second assumption for linear regression that was tested was the assumption of no multicollinearity. Multicollinearity exists when an independent variable interacts or highly correlate with one or more independent variables. The correlation matrix and Variance Inflation Factor (VIF) tests were used for this. It is recommended that the VIF score is less than 10 to determine non-existence of multicollinearity. If the VIF score is more than 10, it implies that there is problem of multicollinearity in the data. The VIF test indicated that none of the VIF results passed 3 while the overall average VIF score was

less than 2 for the data. this was interpreted that there was no problem of multicollinearity in the data as the VIF was less than 10.

Normality of residuals: the normality assumption dictates that the residuals are normally distributed. In order to run normality test for the error term, the predicted value of the dependent variable (yhat) and the residuals of the error term were generated. Once the residuals of the error term were computed, normality assumption was verified using histogram as a graphical representation which provided a normal bell-shaped graph for the error term, e.

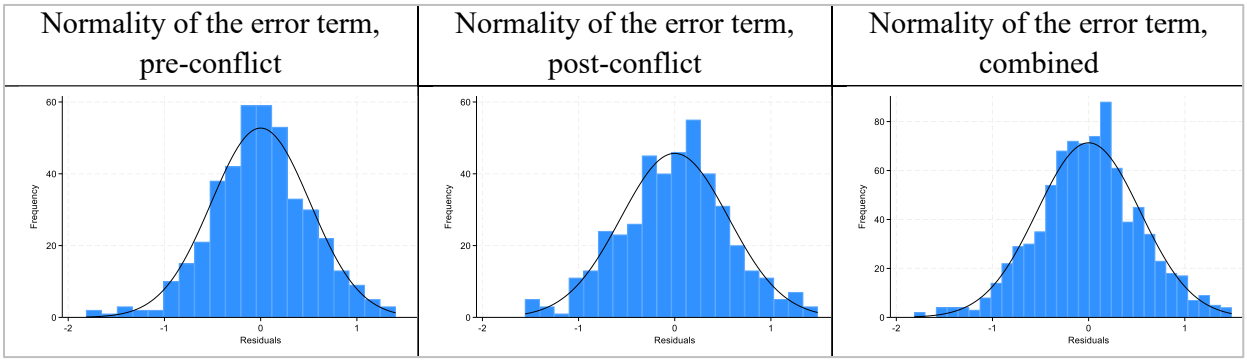


Figure Appendix 6.1: Histogram representation of the error term (e)

In addition, the Shapiro-Wilk test (swilk test) was used to statistically determine normality of the error term. The null hypothesis for the swilk test is that the probability value (p-value) is less than 0.05, we can determine that the residuals are not normally distributed. However, if the p-value in the swilk test is greater than 0.05, we can determine that the null hypothesis cannot be rejected, meaning that residuals are normally distributed. For the data, the probability of the swilk test was more than 0.05 for both pre-conflict and post-conflict reference periods which confirms normality of the error term.

Table Appendix 6.1: Shapiro Wilk W test for normality of the error term (e)

Variable (error term e)	# of observations	W	V	z	Prob>z
Pre-conflict reference	422	0.99317	1.971	1.619	0.05272
Post-conflict reference	422	0.99628	1.074	0.171	0.43215

No Heteroscedasticity: Heteroscedasticity refers to a situation where there is no constant variance of the error term. The assumption dictates that the variance of the residuals should be constant across different ranges of data meaning that they should be homoscedastic. In order to test if there was problem of heteroscedasticity, the Brush Pagan test (*estat hettest*) was used after running the regression. The null hypothesis for the Brush Pagan test is the assumption of a constant variance. Therefore, if the p-value is less than 0.05, the null hypothesis has to be rejected as it is an indication of heteroscedasticity. The data demonstrates that the p-value was more than 0.05 for both pre-conflict and post-conflict reference periods which indicates that the residuals are homoscedastic (no heteroscedasticity).

Table Appendix 6.2: Breusch–Pagan/Cook–Weisberg test for heteroskedasticity for pre-conflict and post-conflict reference periods

Reference periods	Assumption	Variable	Null hypothesis	Chi2 (1)	Prob > chi2
Pre-conflict	Normal error terms	Fitted values of the log of per capita calorie available	Constant variance	1.40	0.2374
Post-conflict				0.87	0.3502

Model specification test (no omitted variable test): the model specification test for omitted variables was undertaken. The *ovtest* command in Stata was used and the p-value was 0.0651 and 0.2514 for pre-conflict and post-conflict reference periods respectively. In both cases, the p-value was more than 0.05 and we accept the null hypothesis of no-omitted variables. In addition, a link test for model specification was run and the p-values were more than 0.05 where we accepted the null hypothesis of no omitted variables.

Table Appendix 6.3: Omitted variable test using *linktest* for pre-conflict reference

Source	SS	df	MS	Number of observations		422
Model	77.235	2	38.617	F(2, 419)		145.81
Residual	110.973	419	0.265	Prob > F		0.0000
Total	188.208	421	0.447	R-squared		0.4104
				Adj R-squared		0.4076
				Root MSE		0.51464
					95% confidence interval	
New_aver_kcal_log	Coefficient	Std. err.	t	P>|t|	Low bound	High bound
_hat	0.9478	1.2261	0.77	0.44	-1.4623	3.3579
_hatsq	0.0036	0.0847	0.04	0.966*	-0.1629	0.1701
_cons	0.1881	4.4328	0.04	0.966	-8.5252	8.9014

