Addis Ababa University
College of Development Studies
Center for Food Security Studies

Analysis of the Food System Drivers, Food Security, and Resilience Situations in the Majang Zone, Southwestern Ethiopia

A Doctoral Dissertation

By:

Shibru Zerihun

August, 2024

Addis Ababa, Ethiopia

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By:

Shibru Zerihun Fanta

Supervisors: Messay Mulugeta (PhD, Associate Professor)

Meskerem Abi (PhD, Assistant Professor)

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Declaration

I, **Shibru Zerihun Fanta,** do hereby declare to Addis Ababa University School of Graduate Studies that this dissertation paper 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 dually acknowledged.

Name: **Shibru Zerihun Fanta**

Signature: _____

Date of Submission: ___ August 2024_____

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College of Development Studies
Center for Food Security Studies

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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 Examining Board, to the Center of Food Security Studies, College of Development Studies, Addis Ababa University.

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Dedication

This dissertation is dedicated to my beloved mother and elder brother, Birke Umar Mohammed and Getachew Tadese Disassa, who passed away while I was pursuing my PhD. May your soul rest in heaven.

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Acronyms and Abbreviations

ACF	Action Contre la Faim
ADB	African Development Bank
ADLI	Agricultural Development Lead Industrialization
AGP	Agricultural Growth Program
AGRA	Alliance for Green Revolution in Africa
AIDS	Acute Immune Deficiency Syndrome
ATA	Agricultural Transformation Agency
CESCR	Committee on Economic, Social, and Cultural Rights
CFS	Committee on World Food Security
CoDS	College of Development Studies
COVID	Corona Virus
CSA	Central Statistics Authority
CRGE	Climate Resilience Green Economy
CSA	Conservation Agriculture
CSI	Coping Strategy Index
DA	Development Agents
DFID	Department for International Development
DRMFSS	Disaster Risk Management and Food Security Sector
EPD	Estimated Population Density
EPRDF	Ethiopian People's Revolutionary Democratic Front
EPRDF	Ethiopian People's Revolution Democratic Front
EU	European Union
FAD	Food Availability Decline
FAO	Food and Agriculture Organization
FCS	Food Consumption Score
FDGs	Focus Group Discussion
FDRE	Federal Democratic Republic of Ethiopia
FED	Food Entitlement Decline
GDP	Gross Domestic Product
GHI	Global Hunger Index
GPNRS	Gambella People's National Regional State
GTP	Growth and Transformation Plan
HDI	Human Development Index
HFIAS	Household Food Insecurity Access Scale
HIV	Human Immune Virus
IFPRI	International Food Policy Research Institute
IFRC	International Federation of Red Cross
IMF	International Monitory Fund
INDEX	International Dietary Data Expansion
IPC	Integrated Food Security Phase Classification
IRB	Institutional Review Board
KIIs	Key Informants Interviews
KMO	Kaiser–Meyer–Olkin
LULCC	Land Use Land Cover Change
MELCA	Movement for Ecological Learning Through Community Action

MoALR	Ministry of Agriculture and Livestock Resource
MoANR	Ministry of Agriculture and Natural Resources
MoFED	Ministry of Finance and Economic Development
MoLF	Ministry of Livestock and Fisheries
NAPA	National Adaptation Program of Africa
NMA	National Meteorology Agency
NNP	National Nutrition Program
NTFP	None Timber Forest Product
OCHA	Office for the Coordination of Humanitarian Affairs
PASDEP	Program for Accelerated and Sustainable Development to Eradicate Poverty
PCA	Principal Component Analysis
PSNP	Participatory Safety Net Program
RIMA	Resilience Index Measurement and Analysis
RMF	Resilience measurement focus
RMS	Resilience measurement sensitivity
RRC	Relief and Rehabilitation Commission
SDG	Sustainable Development Goal
SDRRP	Sustainable Development and Poverty Reduction Program
SLA	Sustainable Livelihood Approach
SLF	Sustainable Livelihood Framework
SNNPR	Southern Nations and Nationalities and Peoples Region
TANGO	Technical Assistant to NGOs
TLU	Tropical Livestock Unit
ToR	Term of Reference
UK	United Kingdom
UN	United Nations
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Program
UNECA	United Nations Economic Commission of Africa
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
US	United States
USAID	United States Agency for International Development
USD	United States Dollar
USDA	United States of Department of Agriculture

Abstract

Food security has always been a pressing issue, especially in developing nations like Ethiopia. Despite ongoing efforts, Ethiopia continues to face numerous challenges in ensuring food security. The objective of this study was investigating the food system drivers, the status of food security, and the resilience situation of households in the Majang zone of Ethiopia. The study involved 320 randomly chosen households from 10 villages in the two districts. Both quantitative and qualitative data were collected from the primary and secondary sources. . Analytical measures such as Framework-based assessment, descriptive statistics, binary and ordered logistic regression, principal components, and Chi-square test analytical methods were utilized to generate the results. The framework based assessment results revealed that unproductive agriculture, population increase, natural resource misuse, less productive health and education sectors, ineffective policies, and poor infrastructural and service institutions were the major factors driving impairing productivity of the food system in the area. Additionally, the study found that family size, education, landholding, livestock ownership, income, and possession of beehives positively determined the food security status of households. Conversely, the use of chemical pesticides and the age of the household head had an inverse relationship with food security. Furthermore, the study examined the resilience of households and found that 40% were resilient, while 60% were non-resilient. Regarding food insecurity, 14.76% of household were food secure, while 36.87%, 37.11%, and 11.26% were mildly, moderately, and severely food insecure households, respectively. The coping strategy index revealed that 2.81%, 38.75%, 31.56%, and 26.87% of the households adopted less severe, mildly severe, moderately severe, and highly severe coping strategies, respectively. The finding of the study revealed various drivers and pressures that strain the local food system and security, leading to high level of food insecurity and weak resilience capacity. Consequently, the households forced to adopt diverse coping strategies. The study suggested that it is crucial to implement programs and policies that promote sustainable use and management of natural resources, improve the service sectors, support agriculture with improved technologies and practices, strengthen income diversification to enhance resilience capacity, and reduce severe coping practices.

Key Words: Ethiopia, Majang, Food security, Households, food systems, Resilience, Coping strategies, Regression

CHAPTER ONE: GENERAL INTRODUCTION

1.1. Background

All citizens have human and constitutional rights to food and nutritional security, even though achieving these rights is still a very difficult goal internationally, especially in low-income countries (FAO, 2006). According to the 1996 FAO working definition food security is achieved when "all people at all times have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (Clay, 2002). Inversely, food insecurity exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and an active and healthy life (FAO, 2005).

Food security issues are fundamental elements and functions of a sustainable food system. A sustainable food system is “a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised” (FAO, 2018c). The elements, activities, and results of a sustainable food system all contribute to ensuring food security. Food systems include all parties involved in the production, use, and disposal of food products as well as their value-adding activities. A sustainable food system guarantees food security and nutrition for everyone while maintaining the economic, social, and environmental foundations necessary to produce food security and nutrition for future generations according to the same source. A food system's output impacts food accessibility, cost, and quality (Kumar & Babu, 2021).

Even though attempts are being made to solve the food security crisis, it has been estimated that approximately 735 million people worldwide—more than 270million of whom reside in Africa—are still food insecure (FAO *et al*., 2023). Additionally, according to a preliminary assessment of FAO and its partners , the COVID-19 pandemic may increase the number of undernourished people worldwide (FAO *et al*., 2020). In Ethiopia, the number of poor and severely food-insecure people was 21.1% in the year 2022 (FAO *et al*., 2023), with an estimated 25 million people living below the threshold of survival (Diriba, 2020a), which is similar to the

situation in most of sub-Saharan Africa, where it was predicted that 8.5 million people had experienced extreme food insecurity in the early 2020s (FAO *et al*., 2020).

Similarly, FAO *et al*. (2021) found that the main causes of food insecurity in sub-Saharan Africa are unemployment, violence, and climate shocks. In the same vein, approximately 87% of Ethiopia's population suffers from multidimensional poverty, including a lack of employment prospects, inadequate access to education and healthcare, and food insecurity (WFP, 2020). Accordingly, developing nations may need to increase the production of several key commodities in addition to additional food to address their problems, improve service delivery, and improve institution and infrastructure (Zegeye *et al*., 2020).

Moreover, the effects of COVID-19, desert locusts, relocation, and high food costs are some of the recent driving forces and causes of food security (IPC, 2020). The violence that broke out in the country's north took more than three years to develop, and it has contributed to only escalating the country's long-standing issues with food insecurity. USAID's (2015) also revealed that 10.2 million individuals were dependent on food assistance. Given these findings, the 2021 GHI estimates place Ethiopia 90th out of 116 nations with a score of 24.1, an improvement over the estimates from previous years but still seriously characterized (Von Grebmer *et al*., 2022). According to the same estimate, the population's under-nutrition rate was 16.1%, the prevalence of stunting and wasting in children under-five years was 36.8% and 6.8%, respectively, and the under-five death rate was 5.1%. The FAO *et al*. (2023) report showed prevalence of stunting and wasting in under five years children in the tear 2022 was 34.4% and 4.9% respectively, indicating a slight reduction in both indicators.

A household's level of food security can be viewed as the main result of food systems sustainable functioning (Ericksen, 2008). According to Mbow *et al*. (2019), the four pillars of food security are impacted by both climate-related and non-climate-related pressures on the food system. Denning & Fanzo (2016) supported the idea that all four aspects of food security are negatively impacted by the deterioration of natural resources. Insufficient land policy and management techniques were cited as causes of sub-Saharan Africa's deforestation and land degradation, which resulted in flood disasters and food shortages (Eneyew & Bekele, 2012).

The government of Ethiopia has been planning and implementing some response measures to augment the food gap both for the population and for children under-five years of age via foreign food aid, more recently, school feeding program initiations. The productive safety net program has supported more than eight million people in recent years (International Food Policy Research Institute (IFPRI), 2021). Nevertheless, similar to other countries, Ethiopia's food insecurity and unsustainable food system are primarily caused by factors such as a high dependency ratio (approximately 110%) on less productive agriculture, a fast annual population growth rate (2.6, according to a 2018 World Bank report), climate change, deforestation, conflict, education, per capita land holding, production capacity, health, institutions, technologies, and access to infrastructure, as well as subpar services (Endalew *et al*., 2015; MoFED, 2012). Gaps in program and policy, according to Eneyew & Bekele (2012), have been another issue. On the page of vacant national development policy, the Ethiopian food security policy has been bound by multiple weaknesses. The Ethiopian food security policy has several flaws and is restricted by the blank page of the national development policy. According to Devereux (2000), the first is a lack of conceptual understanding of the dynamic and multifaceted nature of food insecurity. Policymakers and development practitioners in Ethiopia have given little weight to this issue.

Additionally, it was suggested that the consequences of climatic variability on ecosystems, biodiversity, and drought had a significant impact on food security (Keller, 2009). As evidence of this, the nation has experienced numerous floods and droughts throughout its history, including the most recent El Nino damage in 2015 and 2016 (FAO, 2017; FAO *et al*., 2017; UNOCHA, 2016; World Bank, 2010; NAPA, 2007). In the past 50 years, Ethiopia has undergone more than 15 drought occurrences (World Bank, 2017). According to Kasie (2017), Ethiopia is a country that is structurally food insecure and where access to food is restricted due to several issues.

In Ethiopia, the agriculture sector remains the largest pool on which the livelihood of the people relied. Hence, several of the policies and programs have been formulated and implemented founding on the agriculture. Ethiopia’s effort to modernize the agricultural sector started to take shape in the early 1950’s where three successive five years development plans were prepared

covering 1957-1961; 1963-1967; and 1968-1973 during the imperial era (Diriba, 2020a). The *Derg*, overtaking power in 1975, has established agricultural economy and food supply policy of the nation. Nationalization of rural land and creation of the peasant associations, national revolutionary production campaigns, the minimum package program, peasant agricultural development and extension program, formation of cooperative societies, villagization programs (Diriba, 2020a) and the Relief and Rehabilitation Commission (RRC) to prevent disasters (Degefa, 2005) were the policies and programs endorsed. Similarly, the Ethiopian People's Revolution Democratic Front (EPRDF) after taking charge of the nation installed the concept of Democratic Developmentalism. The sustainable development and poverty reduction program (SDRRP), The Program for Accelerated and Sustainable Development to Eradicate Poverty (PASDEP) (MoFED, 2006), and later the Growth and Transformation Plan I and II (GTP I and II) have been the development spheres (Diriba, 2020a) under the agriculture-focused rural development program agricultural development-led industrialization (ADLI) (MoFED, 2003).

Moreover, in its effort to curb the challenges and develop sustainable food system, food and nutrition security endeavors Ethiopia has identified, prioritized and defined national policies, programs and strategies. Among these initiatives the Food Security Program 2010-2014 (MoARD, 2009); Ethiopian Sustainable Development and Poverty Reduction Program (MoFED, 2002); Ethiopian Nutrition Sensitive Agriculture Strategy that was developed to strengthen the synergy between agricultural initiatives and national nutrition program initiatives (MoANR & MoLF, 2016); National Nutrition Program (NNP); Seed System Development Strategy (MoANR & ATA, 2016); National Food and Nutrition Strategy (2021–2031) which was designed to operationalize the food and nutrition policy based on identified seven priority intervention areas as policy directions (FDRE, 2021); Ethiopian Food and Nutrition Policy (FDRE, 2018) that provides an overarching framework covering the key dimensions of food and nutrition security; agro-ecological zones and livelihoods as well as in recurring emergencies; Climate Change Education Strategy of Ethiopia 2017-2030 (FDRE, 2017); and Climate Resilience Green Economy (CRGE) (FDRE, 2019) have been some of the enacted food and nutrition security and food system encompassing policies, programs and strategies formulated to meet the sustainable development goals (SDG 2), attaining zero hunger by 2030. Ethiopia is fully committed achieving Sustain Development Goals and has been participated in UN food system submit

(FDRE, 2021). And, unless there is a gradual shift in the contribution of the agriculture sector, which accounts for roughly 39% of the country's GDP and around 75% of export earnings (MoARD, 2017), the agriculture sector had been continued to be the foundation of the country's economy with a 45% GDP contribution, more than 80% of employment opportunities, and over 90% of foreign exchange earnings (Yishak *et al*., 2014).

However, despite the agricultural sector's developmental programs and policies significant economic contribution, the food and nutrition security situations never become achieved. Being a rain-fed production system is the main barrier, as it prevents the industry from reaching its potential productivity and makes it unpredictable. The main causes of food insecurity in sub-Saharan Africa are unforeseen shocks and crises (Alinovi *et al.*, 2010). Numerous literatures, including Gebissa (2021), have reported on the effects of climate change on weather variability, low resource utilization, low-tech farming techniques, inappropriate agrarian policy, inappropriate land tenure policy, ecological degradation, increases in the unemployment rate, political unrest, and civil conflict affecting food security. For instance, official data on Ethiopia's landholding size revealed that 38% of households have access to less than 0.5 hectares of land, 23.6% have access to land between 0.51 and 1.0 hectares, 24% have access to land between 1 and 2 hectares, and 14% have access to more than 2 hectares, demonstrating the scarcity of land resources and the need for intensive work to improve productivity (Diriba, 2020a). Consequently, as an alternative, households adopt and develop diversified coping strategies and sequential responses at times of decline in food availability (Belay, 2012).

Therefore, achieving food and nutrition security requires developing productive, sustainable and resilient food systems besides resilient households that can handle shocks and pressures, especially when it comes to low-income nations with weak and unsustainable food systems. Therefore, to ensure that food systems continue to operate during catastrophes and recover quickly, it is essential to increase their resilience (Andhov *et al*., 2024). A resilient and strong agri-food system has the capacity to open doors for innovation and new development pathways despite shocks (Thompson *et al*., 2007). According to Jones (2019) and Alfani *et al*. (2015), measuring resilience capacity facilitates the identification of food insecurity vulnerability. Designing and assessing programs for developing resilience in Ethiopia also requires an

understanding of and measurement of the traits and dimensions of household resilience in the context of a protracted crisis (Kasie, 2017). Resilience, according to Woller *et al*. (2011), is the capacity of individuals, families, communities, nations, and systems to lessen chronic vulnerability and promote inclusive growth through preparing for, responding to, and recovering from shocks and pressures.

According to van Berkum *et al*. (2018), an effective multidisciplinary conceptual framework for research and policy focused on long-term solutions for the adequate supply of healthy food is the food systems approach. To develop appropriate working frameworks, recommend efficient policies and intervention strategies, and align coordinated links among concerned stakeholders to better address the food system and security challenges, it is therefore important to better understand the general situation of the food system and security, how the system responds to shocks, and the relationships of these to the food security status of the households. In general the purpose of this dissertation centers the concepts and issues of food system, food security, and resilience and coping mechanisms to food insecurity shocks and stresses.

1.2. Statement of the Problem

It is clear from a variety of sources that the study area's food security situation is fragile pertaining to ecological, socioeconomic, and bio-physical factors. Deforestation that is intensifying greatly, migration, institutions and infrastructure that are weak, reliance on conventional and natural factors for crop and livestock production, fragmented holdings, environmental degradation, rapid population growth, limited access to new agricultural technologies, and illiteracy are some of the main drivers and causes (IMF, 2012). Additional cited causes of food insecurity include drought, poor off-farm employment, illnesses, inadequate market and credit access, poor access to clean water and sanitation, policy gaps, and price inflation on food products (DRMFSS, 2015). People's lives have been severely impacted by the extensive deforestation and destruction of the natural, dense forest, which served as the primary source of subsistence (Seyoum, 2015; MELCA-Ethiopia, 2013). According to Guyalo *et al*. (2022), the land and project governance structure or policy in the area is determined to be unresponsive, opaque, non-participatory, and corrupted to this goal.

According to Hailemariam (2012), the average food shortage in the majority of the region's districts, including Godere and Mangeshi, is between three and six months. Additionally, according to the evaluation study by DRMFSS (2015) in Mangeshi district, 39%, 24%, and 19% of the population have received food aid, faffa, and agricultural tools and seeds, respectively, and 84% of the population has insufficient resilience capacity. Additionally, one-third of the households were unable to recover from their disaster losses, and more than 40% found it difficult to raise Birr 500 in one week, showing their vulnerability to disasters that strike suddenly. This evaluation result seemingly indicated the fact that Godere district had been under similar challenges as both are characterized by similar livelihood and agro-ecological conditions.

However, given such several impediments, there have been few to no evidences that scientific studies conducted on the state of the food system and food security conditions nor the measures of the resilience capacity or coping strategies of the households in the area. In addition several of the studies either conducted in Ethiopia or globally, have rarely integrated food system or food security studies with such a particular livelihood of the study area, non-timber forest product dominant settings. Moreover, the instance of considering apiary activities, a dominant income generating activity in the study area, as key variable while undertaking food security as center of the theme is overlooked and is an existing gap. In this regard, the study conducted to evaluate factors determining adoption of modern beehive in Mangeshi District has tried to point out some of the socio-economic factors influencing adoption of modern beehives (Ojulu, 2021). There have been also noticed limitations of scientific approaches studying food security applying globally recognized food security measuring indices in the study area. Specific to the study area, a recent study addressing food security entitled “Impact of climate variability on household food security in Godere District, Gambella Region, Ethiopia” has reported the prevalence of severe food insecurity in the study area (Ayinu *et al*., 2022). Unless, several of the studies carried out in the study area dealt with land use land cover change such as (Girma & Muluneh, 2021; Tadese *et al*., 2021; Mathewos & Bewuketu, 2018), climate change (Bwalya *et al*., 2012), soil and water conservation (Gatbel *et al*., 2019), ethnic conflict (Ruon, 2018), conservation and plant species diversity (Fakana *et al*., 2019*;* Asfaw & Etefa, 2017; Abesh & Girum, 2022; Yohannis & Abdulaziz, 2019)), tourism development (Fakana *et al*., 2019), politics (Kase, 2021; Gatluak *et al*., 2018), and health issues including the studies by (Qanche *et al*., 2021).

In turn, this may have made it difficult to identify the roots of the problems with the dynamic food system and food security, and to plan and implement effective interventions besides identifying the important determinant variables under investigation. Additionally, scientific approaches have been used to address the resilience status of households amid shocks and stresses, and methods of coping with food shortages, which has led to ambiguity in the identification, planning, and targeting of intervention efforts. As a result, there is a lack of knowledge on the general state of the local food system and food security conditions. The nobility of this research further places itself in integrating the resilience concept and the methodological approaches, a contemporary concept, in dealing with food security issues, for being few in Ethiopia and none in the study area. Therefore, this dissertation believed to contribute in filling and bridging the aforementioned gaps to its limitation, scope and capacity. As a result, the dissertation's study goals were set to answer to the following questions and objectives.

1.3. Research questions

1. What are the primary drivers and pressures within the food system that impact food and nutrition security outcomes?
2. What is the current food security status of the households in the study area?
3. Which factors determine the food security situation in the study area?
4. Are households resilient in the face of shocks and stresses?
5. To what extent is the resilience capacity of households affected by various stress factors?
6. How do households respond to and cope with severe food insecurity conditions?

1.4. Objective

1.4.1. General objective

The general objective of this study was to investigate the food system drivers, the level of food security, and the resilience and coping capacity of households in the Majang Zone of Ethiopia.

1.4.2. Specific objectives

The specific objectives of the dissertation are to:

1. Identify and analyze the main drivers of the food system that affect food and nutrition security outcomes in the study area.

2. Examine the food security status and factors determining in the study area
3. Evaluate the resilience status of households to food insecurity in the study area
4. Investigate the coping strategies employed by food insecure households in in the study

1.5. Literature Review

1.5.1. Conceptual and Theoretical literature Reviews

1.5.1.1. Theories of food system and security

This dissertation attempts to apply the fundamental ideas of theory of change, food security theories, political economy explanations, and the sustainable livelihood approach to frame the food system, food security and resilience concepts. Below are the specifics for each theoretical explanation.

Different development and post-development scholars have defined and hypothesized about food security, and other current time scholars have provided their unique period food security scenario dynamics. According to Yaro (2004), the theories of food security can be divided into three categories: entitlement failure, livelihood failure, and decline in food availability (deficient model of food requirements). Burchi & De Muro (2012) divided them into five categories by introducing the income-based and fundamental needs methods in addition to the preexisting theories. Political economy theory, food economy theories, and vulnerability theory are the three basic types of food security theories that Bazezew *et al.* (2013) grouped after analyzing many sources. These theories call for positivistic and interpretive approaches in the examination of food security. He made an effort to take into account some of the elements of each theory, such as land tenure, safety net targeting, accountability, and transparency in local governance, which are all properly theorized in the political economy theory, whereas the food economy theories, which address the declines in food accessibility and availability, took delivery of inputs, marketing infrastructure, and access to basic needs into account. He presented vulnerability theory concerning PAR and the access model by putting population pressure, living in marginal and drought-prone areas, drought, unpredictable rainfall, and lack of access to basic capital assets.

Theoretical frameworks for food security have generally changed in three ways since the 1970s, when the topic was first introduced. Indicators and measurements were changed from being

"international and national" to "households and individuals," from putting "food first" to "livelihood perspective," from being "objective indicators" to "subjective perceptions" or from being "quantitative to qualitative." According to Degefa (2005), it is important to realize that shifts in the way people think about food security suggest that new knowledge is being added to what already exists rather than that old knowledge is being thrown out since the shifts show that scientific intervention and food security thinking are both evolving. The population theories, the fall in food availability, and the decline in food entitlement discourses are the greatest explanations for the first change in thinking about food security from international and national to homes and individuals. This change indicates that the availability of food on a global or national scale does not ensure the food security of individuals and households, and it thus asserts that access to food (or the right to food) is necessary to address food security challenges at the grassroots level.

The idea that food security issues cannot be solved with short-term intervention strategies, such as the provision of food and non-food items during the onset of relief, is clarified by the shift from the food first to livelihood perspective. Instead, it is believed that a long-term and sustainable plan and intervention involving a sustainable livelihood approach is the best course of action. Food must be regarded as one of the components of a household's means of subsistence (Degefa, 2005), and effective food security interventions must address both narrower issues about households' livelihoods and their contexts of vulnerability. The third, the transition from objective indicators to subjective perceptions or from quantitative to qualitative indicators and measurements, enables one to perceive the challenges of food security not only from quantitatively measurable variables but also the thinking that it has the abstract magnitude to understand in line with individuals' perceptions, anxiety, preferences, religious, social, and cultural restrictions or taboos, and other factors affecting food security.

Demographic theories: Food Security and Population

There are two competing hypotheses, namely those of Thomas Malthus and Ester Boserup, regarding population dynamics as a factor affecting food security. According to Malthus's population theory, productivity and means of sustenance only develop "exponentially" unless restrained (Malthus, 1798), implying that the productive capacity cannot support the quickly

growing population. The checks were either preventive, involving a deliberate reduction in fertility, or positive, involving the use of nature's instrument in the form of starvation, illness, conflict, and famine (Ashraf & Galor, 2008). In this regard, Malthus summarized his theory of population into three propositions: it must be constrained by the means of subsistence; it always rises in tandem with rising means of subsistence, unless checked by some very strong and obvious barriers; and the barriers must all be reducible to moral restraint, vice, and misery (Barrus, 2004). According to the Malthusian theory, land is scarce, and its productivity tends to fall with time. As a result, the land's capacity to care for people is constrained. Therefore, as mentioned by Millman and Kates (1990) in Degefa (2005), the strain of population increase on the limits of productive capacity was what inevitably had led to hunger and other forms of human poverty and misery. Malthus' population theory, however, is unable to account for technological advancements in agriculture that help to increase agricultural productivity, as well as the infrastructural revolutions that have had a significant impact on the production, productivity, and transformation of communities' and households' means of subsistence (Devereux, 2000).

Given that the setting is a less developed country, where there is high unemployment, a weak working culture, less advanced technology, high illiteracy, and so on, and cannot produce to feed its population, the epoch of stagnation of Malthus's population theory still holds. According to Ashraf & Galor's (2008) argument, the factors that led to the remarkable break from the Malthusian perspective and their importance in comprehending the current growth process of both developed and less developed economies have presented critically significant issues. Degefa (2005) emphasized that the theory still has practical relevance to the situations of some less developed countries, including Ethiopia, where there is still an attempt to issue and implement the neo-Malthusian "restrictive population policies," for example, through the use of medical contraceptives. This was done in support of the economic growth context-specific explanation of Malthus' theory. According to Marquette (1997), from Malthus's viewpoint, technology and the environment (land) are considered independent variables that combine to affect population, the dependent variable that he sees primarily in terms of population increase and size.