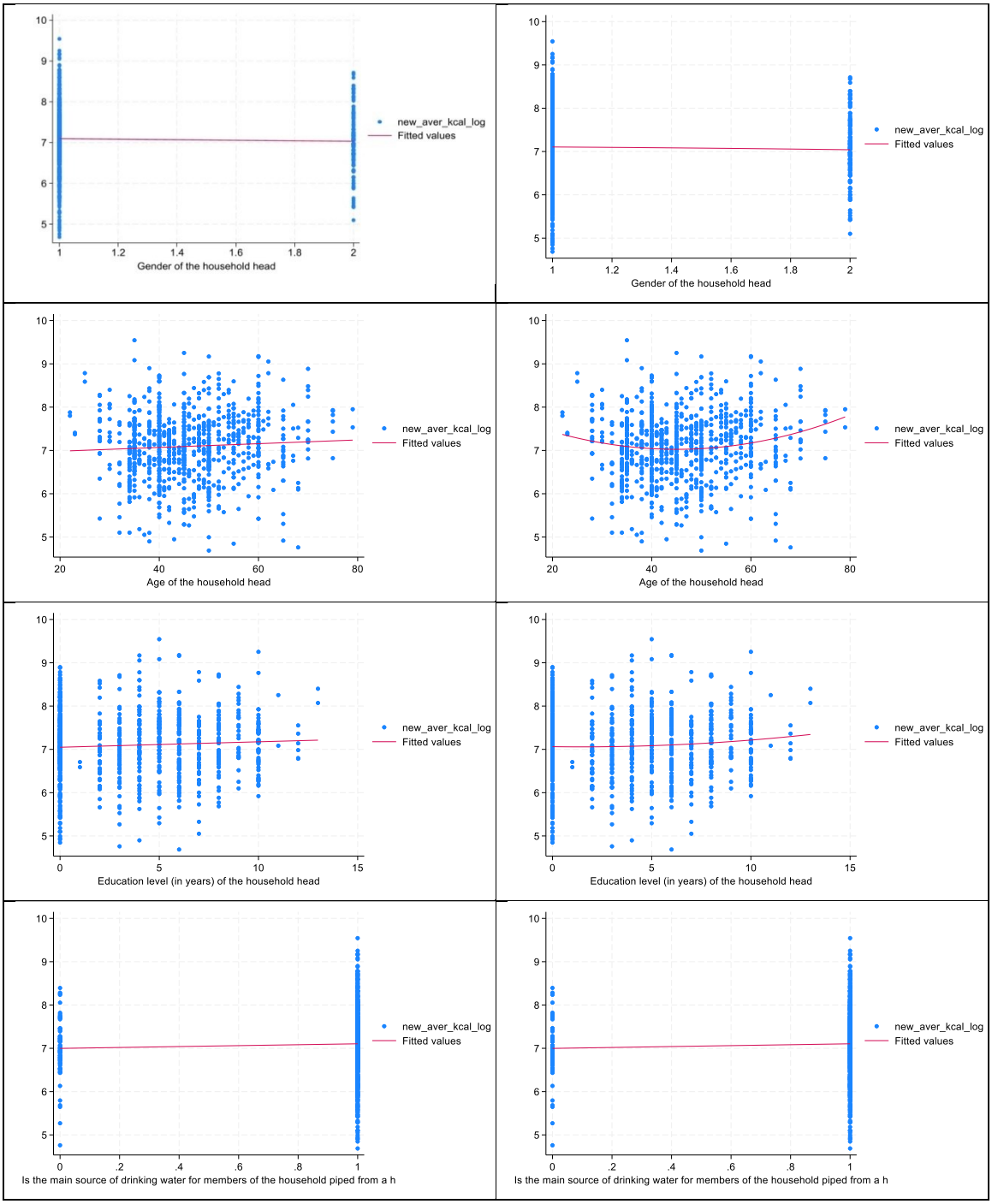
* p-values which is not statistically significant resulting in acceptance of the null hypothesis that there is no omitted variable.

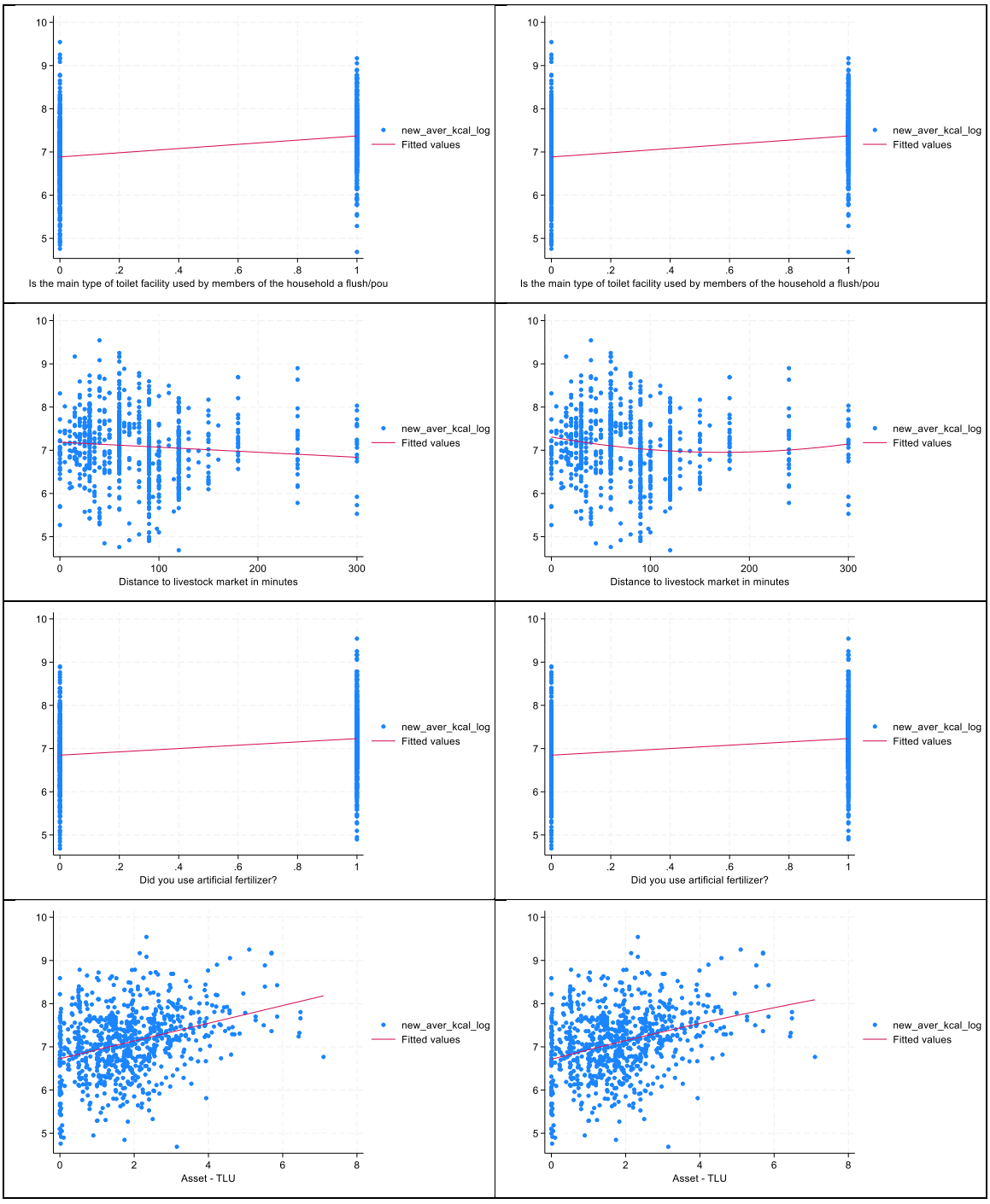
Table Appendix 6.4: Omitted variable test using linktest for post-conflict reference