Ester Boserup (1965) in Soby (2017) has produced a theory explaining the connection between population expansion and the transformation of agriculture, which is in opposition to Thomas William Malthus' population theory. According to Boserup, population expansion is a driving force behind the acceptance and spread of technical innovation that increases agricultural production, hence lowering the risk of hunger and food insecurity. Population and technology were listed as independent variables that positively affect the environment (the dependent variable), increasing productivity. She demonstrated the advantages of population density by making financially sound infrastructure expenditures. One of her counterarguments to Malthus claims that although the land is inexpensive and the region is sparsely populated, poverty persists there due to inefficient land use (intensification) and underdeveloped technology, not due to population pressure (Marquette, 1997). She elaborated on her theory from the perspective of agricultural technology innovation and development, according to an unnamed source (Grigg, Undated), explaining how historically increasing labor inputs (population) have accompanied the transition from bush fallow to short fallow, then from annual cropping to multi-cropping, and how these changes in the frequency of cropping also necessitate changes in advanced agricultural technologies. The time of fallowing was also shortened as a result of changes in land tenure and settlement patterns brought about by population growth. According to her, the more advanced intensive methods used now necessitate working longer and more regular hours, which increases the productivity of labor and enables denser populations to take advantage of the division of labor and the economies of scale.

According to Darity (1980)'s theory, Boserup's peculiarities revolve around the following four key aspects: the first is a causal relationship that runs from population growth to agricultural intensification rather than the other way around. Third, she portrays peasant societies as having a variety of techniques, but they choose the one that most easily allows them to meet a subsistence threshold, which inverts the conventional view that population growth responds to consumption. Second, she claims that population growth can lead to the use of more intensive techniques of production, a clear repudiation of Malthusian population pessimism.

The Food Availability Decline (FAD)

Following the famine of the 1970s, a notion called food availability decrease evolved that urges nations to collaborate and debate potential remedies (Degefa, 2005). It focuses on the total amount of food offered at local, national, and global hierarchies. The theory states that a decrease in food availability can be attributed to several factors, particularly demographic (rapid population growth), and several related factors such as diminishing per capita livelihood resources, land fragmentation, and competition over resources) and natural hazards, such as drought, flood, pests, and diseases of crops and livestock (Cheber, 2018).

The Food Entitlement Decline (FED)

After Sen (1982), the Food Entitlement fall became well-known as a different strategy for combating the fall in food availability, focusing on the food access element of food security. According to Sen, it is "the set of alternative commodity bundles that an individual can command in a society using the totality of rights and opportunities that he or she faces." Food can be available but not always accessible to everyone due to barriers like the law that can stand between food availability and food access, according to Sen. This is because food can be available but not always accessible to everyone due to barriers like the law that can stand between food availability and food access (Muzerengi *et al*., 2021). The aforementioned narrative is supported by empirical investigations on Sen's contention that famines have frequently occurred without a fall in present aggregate food availability (Martin, 1997; Laurie *et al*., 1998). Sen categorized the possible forms of entitlement into four groups: production-based, trade-based (exchange), own labor, inheritance, and transfer entitlement. While the trade-based entitlement looks at purchasing food from various sources, the production-based entitlement concentrates on growing food. While the inheritance and transfer entitlement considers food supplied by others to those in extreme need of it, the labor-based entitlement considers working for food in programs like PSNP (Muzerengi *et al*., 2021).

Additionally, a variety of academics present their argumentative justification for or against the FAD and FED methodologies. Sen's support for the entitlement approach over the FAD approach was given two justifications by Osmani (1993). He identified the two causes as having several root causes and asymmetrical effects. Famines can arise from a variety of causes, as he suggests, without any decrease in the amount of food; in such situations, the FAD method is

obviously ineffective whereas the entitlement approach is eminently appropriate. The entitlement approach should, in theory, be able to pinpoint the cause, while the FAD approach had no idea what it is if a famine is caused by something other than a drop in food availability, he continued. On the other hand, famines often affect some groups of individuals more than others and some not at all, regardless of whether FAD plays a causative role. One can never understand why this is the case by examining the overall supply of food, whereas the entitlement approach should be able to explain such disparities by examining the entitlements of various socio-economic classes separately.

According to Degefa's (2005) review of the academic literature for his dissertation research, even though the FED attempts to address food insecurity challenges by addressing accessibility, it is in short of taking into account intra-household distribution of food, exclusion of relief entitlement (aid food), concentration on proximate causes of famine rather than addressing underlying causes, heavy focus on food deprivation, and the assumption that famine mortality is irrational. The study lacks a temporal component, is ahistorical, and cannot take into consideration shifting vulnerability to entitle failure. For instance, USAID (2012) claimed that differences in the status of intra-household food security could be related to a variety of factors, such as different household members' varying access to and control over assets, whether as a result of particular intra-household power dynamics, more general social norms, or other factors that affect their capacity to allocate labor and non-labor resources to generate income and improve their access to food.

The Sustainable Livelihood Approach (SLA)

The sustainability or stability pillar of food security is not taken into account by the FAD or FED because those are the long-term structural and historical processes that determine how particular patterns of entitlements and property rights are distributed. Additionally, as was mentioned in the research gap analysis, environmental and socioeconomic factors that hinder the productivity, resilience, and sustainability of the entire food system contribute to the issue of food insecurity in the studied area. Food insecurity can never be attributed to a single factor, but the interplay of a multiplicity of context-dependent social, political, and economic factors. Furthermore, as the sustainable livelihood approach focuses on the sustainability of livelihood elements in vulnerable

contexts for a long time rather than on short-term intervention methods, resilience is better theorized with this approach, as are food systems and security.

The SLA is a comprehensive concept that encompasses several elements and explanatory variables that are interrelated in a complex framework (Degefa, 2005). The approach originated in the mid-1980s to early 1990s, as a new way of thinking about development objectives, scope, and priorities (Alinovi *et al*., 2010). It represents a significant shift in food security from the "food first" approach to the "livelihood" approach (Fisseha, 2014). It also offers a rigorous conceptualization of the stability aspect of food security, acknowledging the long-term requirement to maintain a consumption level that is improved when availability, access, and utilization are maintained for extended periods of time (Gautam, 2017).

The SLA, which fills the gaps left by entitlement and FAD approaches in properly explaining the condition of food security, has emerged as a leading theory of the food system and security. The SLA integrates the vulnerability (capability) concept, the five fundamental assets, long-term historical and structural processes (sustainability), and a more general and experiential approach. SLA puts individuals and their priorities at the heart of development (Alinovi *et al*., 2010). Additionally, Gautam (2017) citing Pinstrup-Andersen (2009) argue that because the availability and access paradigms focus on meeting food needs, they fail to mention that there are many other needs in a household that are occasionally given priority over food. Therefore, by emphasizing livelihood security more broadly, the circumstances and procedures by which food is accessible and utilized are better contextualized. Cletus & John (2015) stressed the method as a way for people to earn a living so they can meet their fundamental necessities. As a result, they were better able to deal with stress and setbacks, recover from them, and improve their welfare as well as that of future generations without harming the environment or the natural resource base. Generally, the method is a useful tool that describes a comprehensive approach to the design and monitoring of interventions for improving food security and livelihoods (ACF International, 2010).

The sustainable livelihood approach makes use of the sustainable livelihood framework (SLF) as an analytical tool, which enables investigating how, given a particular context and resource

accessibility, local institutions and government policies can influence people's livelihood activities and survival strategies (Degefa, 2005). Fisseha (2014) observed in his review that the method is frequently utilized as an analytical framework to study poverty and food insecurity. The USAID (2012) framework consists of six livelihood assets that are necessary for protection and productivity. These include human, physical, social, financial, natural, and political assets. Livelihood activities are divided into three categories: income-generating activities, risk reduction strategies, and loss management strategies. Vulnerability contexts are defined by a household's susceptibility to shocks and stresses that affect their ability to generate sufficient income for a healthy life now and in the future. This includes achieving a threshold level of nutritional requirements.

Theory of Change (ToC)

The concept of the theory of change (ToC) has been applied in diverse disciplines, including the food system and food security. The concept was evolved following the need for development projects and the rise of participatory approaches that catalyze positive development outcomes via social learning (Kristjanson *et al*., 2014). The ToC responds to the expectation that knowledge and measurement of externalities, as assessed through valuation tools and frameworks, can be used to influence decision-makers to redirect resources, products, or practices so as to achieve greater sustainability in the food system (Luis Fernando *et al*., 2018). There is no single definition of the concept and no set methodology; rather, the approach allows flexibility according to the needs of the user or implementer (Vogel, 2012). Luis Fernando *et al*. (2018) defined ToC as a basis for planning intervention in a given policy or project arena. The United Nations Development Group described the concept as a method that explains how a given intervention, or set of interventions, are expected to lead to a specific development change, drawing on a causal analysis based on available evidence (United Nations Development Group, 2015). It represents our best understanding of how engagement and learning can enable change as well as how progress towards outcomes might be measured (Thornton *et al*., 2017). It sets out an impact pathway for efforts to reach a logical set of outcomes or impacts based on the experience and expertise of those undertaking efforts (Dinesh *et al*., 2021). A ToC provides benefits at multiple levels and has many potential uses. For example, by providing a detailed map showing pathways of change that are based on testable hypotheses, it helps build a common

understanding and consensus of the steps needed to achieve the desired change (Starr, 2019). The cornerstones of the ToC consist of supportive governance systems and enabling institutions as building blocks (including rules) and mindsets (both worldviews and values) (Luis Fernando *et al.*, 2018). The ToC approaches can provide critical guidance through the maze of transformation concerning engagement, partnership, and research in light of food system approaches (Thornton *et al*., 2023).

1.5.1.2.Overview on the concepts of food systems and security

Concepts of food system

The concept of the food system has been around for an extended period, but it came to the center of policy talks in 2008–2009 due to the dramatic increase in the cost of agricultural and other commodities. The food system provides a comprehensive list of topics that need to be addressed to achieve food security-related policy objectives. Along with enhancing the food system's resistance to climate change, it aids in determining the effects of environmental and climate changes on food security. Additionally, it can help to identify effective interventions to improve food security (van Berkum *et al*., 2018). A food systems approach is a style of thinking and behaving that looks at the food system as a whole, accounting for all of its components, connections between them, and effects on one another (FAO, 2018c). The UN Food Systems Summit (UNFSS) in New York in September 2021 conveyed the concept to support member states in driving food system transformation, thereby accelerating global progress towards the Sustainable Development Goals (SDGs). The submission was organized around 5 'Action-Tracks' or key outcomes: (i) ensure safe and nutritious food for all; (ii) shift to sustainable consumption patterns; (iii) boost nature-positive production; (iv) advance equitable livelihoods; and (v) build resilience to vulnerabilities, shocks, and stresses (Federal Democractic Repolic of Ethiopia (FDRE), 2021).

All of the components (environment, people, inputs, processes, infrastructures, institutions, etc.) and actions that are involved in the food's production, processing, distribution, preparation, and consumption, as well as the results of those actions, such as socioeconomic and environmental outcomes, are grouped under the umbrella term of "food systems" (Lomax, 2018). The system consists of a complete set of actors, resources, processes, and activities that span the areas of

food production to consumption and food waste disposal. It also includes the results of these activities, such as nutrition and health, socioeconomic well-being, and environmental quality, as well as the feedback, tradeoffs, and synergies between these results (Melesse *et al*., 2020). The systems consider the governance and political economy of food production to consumption, sustainability, effects on health and well-being, and drivers of system change (Béné, 2020). The food systems approach is crucial for understanding changes in food systems concerning food security and climate change and hence in building resilience to the (van Berkum *et al*., 2018). Furthermore, a food system has to be sustainable to be able to serve the current and future generations to come. A sustainable food system is a system that ensures food security and nutrition for all without compromising the economic, social, and environmental bases of the system for future generations (Kumar & Babu, 2021).

Food systems are considered sustainable if they can successfully balance five key factors: (1) the ability to guarantee food security; (2) the ability to uphold people's right to food; (3) the ability to reduce poverty and inequality; (4) the ability to perform well in terms of the environment; and (5) the ability to display high levels of social-ecological resilience, demonstrating that a food system must be both resilient and sustainable to ensure both human well-being and ecological functioning . According to Tendall *et al*. (2015), food system resilience is the ability of a food system throughout time and its components at all levels to meet everyone's needs for sufficient, suitable, and accessible food in the face of a variety of unanticipated shocks. In the face of disruption and change, resilient food systems allow individuals to become more food secure through time and space (Schipanski *et al*., 2016).

The evolution of concepts of food security

Following the food security crises of the 1970s, the idea of food security gained prominence on a worldwide scale. The global food crisis of 1973–1974 marked the official emergence of "food security" concerns (Upton *et al*., 2016). It was conceptualized in the 1970s as a result of experiences with global hunger and subsequent anti-hunger initiatives during the ensuing four decades. The World Food Conference was held in 1974 after the World Food Conference was called in 1974 as a result of the food insecurity situation being brought to light by unfavorable weather conditions and the subsequent food production shortfalls and food crises that claimed

over two million lives in Africa and Asia in the early 1970s. The Universal Declaration on the Eradication of Hunger and Malnutrition, which was adopted in 1974 at the World Food Conference, established the following definition of food security, emphasizing the availability of food: "Availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (FAO, 1996). Through significant expenditures in green revolution technology intended to enhance food supply, this strategy places a strong emphasis on food supplies as a major contributor to food insecurity.

However, if the definition solely takes into account the availability dimension of food security, it can only refer to the food that is available on a national and/or worldwide level, ignoring the food that is available to households and people. Furthermore, cultural, religious, health, and other variables may have an impact on dietary diversity and personal preferences. The limitations of the food supply focus were revealed during the food crisis that once again afflicted Africa in the middle of the 1980s (Frankenberger *et al*., 1998). They realized that adequate food availability at the national level did not necessarily translate into food security at the individual and household levels.

As events and time progress and the complexity of the food security debate increases, the definition's content and meaning expand to include new components. Additionally, as stated in Gautam (2017), the variable prevalence of hunger within a particular location and population raised concerns about the veracity of the food availability thesis. This resulted in the idea that food security had changed from being a national and global supply phenomenon to becoming a problem of access at the household and individual levels. According to Upton *et al*. (2016), who spoke for a different consortium of academics, food security measurement has improved over the past 50 years or so, albeit unevenly. In the 1950s–1970s, the emphasis was on the national level, supply-side availability of enough food to feed an expanding population. They go on to describe how the emphasis has shifted from the supply side of food security to the demand side, incorporating additional pillars such as access, utilization, and stability in addition to availability.

After nine years after the initial definition in 1983, dimensional shifts were made while keeping track of progress. In its 1996 proposal, the FAO proposed a revised definition of food security

that included the availability and access pillars of food security and stated that it meant "ensuring that all people at all times have both physical and economic access to the basic food that they need" (FAO, 1996). The 1996 World Food Summit established a modern, practical definition of food security based on the utilization and stability pillars of food security. According to the FAO, "all people at all times have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life"; only then does food security exist. According to Mohamed (2017), the four pillars can be measured and occur on a large or small scale, depending on whether a country's citizens have physical or financial access to the food they need.

Even though they designate and express particular analytical characteristics, the four pillars that make up the concept of food security are interconnected and dependent on one another. According to Christopher & Lentz (2009), the four pillars are essentially hierarchical, with availability being necessary but insufficient to provide access and, in turn, being necessary but insufficient for the efficient use and sustainability of the other three. The access dimension explains how well people can obtain food to feed themselves, how well they use that food (which is linked to good nutrition, preparation, and feeding behaviors), and how stable these conditions are over time (Upton *et al*., 2016).

More explicitly and specific to each pillar, the availability dimension, a function of macroeconomic factors, refers to the presence of sufficient quantities of appropriate food from domestic production, commercial imports, commercial aid programs, or food stocks that are consistently available to individuals or within their reach. The second pillar, food access, is related to the resources households have to obtain food, either through their production or through purchase, and this segment of food security is largely related to household income and own production. Food utilization is coined with the nutritional benefits derived from food consumption, and it integrates nutrition, health, and sanitation (van Berkum *et al*., 2018; Anderson & Elisabeth, 2015). The details of each of the pillars have been discussed below.

1.5.1.3. Concept and theory of resilience

The unavoidable fact is that building resilience is a typical humanistic or system response to adverse situations to avoid, resist, or recover from shocks or pressures by returning to normal or even changing into a new stable state. The Latin word resilience, which describes a substance's pliable or elastic character, is where the word resilience got its start (Ledesma, 2014). As opposed to Barrett & Headey (2020), who asserted that the word is of Latin origin and stated that resilience, which means to rebound or recoil, is its Latin equivalent. The idea was first put forth in the literature on ecology, and it was later used to investigate the relative persistence of various natural states in dynamic, complex systems like socio-economic systems (Alinovi *et al*., 2010).

The idea was first used in mechanical engineering in the 1940s, and ecologists later adopted it to describe an ecosystem's capacity to respond to shocks in the 1960s (FAO, 2015). This opens the door for using the idea in a variety of fields and situations where it is necessary to better predict and manage change and uncertainty. When the 2008 food, fuel, and financial crises forced people to look for new ways to combat poverty, it became popular among humanitarian and development actors. Fikiru (2016) elaborated on the concept's popularity by citing Constas and Frankenberger (2013), who pointed out that it holds the potential to close the operational gap between humanitarian aid and development assistance and emphasizes the need to increase people's capacity to withstand and/or adapt to a wide range of risks.

Resilience theory has recently gained popularity in studies across cultures and academic fields (Van Breda, 2018). Because of this, Bahadur & Pichon (2016) underlined how the idea evolved from a narrow research use to a wide range of operational applications. It is better to think of it as a dynamic capability or developing process than as a fixed result or trait (Kuldas & Foody, 2022). Masten (2009) in VicHealth (2015) lists two requirements for resilience, including a measure of positive adaptation or development and the presence of circumstances that could disrupt positive adaptation in the past or present. According to Masten (2021), who cited earlier types of literature, the development of developmental systems theory as the field's most prominent unifying theory represented only a portion of the impetus for the field of resilience science to move toward a full-fledged systems approach. She went on to say that, in keeping with

resilience science's practical emphasis, the threat of mass-trauma global adversities like terrorist attacks, natural catastrophes, and pandemics was another important factor driving the shift toward systems theory. According to Alinovi *et al*. (2010), who cited Levin *et al*.'s (1998) argument, resilience provides a useful lens through which to study the development of social systems and aids in the analysis, assessment, and implementation of the systems. Additionally, the growing number of research on resilience demonstrates that many sources of resilience bridge and transcend sectors, highlighting the significance of a comprehensive strategy to enhancing resilience (USAID, 2022).

According to Ledesma (2014), terms like "survival," "recovery," and "thriving" are connected to the trait of resilience and explain several stages that a person may go through while dealing with hardship. Ledesma further went on to examine how different terminologies were used for three resilience models known as compensatory, the challenge, and the protective element of immunity vs. vulnerability models. She did this by reviewing several related research papers. Resilient people are characterized by an active approach to problem-solving, a tendency to see experiences positively even when they are painful, the ability to attract positive attention from others, and a strong reliance on faith to maintain a positive outlook on life, according to the compensatory model, which sees resilience as a factor that neutralizes exposures to risk. This model's elements include optimism, empathy, insight, intellectual prowess, self-esteem, direction or mission, and perseverance and determination. According to the challenge model, if a risk factor is moderately high, it can improve a person's capacity for adaptation, thereby preparing them for future challenges. In contrast, the protective factor model involves the interaction of risk and protective variables, which lowers the likelihood of a bad outcome and moderates the impact of risk exposure. This model is based on systems theory and developmental literature, and its components include problem-solving abilities, academic and career skills, the capacity to rebuild self-esteem, planning abilities, intrapersonal reflecting abilities, and skills for managing emotions.

The most widely accepted and practical definition is that provided by FAO in 2013, which states that disaster risk reduction is "The ability to prevent disasters and crises as well as to anticipate, absorb, accommodate or recover from them in a timely, efficient and sustainable manner"

(Fikiru, 2016). This definition best captures the threats that affect food and nutrition security, agriculture, and food safety issues. The other definitions, which were developed by various academics and organizations, all have the ideas of absorbing, accommodating, and responding to disruption at their core (Pain & Levine, 2012). In addition, a variety of theories and methods are available to help with guidance, diagnosis, measurement, and evaluation of resilience (Bahadur & Pichon, 2017). However, the UN's 2015 Sustainable Development Goals (SDGs) emphasize the idea of "building resilience of the poor and those in vulnerable situations, and reduce their exposure and vulnerability to extreme events by 2030."

The application of resilience in food security

The agro-ecological conditions are highly shock-sensitive, affecting the livelihoods, food security, and general well-being of households and communities. Developing countries rely on agriculture-based livelihoods to meet their needs for food security. The resilience concept is the ideal fit for inclusion in food and nutrition security agendas for these and other motivating factors. Constas *et al.* (2014) asserted that the integration of the resilience concept into food security and nutrition came about as a result of the 2011 droughts, which had an impact on the food and nutrition security of millions of people in the Horn of Africa and the Sahel.

The idea and its practical application in developing and implementing food security (and nutrition) policies have lately gained importance in the humanitarian and development communities (FAO, 2015). Furthermore, Iyappan & Babu (2018) stressed its significance as a crucial tactic for ending the cycle of food and nutrition insecurity. Both conceptual frameworks and approaches for measuring resilience in the context of food security have evolved (Ansah *et al.*, 2019). Similarly, Ciani & Romano (2014) emphasized the significance of the idea in food security that analyzing a resilience-based approach to food insecurity causes may increase the household's capacity to respond to unforeseen occurrences and aims to determine the strength of the food system at the moment.

The use of resilience to food security, according to Alinovi *et al*. (2010), allows for the measurement of households' capacity to absorb unforeseen shocks rather than catastrophe prognostication, as is the case with vulnerability discourse. According to Upton *et al*. (2016), a

significant policy subject has started in the two African countries of Ethiopia and Niger by using nationally representative panel data for analysis and measurement.

By ensuring that agriculture and food systems are productive and risk-sensitive, and result in lasting gains for feeding both the present and future generations, the resilience of agricultural livelihoods is essential to achieving the SDG commitment "to leave no one behind" (FAO, 2018a). To develop household resilience to the shock of food insecurity, it is necessary to understand the elements that have improved a household's ability to both absorb external shocks and effectively respond to them (Fikiru, 2016). According to numerous academics, comprehending family food systems' resilience enables better design of interventions in shock-prone areas (Ansah *et al.*, 2019). The most complex short- and long-term global development problems, including food security, must therefore be addressed through national agendas through good governance, infrastructure, capacity building, and other initiatives (Iyappan & Babu, 2018). Resilience is a crucial component of these solutions.

1.5.2. Empirical literature

1.5.2.1. Global food system and food security conditions

The global food system is shaped by several drivers and pressures that were defined and categorized differently by different authors. In this regard Dury *et al*. (2019) distinguished six main categories of the drivers shaping food systems in low income and low and middle income countries that include demographic, biophysical and environmental, innovation, technology and infrastructure, sociocultural, economic and political. More specifically, ten forces that were identified to influence the global food system include the degradation of natural resources, climate change, urbanization, globalization, consumer behavior, culture and tradition, government policies, conflict and fragile states, technology innovation, and sustainability in adoption of policies and strategies (Denning & Fanzo, 2016b; Béné *et al*., 2019). Similarly, Fadda *et al*. (2023) come to identify forces that affect the food system in Africa as population growth; urbanization; dietary shift and changing food distribution systems; increasing regional trade within Africa to boost local food demand; climate change; technological innovations and change in all sectors - including information and communication technology and agricultural value chains; sources of capital and investment – with an increase in the proportion of foreign direct investment in Africa as compared to development aid; governance factors (policies,

institutions, markets), and global disruptions including conflicts, pandemics, etc. disrupting supply chains and forcing people into unsustainable, environmentally harmful livelihoods. According to AGRA (2023), Africa's food system is failing to deliver sustainable healthy diets to all, largely due to the combination of climate change, conflict, economic instability, low agricultural productivity, and recently the impacts of the COVID-19 pandemic.

Likewise, Ethiopia has developed a strategy of a food systems approach for its significant benefits in policy-making for that the food system enables thinking systemically and at an interdisciplinary level to ensure that challenges are tackled from multiple perspectives and in a holistic way, which more closely matches the on-the-ground reality of policy-making (Bhunnoo, 2018). The Ethiopian food systems largely rely on the agricultural production and productivity that is liable to adverse natural and human-induced factors. According to Geda *et al*. (2024) most of food and nutrition policies are constrained by lack of implementation capacities. It was claimed that poor human capital, food taboos and tradition, cultural practices such as gender-based norms, poor education, poor food chain, demographic pressure and other environmental drivers play critical role in food and nutrition security of most vulnerable population groups in Ethiopia. Ethiopia's food system is further intertwined by low institutional and economic capacity to build climate resilience for improved agriculture and food systems (Ouko, 2022). It was also reported that the Ethiopian food system is bound with challenges of low availability and affordability of nutrient–dense foods; low dietary diversity, especially among infants, children and mothers; lack of access to agricultural inputs and technologies; weak market linkages; limited climate adaptation and resilience; lack of food safety management infrastructure; lack of food fortification, processing and packaging; lack of adoption of agro-ecological practices; weak institutional support; shift towards unhealthy diets, especially in urban areas; limited dietary guidelines and education; soil depletion; lack of access to agricultural and rural financial services; high post-harvest losses; limited value addition and processing capacity; need for universal food access, especially in vulnerable areas; need for integrated risk and crisis management; and weak land ownership management infrastructure(MoA & MoH, 2021).

Five central goals of Ethiopian food system approaches were suggested to tackle the multitude challenges. Ensuring diversified food production and increase the supply of nutrient dense foods; promote food production practices that conserve soil health and the environment and provide for better access to agricultural inputs, technologies, and financial services especially for our rural

settings; support the development of equitable food systems livelihoods by promoting agro-and food processing that promote food safety whilst limiting post-harvest losses; build resilience to vulnerabilities and socks; and the fifth and overarching goal is that the food system transformation will utilize innovative approaches and technologies, sustain leadership and governance, women empowerment and leadership and the use of national food based dietary guidelines (Federal Democractic Repolic of Ethiopia (FDRE), 2021). The recently developed food system guide aimed at ensure access to safe and nutritious food for all; shift to sustainable consumption patterns; boost nature positive production; advance equitable livelihoods; and build resilience to shocks and stress.

Owing to the food system challenges the food and nutrition security situation in Ethiopia remains a challenge to fulfill, similar to most low-income countries. The 2021 Global Nutrition Report (GNR) highlighted that the trends in nutrition are of grave concern affirming that diets are not getting healthier for people or the planet (Naoko, 2021). Multiple factors were claimed responsible for food insecurity worldwide, including population growth, climate change, increasing cost of food, unemployment, poverty, and loss of biodiversity (Khanam *et al*., 2020). Urbanization (FAO *et al*., 2022; Thompson *et al*., 2020), violent conflict (Delgado *et al*., 2021), and inequalities persisted in the complex web of social, economic, and ecological factors (Wudil *et al*., 2022) were told challenging factors. The impact of COVID had resulted in an equivalent of 400 million full-time jobs loss, declining of about 82% in earnings for informal workers, with Africa and Latin America to facing the largest decline women and young people being disproportionately affected. There also reported 20% fall in remittance globally and domestic food prices increase in many countries (FAO and WFP, 2021). Consequently, people who have faced hunger in the world showed a trend of increment year in year out where, for instance, between 720 and 811 million people were hungry in the year 2020, 118 million more than the people registered in 2019. It was forecasted that around 660 million people may still face hunger in 2030 (FAO *et al*., 2021). Another report by Global Food Crisis (2024) showed that nearly 282 million people in 59 countries and territories experienced high levels of acute hunger in 2023 - a worldwide increase of 24 million from the year 2022.