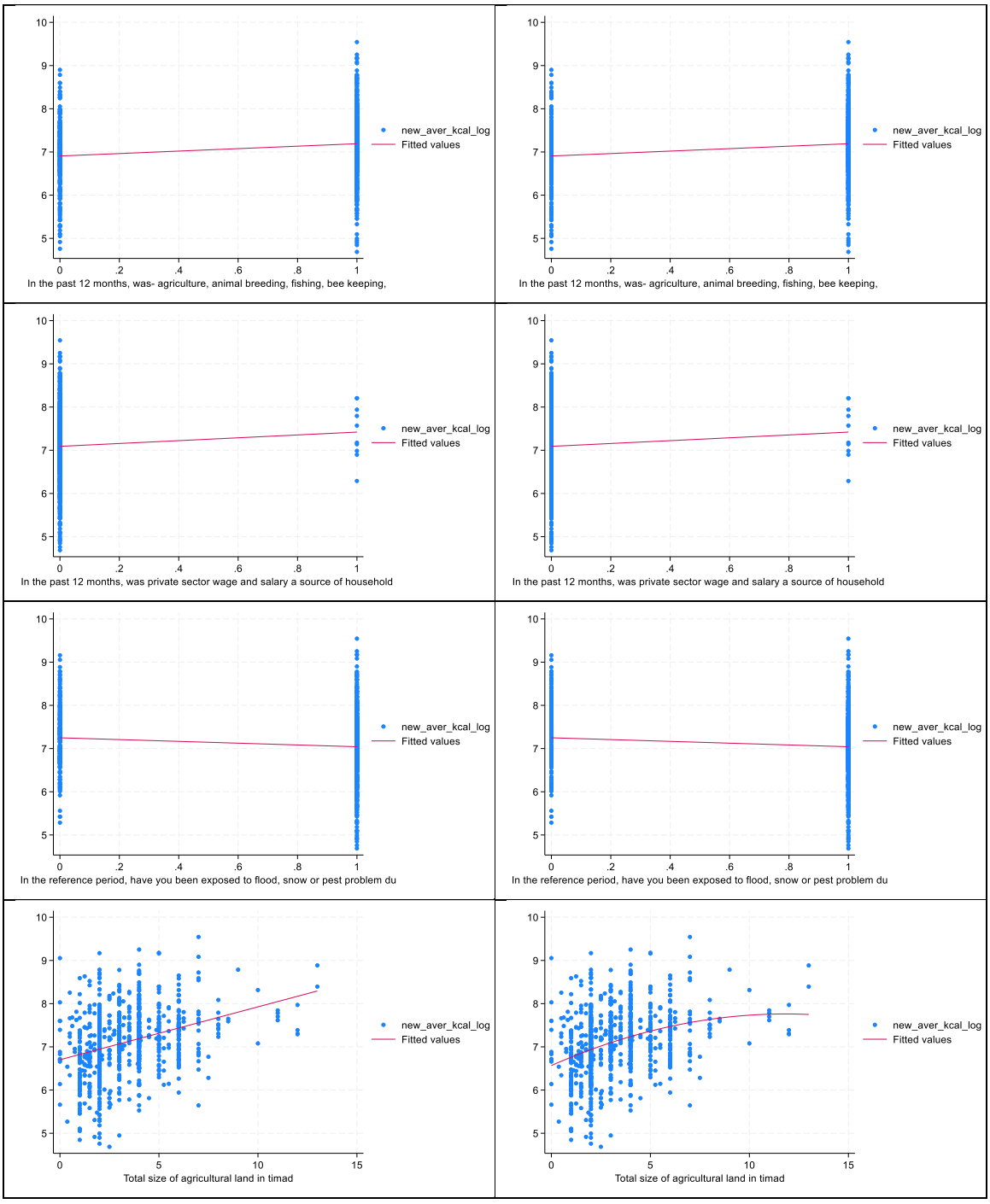
Source	SS	df	MS	Number of observations		422
Model	135.3268	2	67.6634	F(2, 419)		214.38
Residual	132.2487	419	0.3156	Prob > F		0.0000
Total	267.5755	421	0.6356	R-squared		0.5058
				Adj R-squared		0.5034
				Root MSE		0.56181
					95% confidence interval	
New_aver_kcal_log	Coefficient	Std. err.	t	P>|t|	Low bound	High bound
_hat	1.6577	0.8615	1.92	0.055	-0.0357	3.3510
_hatsq	-0.0472	0.0618	-0.76	0.445*	-0.1687	0.0742
_cons	-2.2741	2.9932	-0.76	0.448	-8.1576	3.6094