Several factors have been identified, through research, as food and nutrition security challenges worldwide. Population growth, climate change, agricultural productivity, land and water resources, economic inequality, political instability, global trade, and food waste were reported food security challenges worldwide (Bowden, 2023). A research that aimed at measuring household food security and dietary diversity in south-eastern Nigeria identified factors associated with household food security as age, education, work status and income (Ukonu *et al*., 2023). The study conducted in Iran to identify factors influencing household food security status indicated that severity of household food insecurity increased with increasing distance from the city, and decreases with residential infrastructure, family size and the presence of both parents than single parents at home (Rahim *et al.*, 2011). Besides, policy gaps were also eminent food security challenges affecting the quality and sustainability of food and nutrition programs (Adhikari *et al*., 2023). Similarly, a research conducted by Abu & Soom (2016) to analyze the factors affecting food security in rural and urban farming households of Benue State, Nigeria come up with the result that income of households head and farm size had a positive impact on household food security while age of household head and urban household size had a negative relationship with food security. The odds of being food secure was also positively determined by access to extension services, participation in business incubation program, and access to market information as evidenced from the study of Adeyanju *et al*. (2023) carried out in Kenya, Nigeria and Uganda. In addition to the above food security determinants crops diversification, time given to farm activity and farm size have been stated contributors to poverty reduction of farming households in Pakistan (Rose *et al*., 2021).

1.5.2.2. Food system and security situations in Ethiopia

Food security is one of the government's eye-catching priorities in its growth and transformation plan and sustainable development goal because Ethiopia is one of the world's most food-insecure nations. Almaz *et al*.(2015) and Cochrane (2018) underlined that maintaining food security and addressing issues of poverty reduction have remained top priorities for the Ethiopian government and many non-governmental organizations working in the field of rural development in support of this reality. Accordingly, the government have formulated and adopted the agriculture-centered rural development program (Agricultural Development Lead Industrialization, ADLI) as a major strategy expected to assist in the realization of the country's economic development

objective (MoFED, 2003). The initiatives of formulating and acting on the Millennium Development Goals (MDGs) and the Growth and Transformation Plans (GTP I and II) have been the core agendas aimed at achieving the second sustainable development goals (SDGs 2) of the 2030 that aimed at "end hunger, achieve food security and improve nutrition for all people (Bozsik *et al.*, 2022; Ethiopian Plan Commission, 2017).

According to Kwadwo *et al.* (2013), Ethiopia's primary source of food security and livelihood continues to be the agriculture sector. Accordingly, the sector continues to be the backbone of the Ethiopian economy, contributing 45% of the country's GDP, more than 80% of job possibilities, and more than 90% of foreign exchange profits (Yishak *et al.*, 2014). As the nation works to execute agricultural-led industrialization, the proportion of agriculture is slightly shifting; by the years 2014–2015, the sector contributed around 39% of the nation's GDP and over 75% of export revenues (MoARD, 2017).

According to The World Bank Group (2021) report the national poverty line's poverty headcount ratio decreased from 26% in 2011 to 15% in 2016 in urban, and from 30% in 2011 to 26% in 2016 in rural Ethiopia. The 2018 HDI showed that the country's Gross Domestic Product (GDP) per capita increased from US$129 in 1999/00 to US$863 in 2016/2017; the proportion of the population living below the national poverty line decreased from 45.5% to 23.5% between 1995/96 and 2015/16; and registered an overall increase in HDI from 0.283 in 2000 to 0.448 in 2015 and an annual HDI growth of 3.79 percent, ranking the nation 174 out of 188 countries (UNDP, 2022).

According to Yaro (2004), in sub-Saharan Africa, contextual factors and processes like global climatic change, land-use intensity, demographic factors, macroeconomic policies, and globalization create structural changes that affect how different people access resources for enhancing food and livelihood security. Similar to other countries, Ethiopia faces a problem with food insecurity that has multiple dimensions and levels, including crises brought on by the environment as well as socioeconomic and demographic limitations that harm people's production methods (Dagnachew, 2012).

According to Abebe (2018), Ethiopia's food insecurity issues are serious, particularly among rural communities and smallholder farmers, where 10% of the country's population experiences chronic food insecurity, with this number increasing to more than 15% during years of regular drought. In comparison to metropolitan areas, rural areas have greater rates of food insecurity and malnutrition (Endalew *et al*., 2015). Guush *et al*. (2013) also noted seasonal differences, noting that households often experience significant food shortages throughout the rainy and planting seasons, with February through September being the months with the highest levels of food insecurity. The largest food availability is noted in highland regions during the meher harvest and in lowland regions at the end of and soon after the big rains.

In addition, Tefera (2009) discovered variation in the level of food security among households living in various agro-ecologies. He concluded that households in *Dega* areas had better calorie intake than those in the other areas of the study area and that those living in *Qolla* regions were the most food insecure. The burden that urbanization is placing on rural residents, resulting in eviction and food poverty, is weighing equally in the present. In their more recent research on the impact of urban growth on peri-urban farmers' poverty, Weldearegay *et al.* (2021) concluded that urban growth has a positive impact on peri-urban farmers' poverty, with the prevalence of poverty among displaced peri-urban farmers' households being devastating compared to non-displaced households as a result of urbanization.

Although the severity of the damage may vary depending on geographical and agro-ecological zones, the variables that cause food insecurity in Ethiopia and other sub-Saharan nations take on a more or less uniform form and distribution. The principal obstacles in Ethiopia's north, among others, include severe and frequent drought and famine, low soil fertility, and a lack of cropland. Some additional unique issues might only apply to the other half. For instance, Endalew *et al*. (2015) highlighted some of the primary reasons for food insecurity in Ethiopia after examining the country's current food security situation. Population pressure, drought, a lack of farmland, a lack of oxen, a decline in the ability to produce food, an outbreak of plant and animal diseases, poor soil fertility, frost attack, a lack of cash income, subpar farming techniques, weak extension services, high labor wastage, a lack of social and infrastructure facilities, pre-and post-harvest

crop loss, education, conflict, inadequate funding for agriculture, and natural disasters are a few of these (Endalew *et al*., 2015; Regassa, 2011)

In addition, IMF (2020) reported that the main factors that keep smallholder production in the nation at subsistence levels are dependence on natural factors of production, small and fragmented holdings, environmental degradation, rapid population growth, low access to new agricultural technologies, traditional methods of cultivation, and low institutional support.

In Ethiopia, numerous studies have been conducted to address the most important issues surrounding food insecurity at all levels, from the national to the personal. According to Mohamed (2017), poverty rates rise by 7% for every additional 10 kilometers away from a market town with at least 50,000 residents, demonstrating the importance of infrastructure and market access in enhancing food security. According to a study by Gazuma (2018), the homes under study had food insecurity levels of 70.62%, 37%, and 25.6%, respectively, and were the least able to fulfill the daily required minimum calorie intake.

1.5.2.3. Resilience to food insecurity

There aren't many research outputs on resilience in the context of food, nutrition, and livelihood security in Ethiopia. In their study on household resilience to seasonal food insecurity, Guyu & Muluneh (2015) found that only 34.75% of the surveyed households were resilient, though at varying levels, indicating that the majority of them (65.2%) were less resilient to the shock and that indigenous households were significantly less resilient than non-indigenous ones. On the other hand, Tefera *et al*. (2017) observed that factors such as farm size, intensification, asset ownership, income diversification, credit, cash crop production, membership in savings and credit societies, and labor-sharing groups have a substantial impact on enhancing resilience capability.

In addition, household resilience to food insecurity depends on the availability of agricultural resources, particularly land (Ciani & Romano, 2014). Similar studies in Niger revealed that regions with irrigation capability and low reliance on agriculture dependent on rainfall are more robust. According to the same study, female home-heads have lower adaptive capacities and

fewer resources than male household leaders, making them less robust. Additionally, Boukary *et al*. (2016) found that long-term average rainfall decreases households' resistance to food insecurity even when involvement in the social safety net promotes the development of robust resilience capacity. Ansah *et al.* (2019) similarly concluded that interventions in policies and programs aimed at strengthening households' capacity for resilience can help lower child malnutrition and guarantee long-term food security. Road infrastructure, market access, and off-farm employment prospects were examined to smooth consumption so that the household's food security becomes shock-resistant.

1.5.2.4. Coping strategies in response to food insecurity

Numerous academic studies have shown that different coping mechanisms can be used to deal with challenging circumstances like food insecurity. According to Maxwell & Caldwell (2008) and Maxwell *et al*. (2003), coping with food insecurity is predictable and patterned, with food insecure households first limiting meal size before reducing the number of meals and consuming less preferred foods. If the crisis persists, adults were then limited their intake to protect the children in the home. The varieties of coping mechanisms used in food insecurity situations are typically modeled in more or less identical reaction patterns in low-income countries. For instance, food-insecure households adopt a variety of coping mechanisms, according to Wright & Epps's (2015) analysis of the research. Participating in food programs is one of them, as is exchanging resources, managing one's resources, having a support system, growing income, lowering expenses relocation, and purchasing affordable and nutritious foods. According to Kyaw (2009), seasonal migration is one of the main coping mechanisms used by landless households in Myanmar. Drysdale *et al*. (2019) reported that purchasing less liked foods and doing so on credit, going without food for a whole day, eating seed stock, sending a child to eat elsewhere, and restricting food for family members who work were all reported. The research by Dunga & Dunga (2017) showed that female-headed households were more vulnerable to food insecurity.

More or less, in Ethiopia, most of the coping mechanisms implemented resemble one another. Reducing number and frequency of meals served, selling livestock, migration and relocation, delaying special events, spending a day without food, harvesting immature food crops, petty

trading involvement in support programs, sale of wood or charcoal, begging, pulling children out of school, and borrowing food (Berlie, 2015; Endalew *et al*., 2015; Almaz *et al*., 2015; Mohamed, 2017; Yenesew, 2015; Negash & Alemu, 2013; Mengistu *et al*., 2009). According to NAPA (2007), other ways that Ethiopians have managed to deal with climate variability and extreme induced shocks include, among other, altering cropping and planting practices, gathering wild foods, using inter-household transfers and loans, increasing the production of small-scale goods, storing grain, mortgaging land, obtaining credit from merchants and money lenders, using early warning systems, and launching food appeals and aid campaigns. According to Meskerem & Degefa's (2015) research, the main coping techniques in their study region were eating less of their favored foods, eating fewer meals, and buying food by selling small animals/ruminants, grasses, cow dung, and firewood.

1.5.3. Conceptual Framework

In the context of food systems, food security resilience, and coping mechanism results, the conceptual framework described below illustrates the general research flow of the thesis. Three major analytical chains make up the framework (Figure 1). The activities that make up the food system, such as the enabling environment, food environment, business services, consumer characteristics, and variations in the food supply system, are crucial benchmarks against which the food security situation and the food system's sustainability are assessed.

The socio-economic and environmental drivers of the food system are the segments that were examined for their significance in determining the food security status of the households in the study area. The income and food access, assets, access to public services, social safety nets, stability, and adaptive capacity components of the framework serve as indicators of the resilience level of the households. And, the coping variables used to know the coping strategies adopted. The segments of the food system's socioeconomic and environmental factors were looked at for their importance in determining the level of food security in households in the research area. The framework's components for access to food and income, assets, public services, social safety nets, stability, and adaptive capability act as gauges for how resilient a household is. And the variables for coping that were used to determine the coping techniques applied.