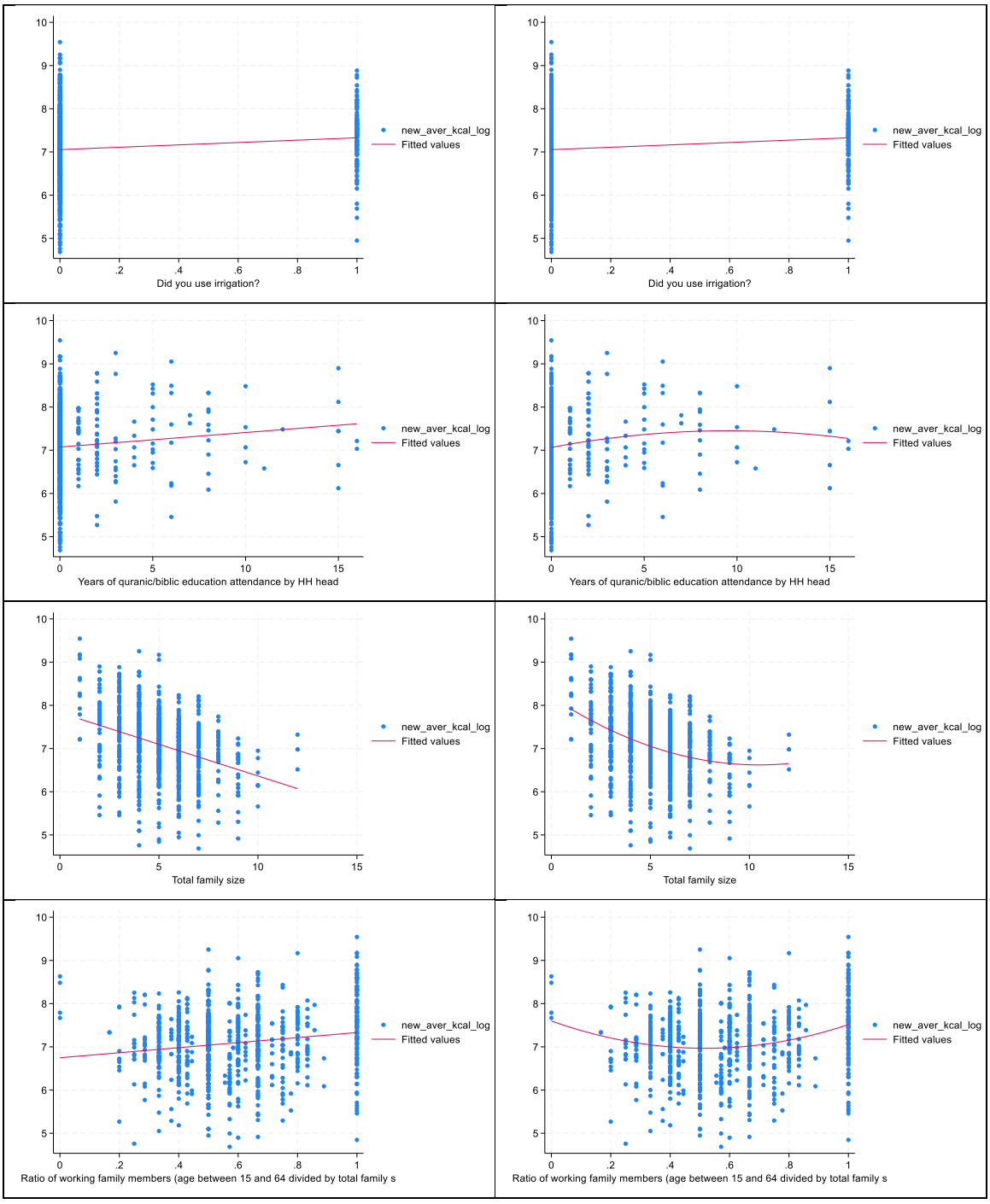
* p-values which is not statistically significant resulting in acceptance of the null hypothesis that there is no omitted variable.