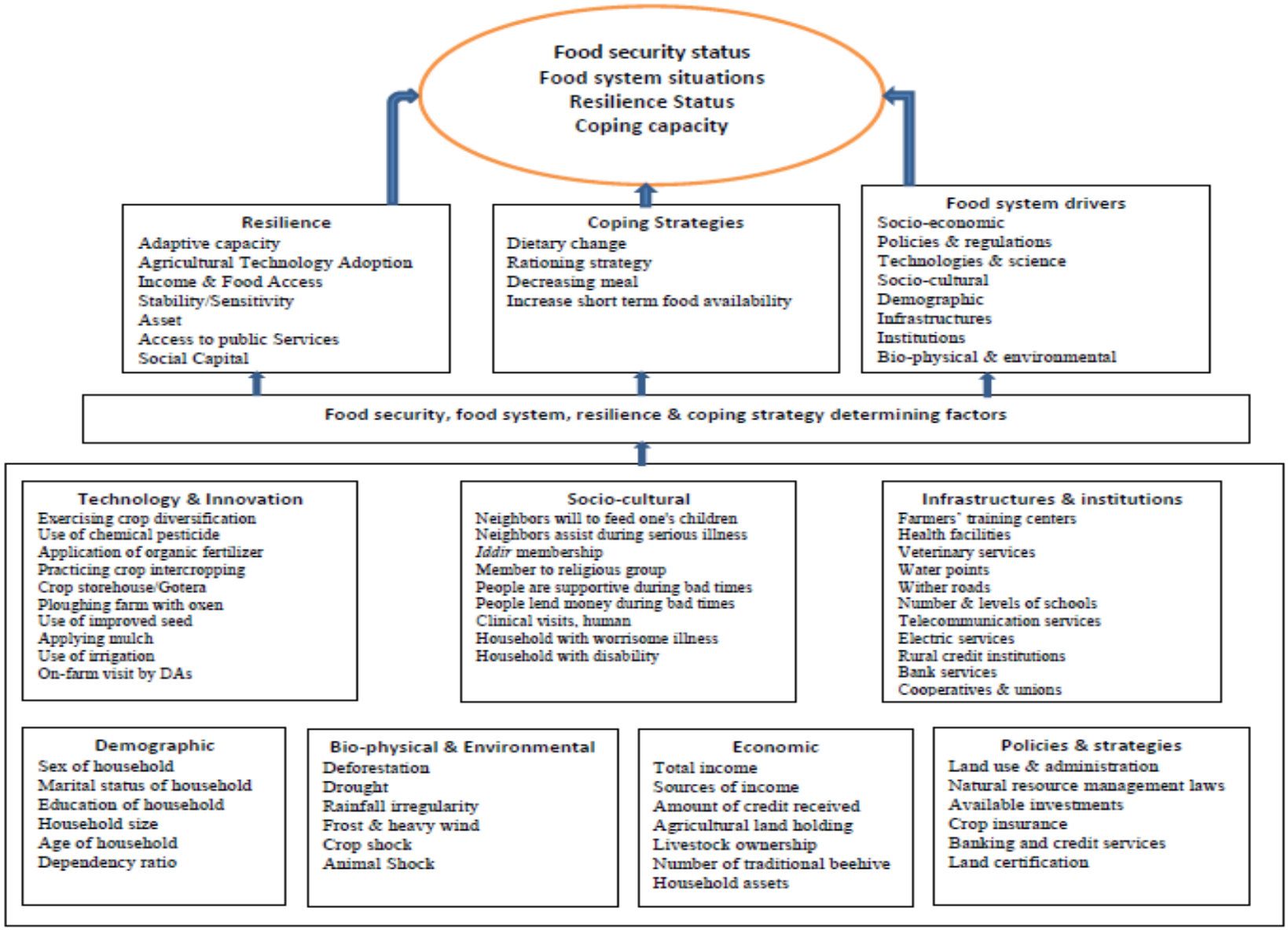

Figure 1Conceptual framework of the dissertation

1.6. Materials and Methods

1.6.1. Description of the Study Area

The geographical coordinates of the Gambella People's National Regional State (GPNRS) in South West Ethiopia are 6028'38" to 8034' North Latitude and 330 to 3501111" East Longitude. It takes up around 29,782.82 km2, or 3%, of the country. Gambella, the regional seat, is located around 767 kilometers from Addis Ababa, the country's capital. Majang zone is one of the three administrative zones in the Gambella region, whose capital city is Metti, which is 620 kilometers from Addis Ababa.

The Southern Nations and Nationalities and Peoples Region (SNNPR), the Anyuak zone, and the Oromia region all border the study area's approximate position on the east, west, and north, respectively. The Majang zone is situated between 7° 4' 2.41" and 7° 46' 47.79"N and 35° 38' 48.00"E longitude. The study region is divided into two districts, Godere and Mangeshi (Figure 2). The region experiences a hot, humid environment. Maps of Ethiopia's rainfall indicate that this area is the wettest in the nation. Despite the absence of a weather station close to the forest, the average annual rainfall is thought to be around 2100 mm. The mean temperature ranges between 20 and 33°C. Between 20 and 33°C are the permitted temperature ranges.

According to MELCA-Ethiopia (2013), the region is characterized by a flat to mild slope, occasional rocky steep slopes, and deep valleys along main streams and on the hills. The Zone's total land area is 225,279.2 hectares, of which 132648.2 (58.88%) are covered in forest, 13269.1 (5.89%) in woodland, 30465.99 (13.52%) in agricultural land, 147.6 (0.07%) in water bodies, 12333.6 (5.47%) in settlement areas, and 36414.63 (16.1%) in plantations (Mathewos & Bewuketu, 2018). Commercial farming (coffee), agriculture, honey production, fishing, hunting, foraging for fruits and spices in the forest, small and petty trades, and commercial farming are the main sources of subsistence in the study region. NTFPs make up roughly 87% of the total household income, with traditional honey making up the highest share of cash income (47%), followed by edible NTFPs (38%) and wood products (2%). The anticipated population for the Majang zone in 2021 is 78,392 (51.6% males, 48.4% women), with a total recorded population of 59,227 (CSA, 2007) and an estimated population density (EPD) of 31.8hab/km^2. Mangeshi district has 14 villages and an estimated population density of 14.4 hab/km^2, whereas Godere

district has 12 villages and an estimated population density of 80.7hab/km2, with 8,787 households per 590km^2 and 4,104 households per 1,660km^2, respectively. Over 60% of the population (or around 88% of the total) lives in rural areas in households with an average of 5.3 individuals. The Ethnic composition is a majority of Majang (almost 50%), 30% Amhara, 12% Tigray, 8% Oromo, and 3% others (MELCA-Ethiopia, 2013). Majang make up the majority of the population (almost 50%), followed by Amhara (30%), Tigray (12%), Oromo (8%) and others (3%) (MELCA-Ethiopia, 2013).

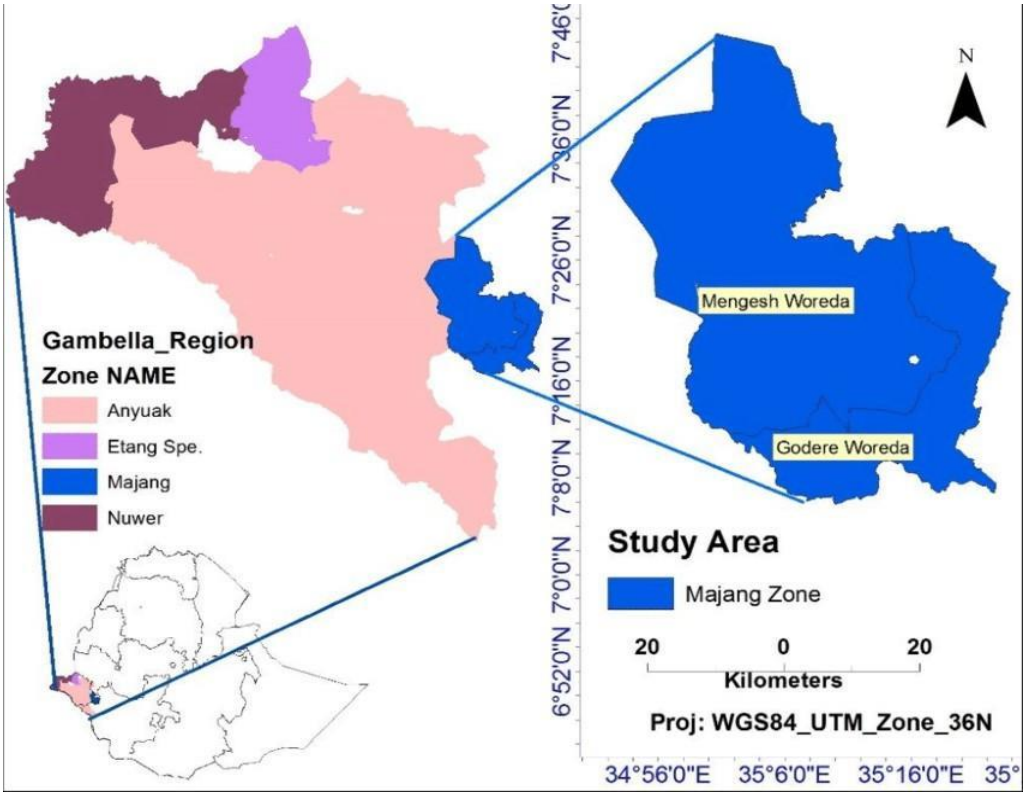

Figure 2 Map of study area (adapted from Mathewos & Bewuketu, 2018)

1.6.2. Methodological foundation

In the realm of science, the majority of researchers and researchers have been limited to qualitative or quantitative methods; however, the hybrid approach has grown in popularity. Three methods for doing social sciences research were recognized by Creswell (2009): mixed, qualitative, and quantitative methods. The researcher's aim for what to study, the paradigm, and the theoretical viewpoints, along with all other preconditions for the research, had defined which of the three to use. According to Hesse-Biber (2010), a researcher's methodologies are derived

from their presumptions about the nature of existence (ontology), which in turn influence their perspective philosophy or set of philosophies on the nature of knowledge construction (epistemology) concerning fundamental questions like who can know? What is knowable? The methodology can be seen as a theoretical link connecting the research problem and the research approach. Additionally, defining the research's ontological reality and epistemological perspective allows the researcher to precisely describe the theoretical perspective, which in turn leads to the specification of the research's methodology and procedures (Gray, 2018).

According to Julia Brannen (1992) in Degefa (2006), mixed techniques can support one another within a single study project. According to reports (Creswell, 2012; Somekh & Lewin, 2005), mixed-method methods of social inquiry are uniquely equipped to produce superior insight than research constrained by a single methodological tradition. According to Degefa (2006), combining qualitative and quantitative household data in a single research project enables a thorough and holistic comprehension of scenarios involving food security, claiming to comprehend situations involving livelihood, well-being, and food security.

According to Datta (1994), who is cited in Degefa (2006), there are five signs that qualitative and quantitative research methods can coexist: "Both have been used for years, many researchers have urged using both methods, funding agencies have supported both methods, both methods have influenced policies, and so much has been taught by both methods." Because it attempts to deal with food system analysis that is governed by food security, as well as environmental and socioeconomic outcomes, the methodological philosophy of my dissertation uses the mixed approach.

Degefa (2006) asserted that the foundation of food security research on a "mixed research method" design gives the opportunity to examine food security in its changing over time contextual paradigm and multiple dimensions, the factors related to state-society relations (political economy issues), and the utilization dimension. Therefore, understanding the complex situation of livelihood calls for food security research to be underpinned by a "mixed-research method" design. In addition, Ciani & Romano (2014) identified three key areas for future developments in the field of resilience to food insecurity: first, merging quantitative and

qualitative approaches; second, dealing with both shocks and stresses; and third, scaling up the quantitative at a more aggregated level (e.g., community).

Degefa (2006) also claimed that the coexistence of quantitative and qualitative techniques, as well as how combining them could improve knowledge of social reality, has significantly influenced the development of the new approach known as "pragmatism" or the "compatibility thesis." The objectivism and constructivism approaches are both included in the research's epistemology paradigm, which is composed of both positivist and interpretivist theoretical perspectives. The study adopts the positivist viewpoint, which frequently employs qualitative research as an adjunct to a primarily quantitative approach as a means of contextualizing people's experiences and knowledge as well as understanding the larger objective background.

1.6.3.Research design and approach

As has been discussed in section 1.6.2 above the research adopted mixed research approach that utilizes constructivist epistemology of phenomenological interpretivism theoretical perspective combining the qualitative and the qualitative research approach. The embedded design, which aimed to collect both data simultaneously or sequentially, but to have the quantitative form of data considered as the primary and the qualitative one plays a supportive role to substantiate the result from the quantitative method, was adopted in this research as one of the six mixed types of methods proposed by Creswell (2012). For more emphasis, qualitative data often gets added to quantitative designs in embedded-type designs.

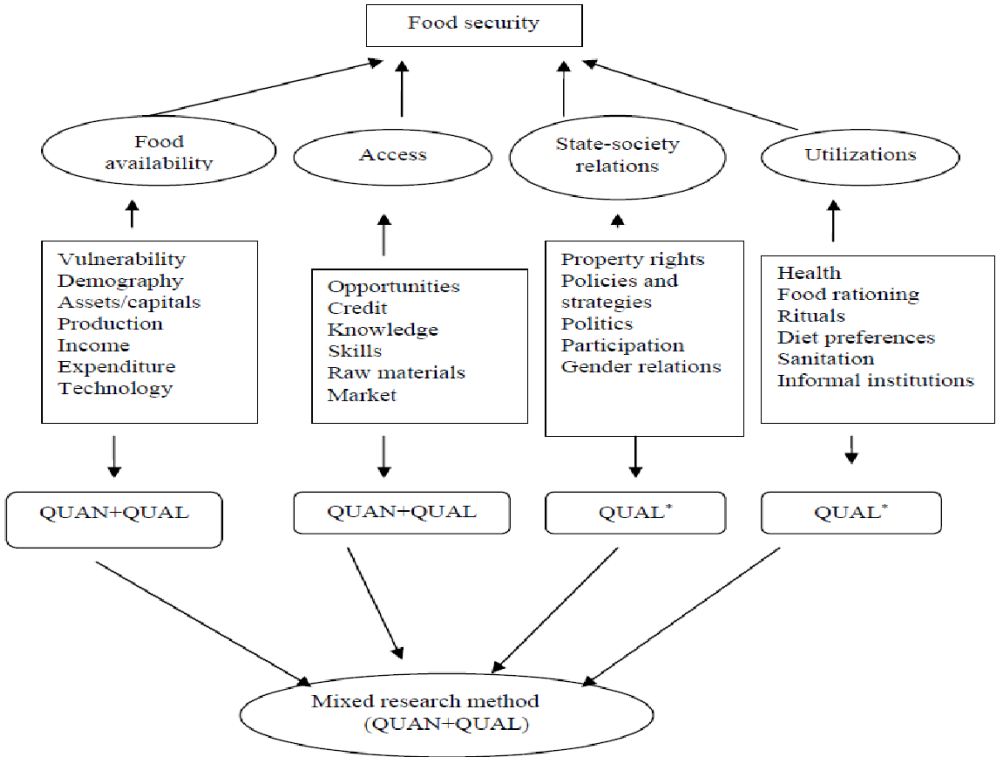

Figure 3 Pragmatic research approach in food security studies (Adopted from Degefa, 2006)

1.6.4. Data types and sources

Primary household respondents, villages administrations, DAs, health extension and post workers at the village level, as well as district-level specialists from government offices of agriculture, health, disaster risk response, environment, research centers, and other NGOs working on food security and related initiatives, were the main data sources. The input acquired through questionnaires served as the quantitative data, and FGD and KII results were used as qualitative data to support the quantitatively assessed results.