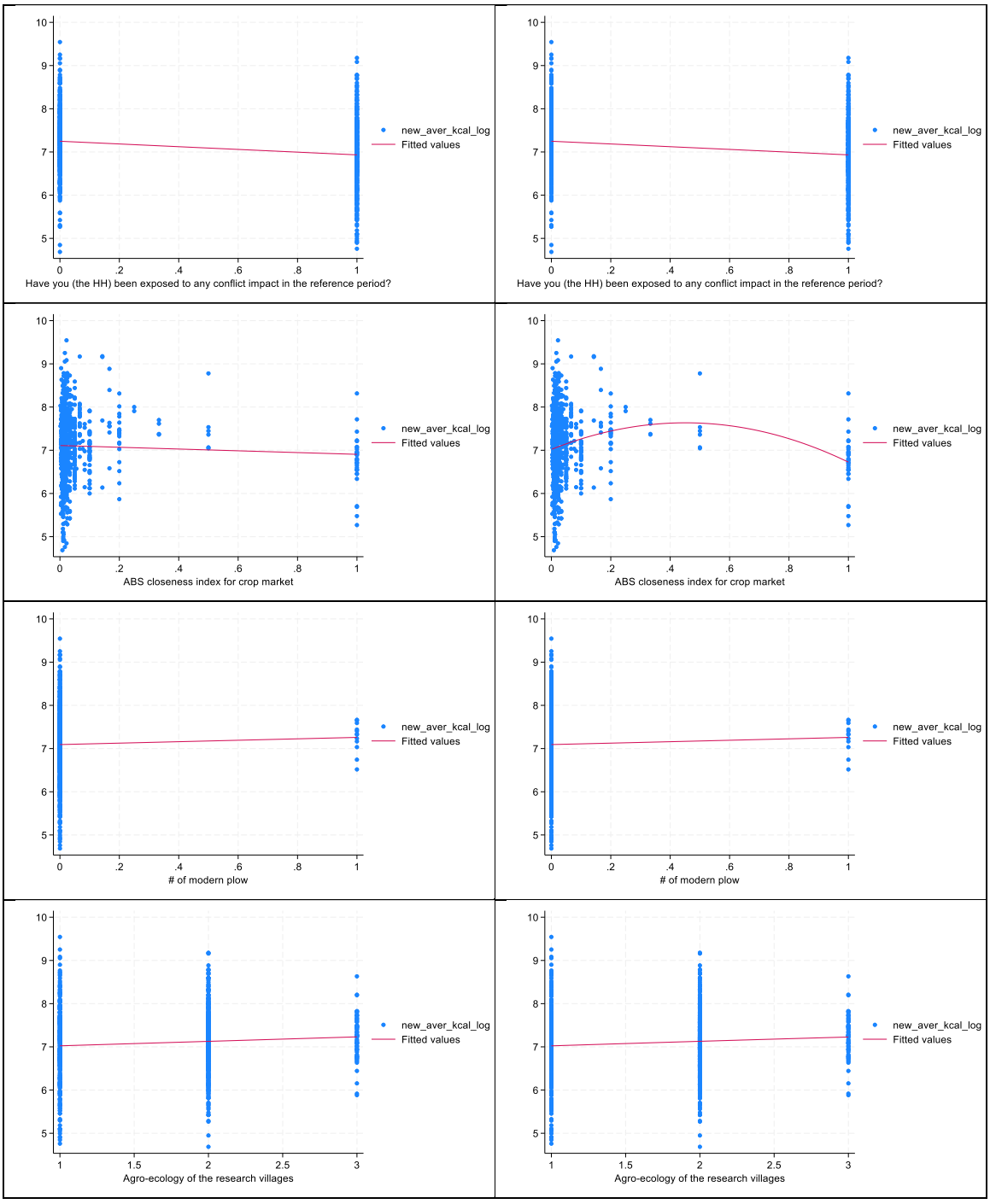
Appendix 7: Linearity Graphs to Suggest Data Transformation

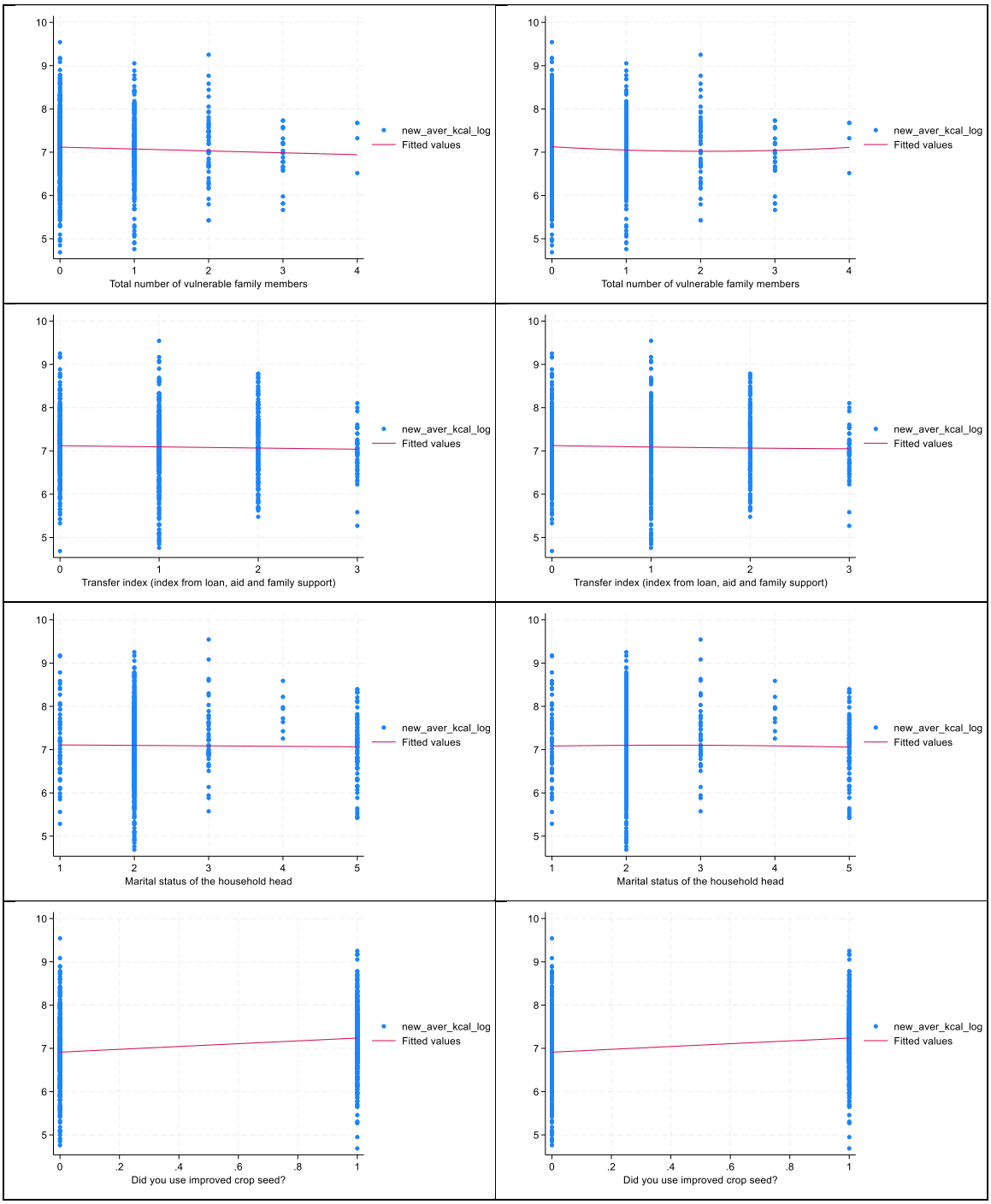


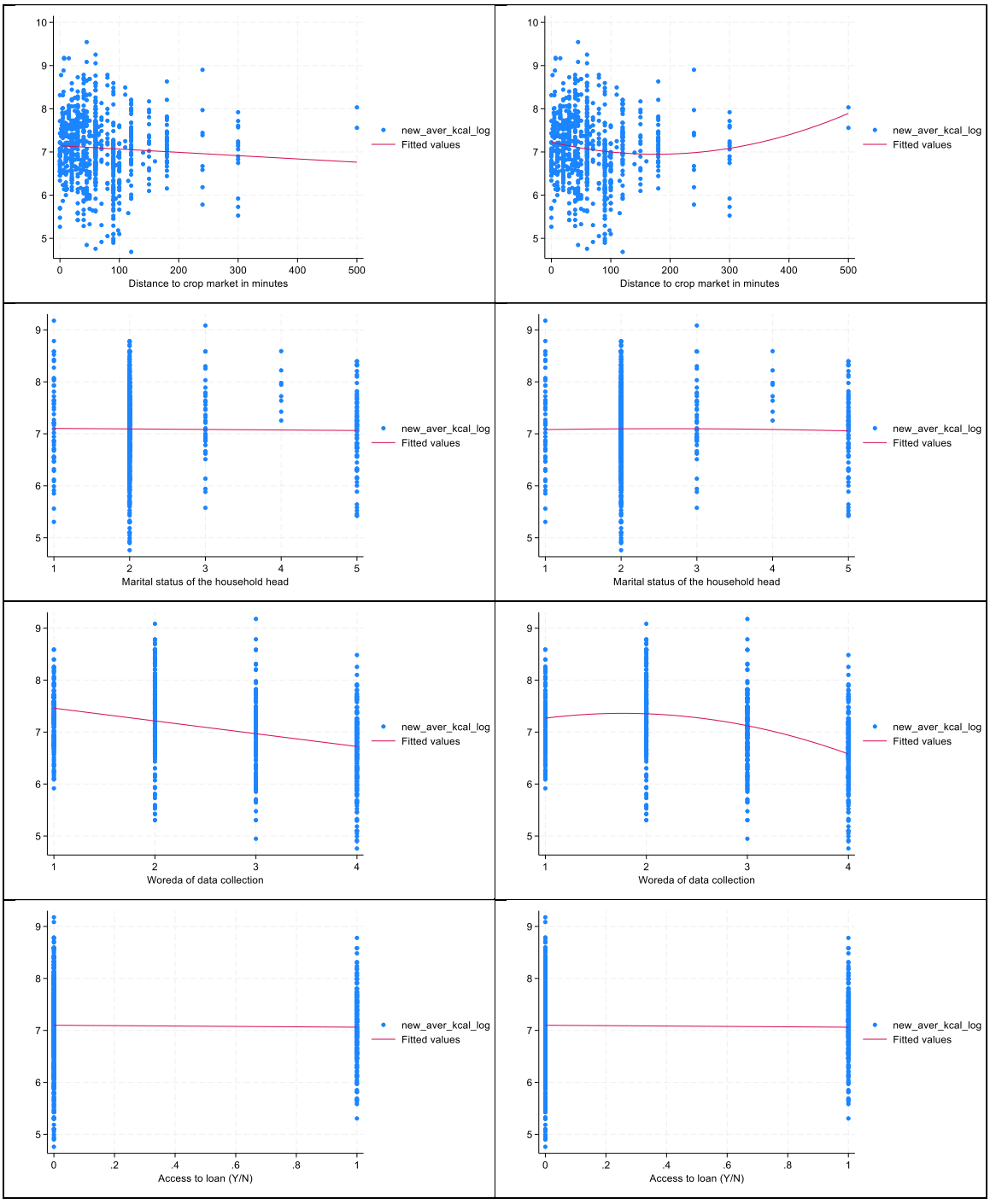

new_aver_kcal_log
Fitted values
Is the main type of toilet facility used by members of the household a flush/pou
Distance to livestock market in minutes
Did you use artificial fertilizer?
Asset - TLU