1.6.5. Sample size determination and sampling technique

The number of families and individuals who actively participate in the food system and its environment has served as the sample size for the study. Since, presumably, rural households engage in agricultural pursuits, which in turn contribute to food security and the food value chain, the sample size from which the working sample was estimated represents the rural population. In addition to questionnaires, focus groups, key informant interviews, and desk reviews of secondary data sources were used in the data collection process. The interview questions were loaded into KoboToolbox (https://www.kobotoolbox.org/) data collection application to collect the data using tablets and smartphones. Ahead of the actual data collection,

the data enumerators were practically trained on how to use the application and pretested for verification. 10 focus group discussions (FGDs) were convened with the consent of the discussants in the 10 villages, from which participants in the questionnaire-filling process were chosen. On issues framed in terms of reference (TOR), around 20 KIIs from the regional, zonal, district, and village-level administration, office heads, department heads, and specialists were consulted.

The study households were chosen using a multistage selection technique. First, the two districts were chosen purposely. The uniformity in agro-ecology and livelihood were purposefully considered to reduce the confounding factors for that the study's unit of analysis is measuring households' food security and resilience status. Moreover, the two districts have been known for dwelling on forest and non-timber forest products as a measure their economic activities, share similar culture, placed in the same zonal administration. Second, out of the 32 Villages, 10 Villages—four in Godere (*Semuy, Goshini, Gelesha* and *Gonchi*) and six in Mangeshi (*Dushi, Ashani, Kumi, Goshine, Fejeji* and *Newi*)—were chosen systematically by random sampling under the premise that a high sampling ratio (about 30%) was thought to be adequate for small populations (1000).

The sample villages were chosen based on the presumption that they were subsistence farmers, that they are Majang community dominated, and are attached to a life reliant on the agriculture and non-timber forest products. To compute the respondent households from each village based on the total household proportion share, the 2022 estimated population (households) of each village was used. The 10 villages' total population is expected to be 15826 people, and there are expected to be 3557 houses overall. Finally, individual respondents were chosen at random using Cochran's (1977) processes for large populations using the probability proportional to size technique.

$$n_o = \frac{Z^2 pq}{e^2} \quad (1)$$

Z^2 is the normal curve's abscissa, which eliminates a region at the tails (1 -α equals the appropriate confidence level), where no is the sample size. As mentioned in the reports of

Hailemariam (2012) and DRMFSS (2015), the research for this study assumes a range of confidence of 95% and a Z table value of 1.96; e is the desired level of precision, p (0.6) is the estimated proportion of an attribute or all types of food insecure households that is present in the zone's population, and q is 1-p. 369 households make up the sample size according to the formula.

The final sample size is calculated using Cochran's (1977) formula for the sample size adjustment for sample sizes greater than 5% of the population.

$$n_1 = \frac{n_o}{1+(n_o/N)} \quad (2)$$

Given that the sample size is greater than 5% of the population, the ultimate sample size is n1, and N is the size of the population. The ultimate sample size is therefore [369/1+ (369/3557)] = 334. Few were removed due to the incompleteness of some households ' data, and 320 sample houses served as the sampling unit for the final analysis.

1.6.6. Techniques of data analysis

Both quantitative and qualitative data sources were used to acquire the data. The data processing used a variety of analytical techniques and methodologies. Using STATA version 17, descriptive statistics, factor analysis (PCA), chi-square, and regression analysis were performed on the quantitative data. The qualitative data gathered from key informant interviews and focus group discussions was sorted and grouped, and contextually synthesized to use in supporting and substantiating the results from quantitative analysis. Additionally, to evaluate the food security circumstances of households in the research area, food security proxy measures such as the household food consumption score (FCS), household food insecurity access scale (HFIAS), and coping strategy index (CSI) were also used. Additionally, a framework was utilized to examine how the drivers and forces of the food system affect one of the outputs of the food system, the level of household food security. Four main, specific objectives serve as the foundation for this thesis's path of inquiry.

1.6.7. Scope and Limitation of the Study

The Majang zone and its two districts were the sole subject of this study. Ten villages from the two districts made up the respondent sample units. To design effective measures to food insecurity challenges, it is important to understand the drivers and pressures on the food system, the levels of food security and resilience capacity of rural households, and the key determinants of food security and coping strategies practiced. Similarly, the analysis of this study was concentrated on the household level in rural areas because this is where the majority of risk management and coping mechanisms for food insecurity are applied. The lack of well-documented information serving the research data was another obstacle that had encountered. In such cases as lack of well documented data in some of the offices, fulfilling and cross-referencing them from compiled biennial and annual reports from planning and human resource sections was considered as alternative data complimenting method. The limitations brought on by a lack of finance, time, and other resources will not be disregarded. If respondents want a daily subsistence stipend, it may be difficult to reach them during data collection, and because some of the communities were rural, there may be a transportation problem.

1.6.8. Significance of the Study

This study believed to fill the vacant in the scarcity of literature, test of methodological approaches, and suggest alternatives solutions for programs and policies to be implemented or improved for sustainable and enhanced food security. An essential component of defining development as an effort to improve livelihoods is an analysis of food systems and food security. This analysis also serves as a research priority and provides feedback and corrective actions in the political and policy spheres. Food systems analysis is cited in an expanding body of literature as being essential for describing the state of the food systems today, exploring causal mechanisms, setting baselines, evaluating impacts, gauging efficacy and scaling up successful interventions, structuring high-level debates, and explaining the complexity of the system to policymakers or the general public. The food system value chain mapping enables the development of a practical framework that opens up possibilities for a more sustainable and efficient use of resources. It also offers guidance for policymakers and other interested parties in the planning, implementation, monitoring, and evaluation of the pressures on the food system and its drivers. The chain's gaps were identified through an analysis of its sustainability, allowing the relevant disciplines to take proactive action.

Additionally, sectors like social protection, disaster risk reduction, and climate change adaptation are beginning to take resilience into account as they develop and work to reduce vulnerabilities. As a result, resilience is now a term that is frequently used by academics, development professionals, politicians, philanthropists, and international development organizations. In addition, literature on food security has recently incorporated the idea of resilience. Therefore, conducting such empirical research would help close the current gap in the literature, aid in determining the level of resilience sought after by various categories of rural households, and aid in identifying the key determinants of current level resilience to design appropriate food insecurity responses in the study area. The study aids policymakers and development professionals in identifying the areas where interventions aimed at reducing vulnerability and boosting household resilience may be most successful. It also gives researchers a starting point for their research and serves as an input for further investigations.

1.6.9.Ethical Issues

I hereby declare that the methods of this research are valid and practically feasible, have a clear objectives, are designed using sound scientific principles, have sufficient statistical power, and are based on adequate knowledge of the scientific literature. The proposed protocol demonstrates a valid scientific basis/ground, enhances health or generalizable knowledge, and benefits individuals and the community where the research was conducted. Moreover, risk subjects were planned to be minimized through using procedures that are consistent with acceptable research design and potential benefits enhanced. Using the work of other scholars and vital secondary materials was duly acknowledged by citations. The justification for selection and the equitable nature of the selection of research subjects were described. Privacy was respected, confidentiality maintained, the opportunity to withdraw at any time or refuse any component(s) of the research was available, and the well-being of research participants was monitored, while information related to research participants was kept confidential. The information provided to research participants was complete and appropriate to the participant's level of understanding. The participants were free to give or refuse consent and were informed about their consent without coercion, manipulation, undue influence, or intimidation. The research encourages the community's involvement in decision-making about the design and conduction of the study. Besides, the research considers the local customs, traditions, culture, and religious practices of

the community given due respect, and not violated. This study was granted ethical approval from the Institutional Review Board (IRB) of College of Development Studies (CoDS) of Addis Ababa University on 24/08/2023 and with Reference number of spe/e/c/28/07/2023, and it is accessible at https://doi.org/10.20372/aau_rdm/EAOGKA (Zerihun *et al*., 2023).

1.6.10. Organization of the Study

Six chapters make up this dissertation. The general introduction, background information, problem statement, the objectives, the research questions, the scope and limitation of the study, the significance of the study, ethical considerations, thesis organization, literature reviews, and methods were all included in Chapter 1. The assessment of the influences and drivers of the food system on the outcome of food security is the subject of Chapter 2, which focuses on the first objective. The factors that affect household food security are covered in Chapter Three. The dissertation's fourth chapter places a strong emphasis on resilience to food insecurity and its determinant factors. The fourth objective, which is depicted in Chapter 5, details the prevalence of food insecurity and the coping mechanisms that go along with it. The synthesis, conclusion, suggestions for further research, and recommendations are all included in the sixth and final chapter.

CHAPTER TWO: ASSESSMENT ON THE FOOD SYSTEM DRIVERS: THEIR IMPLICATION ON THE FOOD SECURITY OUTCOME[1]

2.1 Introduction

The most fundamental human need and human right for leading a healthy, active life is food. Nevertheless, since the beginning of life, people have worried about how to ensure their access to food. Due to the widespread anxiety this situation caused, the term "food security" was first used in the middle of the 1970s during the World Food Conference of 1974, which was organized in response to the then-current global food crisis (Clay, 2002). Since the 1970s, the notion has continuously included additional dimensions and degrees of analysis; this reflects the broader acknowledgement of its complexity in research and public policy challenges. According to the FAO, "food security is a situation that exists when all people at all times have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 1996).

Ethiopia and other developing nations, particularly those in Sub-Saharan Africa, continue to face pervasive food insecurity annually despite the unwavering efforts that have been made. Chege *et al*., (2023) reported that of the six food system driving indicators examined, two have declined and one has remained constant in Ethiopia during the last ten years. Therefore, even though foreign direct investment, annual population growth, and improved technological innovations regarding input utilization to boost production and productivity have changed positively, the effects of climate change and urban population growth are still worsening, and the export sector has not changed. The major drivers, as described by several authors, are generally grouped into biophysical and environmental; innovation, technology, and infrastructure; political and economic; sociocultural; and demographic components (Chege *et al*., 2023; Traore, 2021; Kennedy *et al*., 2020; FAO, 2018b). Evidently, population growth, low total factor productivity

[1] Based on:

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(efficiency of capital and labor use) (UNDP, 2022), a low adult literacy rate (52%), overreliance on traditional food retail markets, climate change in terms of weather variability (Chege *et al*., 2023), decreased public investment and ineffective policy interventions, a large financing gap between long-term investment and short-term emergency food assistance needs, harvest and postharvest losses, and less integrated research and innovations (Bizikova *et al*., 2022) are among the key drivers challenging the Ethiopian food system. For instance, understanding trends in population size is critical to estimating the future demand for food (Godfray *et al*., 2010) and the sectors that absorb the active working force (employment opportunities).

The food and nutritional security concepts are ingrained in the broader concept of the food system as one of the immediate outcomes. According to Capone *et al*. (2014), the food system idea is a comprehensive system approach that incorporates a variety of players that make up the varied collection of institutions, technologies, and behaviors that control how food is accessible, processed, transported, and consumed. According to the definitions and descriptions of numerous scholars, the food system consists of an intricate web of interconnected parts, processes, and outcomes. Grubinger *et al*. (2010) characterized it as an interconnected web of people, resources, and activities. This network can be recognized at several scales and is a reflection of and response to social, cultural, political, economic, health, and environmental situations. It spans all domains involved in sustaining human nourishment and health. Food systems include the entire range of actors and their interconnected value-adding activities involved in the production, consumption, and disposal of food products, as well as parts of the larger economic, societal, and natural environments in which they are embedded (FAO, 2018b).

The FAO's sustainable food systems concept and framework document described a sustainable food system as "a food system that delivers food security and nutrition for all in such a way that the economic, social, and environmental bases to generate food security and nutrition for future generations are not compromised". Lomax (2018) illustrated it as a system that incorporates all the components (environment, people, inputs, processes, infrastructure, institutions, etc.) and activities related to the production, processing, distribution, preparation, and consumption of food, as well as the results of these activities, such as socioeconomic and environmental outcomes. In addition, Lomax (2018) described it further as a system that includes all the

elements (people, infrastructure, processes, inputs, distribution, and so on) and activities associated with food production, processing, distribution, preparation, and consumption, as well as the outcomes of these activities, including socioeconomic and environmental consequences.

Efforts to provide sustainable food and nutritional security depend on a particular food system operating at peak efficiency while taking into account the influences of the environment, population, technology, politics, economy, society, and culture (Chege *et al*., 2023). Kennedy *et al*. (2020) state that strategy specifically takes into account facilitating innovations and connections across food ecosystems, supply chains, consumer behavior, and related forces. These components call for the involvement of all stakeholders through concerted efforts, including a range of disciplines and levels of competence, to develop long-term solutions to both current and future difficulties.

A sustainable food system promotes food security, maximizes the use of natural and human resources, is accessible and acceptable in all cultures, is environmentally sound, equitable, and commercially successful, and offers consumers food that is safe, healthy, and reasonably priced for the present and future generations (Capone *et al*., 2014). Furthermore, as a conceptual tool for comprehending the fundamental drivers of food and nutritional outcomes, the food systems approach has drawn increased amounts of attention (Kennedy *et al*., 2020). This reality makes it necessary for nations to acknowledge and implement the system to enhance food and nutritional security using a more comprehensive systems approach. This strategy has already been adopted by several international organizations and is beginning to be recognized by national governments as well (Traore, 2021). Most recently, the government of Ethiopia included the strategy as a subcomponent in the implementation of the Agricultural Growth Program II (AGP II) throughout the entire country.