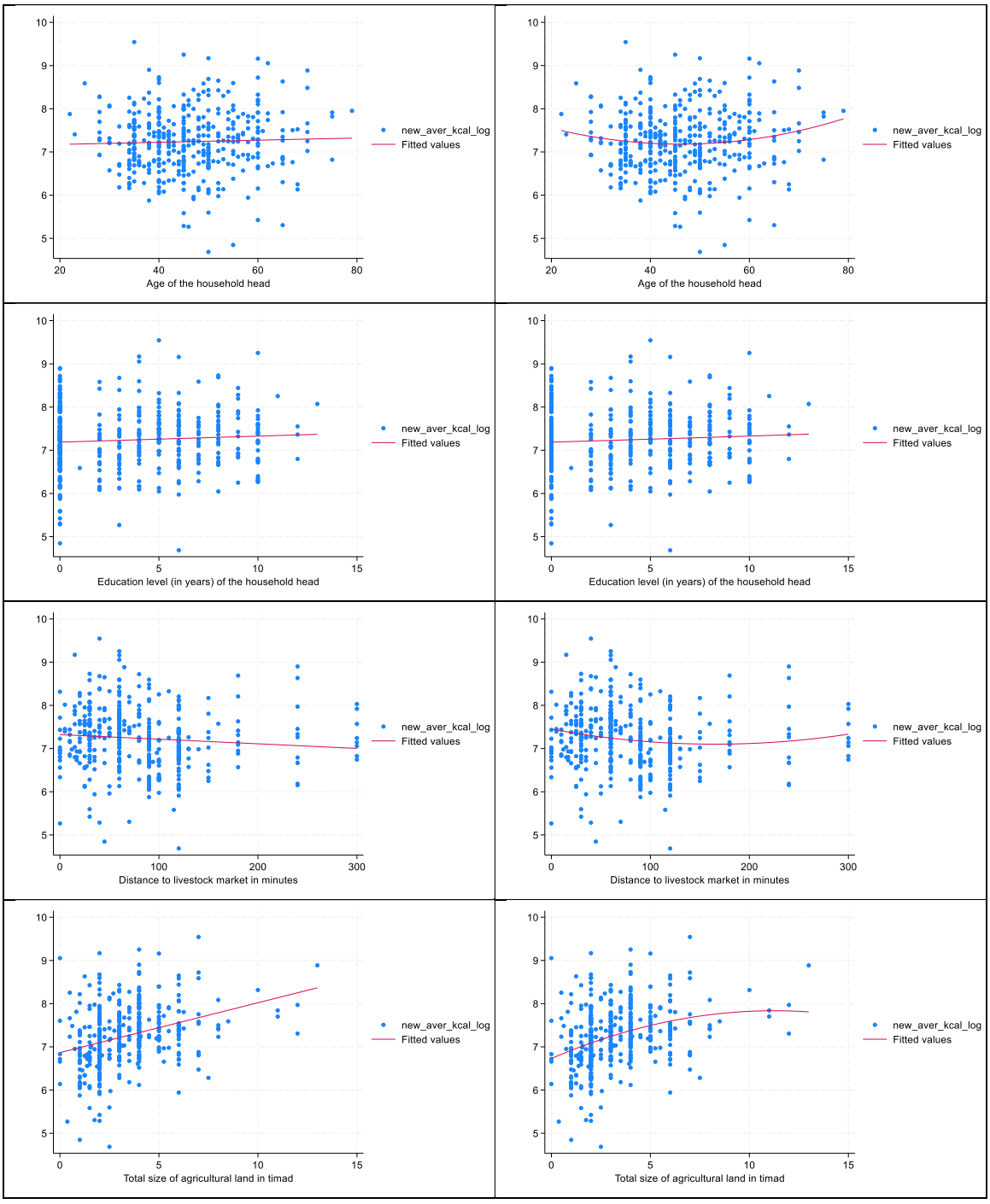

10
9
8
7
6
5
0
.2
.4
.6
.8
1
new_aver_kcal_log
Fitted values
In the past 12 months, was- agriculture, animal breeding, fishing, bee keeping,
In the past 12 months, was private sector wage and salary a source of household
In the reference period, have you been exposed to flood, snow or pest problem du
0
5
10
15
Total size of agricultural land in timad

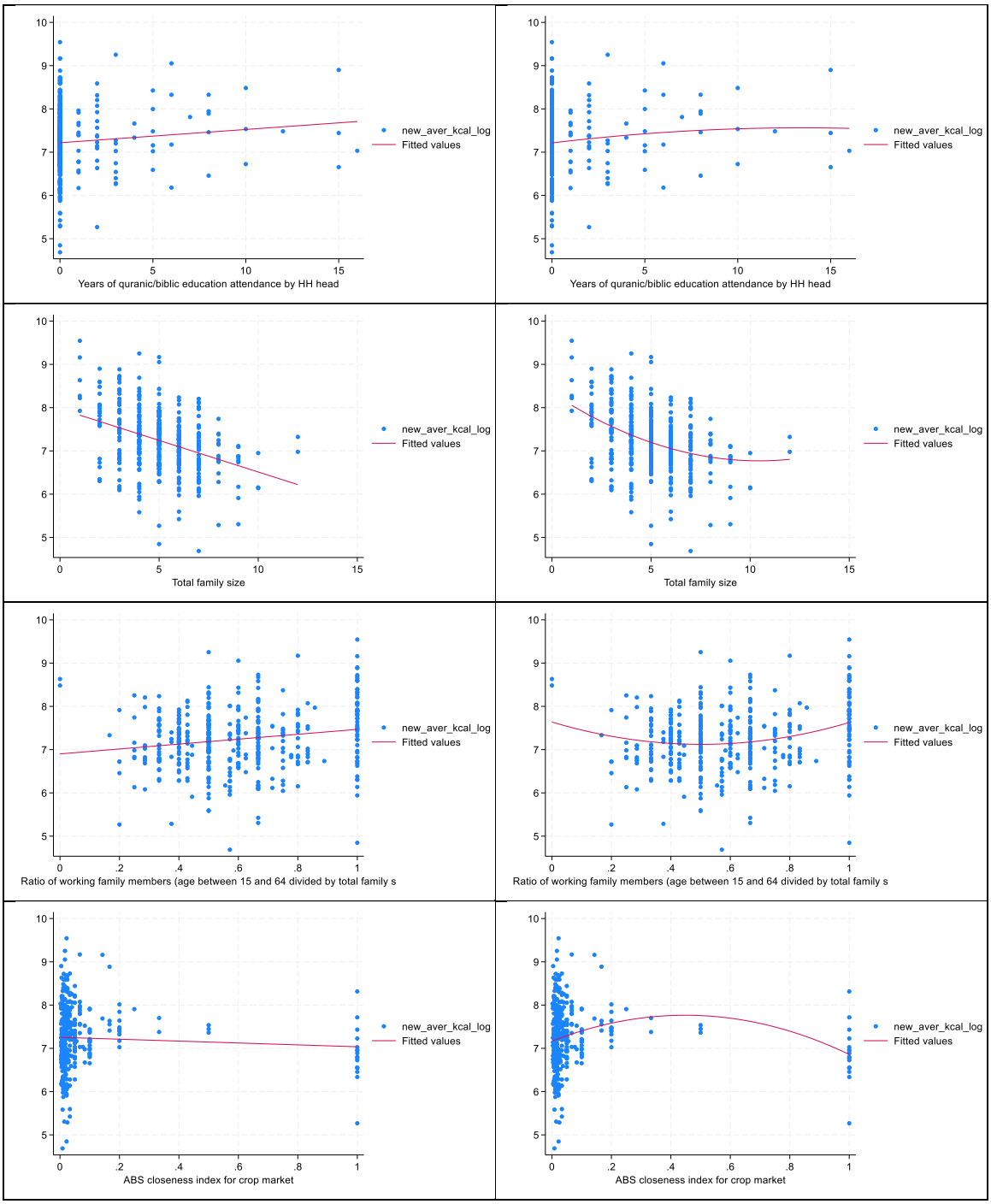

new_aver_kcal_log
Fitted values
Did you use irrigation?
Years of quranic/biblic education attendance by HH head
Total family size
Ratio of working family members (age between 15 and 64 divided by total family s


new_aver_kcal_log
Fitted values
Have you (the HH) been exposed to any conflict impact in the reference period?
ABS closeness index for crop market
# of modern plow
Agro-ecology of the research villages


new_aver_kcal_log
Fitted values
Total number of vulnerable family members
Transfer index (index from loan, aid and family support)
Marital status of the household head
Did you use improved crop seed?


new_aver_kcal_log
Fitted values
Distance to crop market in minutes
Marital status of the household head
Woreda of data collection
Access to loan (Y/N)


new_aver_kcal_log
Fitted values
Age of the household head
Education level (in years) of the household head
Distance to livestock market in minutes
Total size of agricultural land in timad


new_aver_kcal_log
Fitted values
Years of quranic/biblic education attendance by HH head
Total family size
Ratio of working family members (age between 15 and 64 divided by total family s
ABS closeness index for crop market

Appendix 8: Recall Bias and Association with Socioeconomic and Demographic Characteristics

A chi-square test was run to determine any significant association between recall error and different socioeconomic and demographic characteristics of respondents. These socioeconomic and demographic characteristics include level of conflict exposure, age of the household head, sex of the household head, education level of the household head, district, marital status, agroecological variability, off farm participation, and food security status. The chi-square test indicated that none of the socioeconomic and demographic characteristics has significant association with the ability of respondents to recall past events.

Table Appendix 8.1: Chi-square test for recall error and district

Recall error	Research Districts				Total
	Delanta	Dessie Zuria	Kalu	Worebabo	
Yes	26	44	26	29	125
No	63	94	62	78	297
Total	89	138	88	107	422

Pearson chi2(3) = 0.6718 Pr = 0.880

Table Appendix 8.2: Chi-square test for recall error and sex of household head

Recall error	Sex of the household head		Total
	Male	Female	
Yes	104	21	125
No	254	43	297
Total	358	64	422

Pearson chi2(1) = 0.3686 Pr = 0.544

Table Appendix 8.2: Chi-square test for recall error and marital status

Recall error	Marital status					Total
	Single	Married	Divorced	Separated	Widow	
Yes	9	93	8	1	14	125
No	18	234	14	3	28	297
Total	27	327	22	4	42	422

Pearson chi2(4) = 1.1955 Pr = 0.879

Table Appendix 8.3: Chi-square test for recall error and conflict exposure

Recall error	Conflict exposure		Total
	No	Yes	
Yes	3	122	125
No	8	289	297
Total	11	411	422

Pearson chi2(1) = 0.0299 Pr = 0.863

Table Appendix 8.4: Chi-square test for recall error and severity of conflict impact

Recall error	Rate of conflict impact on food system				Total
	No damage	Mild damage	Moderate damage	Severe damage	
Yes	13	24	31	57	125
No	30	55	76	136	297
Total	43	79	107	193	422

Pearson chi2(3) = 0.0519 Pr = 0.997

Table Appendix 8.5: Chi-square test for recall error and food security status on the HFIAS scale

Recall error	Food security status – HFIAS Prevalence				Total
	Food secure	Mildly food insecure	Moderately food insecure	Severely food insecure	
Yes	11	7	42	65	125
No	25	24	123	125	297
Total	36	31	165	190	422

Pearson chi2(3) = 4.0459 Pr = 0.257

Table Appendix 8.6: Chi-square test for recall error and age categories

Recall error	Age categories						Total
	Between 20 – 29 years	Between 30 – 39 years	Between 40 – 49 years	Between 50 – 59 years	Between 60 – 69 years	Between 70 – 79 years	
Yes	6	31	43	25	17	3	125
No	7	71	115	70	27	7	297
Total	13	102	158	95	44	10	422

Pearson chi2(5) = 4.3862 Pr = 0.495

Table Appendix 8.7: Chi-square test for recall error and agroecology

Recall error	Agroecology			Total
	Dega	Weyna Dega	Kola	
Yes	45	69	11	125
No	123	150	24	297
Total	168	219	35	422

Pearson chi2(2) = 1.0763 Pr = 0.584

Table Appendix 8.8: Chi-square test for recall error and off-farm participation

Recall error	Off-farm participation		Total
	No	Yes	
Yes	92	33	125
No	204	93	297
Total	296	126	422

Pearson chi2(1) = 1.0140 Pr = 0.314

Table Appendix 8.9: Chi-square test for association between recall error and food security status based on Household Food Balance Model

Recall error	Food security status based on household food balance model		Total
	Food insecure	Food secure	
Yes	105	20	125
No	261	36	297
Total	366	56	422

Pearson chi2(1) = 1.1500 Pr = 0.284