As a result, identifying, describing, and synthesizing the key drivers of the local food system can serve as a source document for understanding the overall food system situation, prioritizing challenges, and proposing and undertaking scientific and development interventions. According to Traore (2021), modifications are important for creating more inclusive, sustainable food systems because Ethiopian food systems are currently ineffective. The academic community,

researchers, policymakers, local governments, and development actors operating in and out of the Majang zone can benefit from this assessment's knowledge addition and practical recommendations, especially in areas such as this one where there are plenty of resources for the food system but little has been done to fully realize its potential. Thus, the assessment was conducted to pinpoint the primary causes of the food system's results in terms of nutrition and food security, as well as to develop and advocate long-term corrective actions. Methodologically, focus groups, key informant interviews, and a questionnaire were used to collect primary socioeconomic data from ten randomly chosen villages in the two districts. Secondary data were gathered from published papers and articles as well as from in-depth studies of evaluations, reports, and media sources.

2.2. Flow of the assessment work

The domain components are designated with titles describing the major factors determining the food system. The first box contains factors that could explain the primary forces influencing the local food system in the research area. The second, pressures, is explained by the factors that exert pressure on households and how they are having an impact on the food security elements. The third to seventh are represented by the current state, the impact, the responses undertaken, and finally the outlook describing the suggested measures and recommendations. The domain components are identified by titles that outline the key determinants of the food system. The first box includes information on the main elements affecting the local food system in the study area. The second, pressures, is described by the pressures placed on the food system and how they affect the components of food security. The third through seventh sections include the existing situation, the impact, the actions taken to address it, and lastly, the outlook outlining the offered solutions and suggestions.

2.3. Drivers of the Local Food System

2.3.1. Sociocultural drivers

Food security is significantly impacted by sociocultural elements such as women's employment, gender inequality, food preferences, customs, and beliefs. The Majang have a custom known as "Jang" that has allowed them to claim ownership of substantial tracts of forest, which has allowed them to maintain the forest for centuries. The Majang people lived in the forest for all of the recorded times, relying on it for shelter and food. The Majang have always made their living

from the woodlands. Their livelihood consisted of honey production, hunting, and gathering nuts and fruits from woodlands. Their culture placed a high value on forest resources, which has helped with conservation in part. They have traditionally used natural boundaries, such as rivers, valleys, or hills, to divide forests among their tribes. However, ownership has slightly evolved into a more community type since the revolution of 1974, and immigration from many ethnic groups across the nation has increased. Furthermore, in the early 1980s, plantations of palm trees and coffee were brought to the region. All of these factors have had a significant impact on how the Majang people now view the forest in their traditional practices. Coffee plantations are among the permanent agricultural activities in which the majority of Majang people today have started in and near the forest.

Furthermore, a great deal of resource loss from deforestation results from the open access and commercialization of the forest, which is caused by a lack of integration and attention given to certain kinds of priceless traditional customs. Even though some Majang communities still follow their ancient cultural customs, community leaders and elders are treated with less deference and responsibility than they were in the past. Given that they have lived in and depended on the forest for many generations, it is evident from the group discussion involving elders, community members, professionals, and local authorities that locals understand the necessity of maintaining the forest. They have ensured the protection of resources by using their cultural knowledge to responsibly exploit forest products (honey, wild fruits and nuts, game meat). They understand that they were impacted by the destruction of the forests. The impact has become increasingly apparent to many people, particularly in light of the decrease in honey output and the scarcity of huntable wild animals.

2.3.2. Biophysical and environmental drivers

The planning of rural development initiatives, the monitoring of food security and land use, and studies related to climate change depend on an analysis of LULC change (Girma & Muluneh, 2021). Two human-related factors, proximal and underlying causes, lead to LU/LC alterations according to the literatures (Mariye *et al*., 2022; Teshome *et al*., 2019). Economic, institutional, technological, cultural, and demographic changes are cited as indirect forces that accelerate the effect of proximate drivers on natural resource use. The proximate drivers, or direct drivers, are linked to the direct action of humans and include infrastructure development, unsustainable

exploitation of forest resources, and agricultural expansion. In a similar vein, the study area's primary direct drivers were identified as agricultural land expansion, resettlement or villagization; demand for firewood and construction materials; and institutional structure, economic activity, policy, and population pressure, while other factors were identified as indirect drivers (Girma & Muluneh, 2021).

The magnitude of land use and cover change caused by deforestation resulted in the expansion of agriculture and settlement by 108.1% (8339 ha), the reduction of dense forest by 26.4% (44969.9 ha), and the emergence of a new land use/land cover type, a mosaic or mix of managed coffee and open forest, according to MELCA-Ethiopia's (2015) project baseline assessment report. A constant declining trend (1.42% and 1.55% each year in the first and second periods, respectively) was revealed by the land use/land cover change trend analysis. The change statistics matrix also revealed that most of the increases in all the other land use types occurred at the expense of dense forest, except for savanna woodland.

Similarly, in the study of Girma & Muluneh (2021), which covered the years from 1985 to 2018 in the first study period (1985), the landscape was dominated mainly by forest (70%), followed by agricultural lands (17.3%), settlement areas (5.5%), water bodies (2.2%), and shrub/grasslands (5.6%). Their findings showed that after ten years (in 1996), land use changed to 62% forestlands, 23.3% agricultural lands, 8.4% settlement areas, 4.4% shrub/grasslands, and 1.9% covered by water bodies. In 2007, the land use indicated further change, in which the magnitudes of forest, agricultural lands, settlements, water bodies, and shrubs/grasslands were computed to be 51%, 27.4%, 17%, 1.5%, and 3.1%, respectively. In the last study period, 2018, almost two-thirds (62.7%) of the study area was under agricultural lands and settlement areas, while the shares of forest lands, shrub/grasslands, and water bodies decreased to 35%, 1.1%, and 1.2%, respectively. Overall, between 1985 and 2018, there were large decreases in forestlands, shrub/grasslands, and water bodies of 49.7%, 80%, and 42.3%, respectively, while agricultural lands and settlement areas rose by 100.6% and 413%, respectively. The majority of the observed changes, according to the study, are attributable to population increases that were followed by relocation initiatives and the influx of individuals.

2.3.3. Innovation, technology and infrastructure

The zone's poor and inadequate socioeconomic, institutional, organizational, political, infrastructural, and service-providing sectors continue to be its principal constraints. According to evaluation reports, households need two hours and 45 minutes to travel to the closest paved road and urban center, respectively, demonstrating the degree of physical accessibility challenges. It is often known that market accessibility is limited, mostly because of distance and a lack of transportation. Poor credit utilization was also noted in the area, where just 1.1% of households borrowed money, mostly from friends and family. Just 0.3% of the households were in communities with electricity, indicating a lack of access to electricity; 98% and 91% of the households reported not using any kind of pesticide or fertilizer, respectively; only 32% of the households used improved varieties of seeds; 40% of the households had received agricultural extension services; and 78% and 83% of the households reported having poor access to livestock drugs and veterinary services, respectively. According to DRMFSS (2015), almost 95% of the families did not use any form of agricultural input, 92% of the farmers used manual tillage, and 95% of the farmers did not own oxen. According to 78% and 83% of the respondents, respectively, there was poor access to veterinary facilities and livestock drugs in the same research.

The other important aspect that has the greatest impact on how the food system develops is the education sector. According to reports, a zone's educational situation requires urgent fixes in the areas of technological installation, human resources, service delivery, and the provision of supplies and equipment. According to data obtained from the Regional Bureau of Education, while the number of second-cycle schools doubled from seven to sixteen during the same period, the number of secondary high schools, which presently stands at eight, has not increased for eight years (2013/14–2020/21). For a zone with 35 villages, these schools are too few to accommodate students who are promoted from first-cycle schools. First-cycle school enrollment increased during the years for which data were gathered, at least in terms of numbers (36 to 50). In addition, practically all categories—from the first cycle to preparatory schools—have shown rare growth in the number of registered students over the research period. Preparatory class enrollment decreased from 322 in the 2013–14 academic years to 239 in the 2020–21 academic years. These data serve as evidence of the responsibilities that the government and stakeholders

must fulfill. The number of children who dropped out of school climbed from 570 to 1525 between 2013 and 14 and 2020 and 21, defying the projected goal of lowering dropout and school termination rates at all levels, from district to federal. Implicitly, the challenges to the education sectors include the challenges to the development of food security and food systems as well.

One of the key factors determining the effectiveness and efficiency with which a certain food system advances sustainably is the health sector. Numerous elements, both man-made and natural, surround the zone's health sector. The problems that have been faced for a long time include pandemic and epidemic diseases, infrastructure and services, human capital development, stakeholder cooperation, and similar bottlenecks. One of the main causes of health shock in this zone is the prevalence of chronic illnesses such as HIV/AIDS, TB, diabetes, and malaria. This zone is known to have the highest rate of HIV/AIDS incidence in the nation (4.7% in 2021). Little progress has been made in terms of HIV/AIDS prevention and drug coverage. Similarly, from 2018 to 2021, there was a decrease in the cure rate of tuberculosis (TB) despite a higher diagnosis rate.

There is just one primary hospital whose facilities and resources are limited by the availability of medical supplies and equipment. There are only eight general physicians (GPs), 18 health officers, five midwives, 66 clinical nurses, 13 lab technicians, and no environmental health professionals in the zonal health office data, which suggests that the number and discipline makeup of health professionals in the area is insufficient for the level of cases and population. The peculiar limitation that health practitioners face is rationing against established national norms. A lack of access to clean drinking water—roughly 32% of households lacked a toilet, and another 65% of households used outdoor latrines—and poor sanitation—many households rely on rivers and streams as their primary source of drinking water, and the majority of them (approximately 93% of the households) use the water untreated—are signs of poor community health. Family planning, routine HIV and TB medication, and sanitary advocacy are among the services that are still stagnant or declining.

2.3.4.Political and economic drivers

The agricultural industry is primarily responsible for the livelihood of the zone in general and for food security in particular. The community relies heavily on agriculture, beekeeping, and livestock production for its survival. They also made honey and engaged in hunting and harvesting of wild edible plants from woodlands. The Majang culture places a high value on forest resources, which has helped with conservation in several ways. Approximately 19% of the entire land area is used for agriculture, which significantly helps the community meet its food needs. In addition, it is thought that households' main coping strategies consist of increasing working hours, selling more assets than usual, borrowing food and money, and gathering wild foods. Honey and coffee are the major sources of cash income and employment opportunities for local communities. Other sources of income include *bulla* and *kocho* from *the ensets* and livestock. The major crops grown in the area include maize, sorghum, *Enset*, various root crops, and fruits such as papaya, sugarcane, avocado, and banana.

The traditional method, which employs manual tillage and is further constrained by the lack of inputs, is labor intensive, and the agricultural industry in the zone is notable for its low production and productivity. The sector's productivity and production both numerically and qualitatively remained low due to several constraints, including inefficient use of inputs, poor agronomic practices, losses caused by biotic and abiotic factors, inefficient management and resource usage, and disease. It was reported that farmers do not use artificial fertilizers or crop protection, and only 30% of the surveyed ploughs used oxen. For example, nearly thirty percent of the farming households surveyed used oxen to plough their land. Additionally, compared to nearly 35% of the potential yield wasted, on-farm and postharvest losses are far greater. Furthermore, the area allocated for grains and other consumable products has reportedly been decreasing because cash crops such as coffee and chats dominate the market. Even if raising livestock is not as common as raising crops, there are no better techniques available to assist in the production of animals. Technologies such as artificial insemination, veterinary care, feeds, and improved management techniques do not assist native bred plants. Furthermore, inadequate alternative income-generating activities have resulted in a high prevalence of youth unemployment.

Nevertheless, the region is rich in natural resources, and in addition to the disparities in output and productivity, legally enacted laws, regulations, and directives have not yet been fully established according to the country's mandate. For example, the region has used federally produced legal frameworks to control and administer rural land, but it has not developed and implemented its legal frameworks for this purpose. Under the Ministry of Agriculture, the federal government has manipulated the land distribution for substantial investments (>500 hectares) (Federal Democratic Republic of Ethiopia, 2007; Reg No. 135/2007). Due to mandate overlap and conflicts of interest among the players, there is a gap in the implementation of both the planned duties and the policies. These contradictions in land administration and governance mandates, which show a lack of attention given to investment issues, have led to the allocation of 312 hectares of heavily forested land to tea plantations based on inaccurate environmental impact assessment results. This has resulted in recurrent conflicts between investors and the community, which have cost lives. Recurrent conflicts with the community were caused by agricultural investment land transfers, which demonstrated similar shortcomings in terms of the economy and natural resources. These data unequivocally show that the region is less equipped to create and carry out any policies or strategies about rural land since it was unable to create its own legal framework for managing the land under its legal authority.

In addition, where they were unable to fully participate for an extended length of time, the land registration and certification responsibilities continued to be poorly managed and administered. Land administration and governance attempts are beset with difficulties in addition to gaps in policy, employee incompetence, corruption, professional workers' lack of knowledge, lack of funding, improper leadership, inadequate monitoring and evaluation systems, insufficient sense of ownership, and conflicting interests. Low awareness, improper policy implementation, and a lack of connections between stakeholders and the community have all been noted as frequent issues in the zone in the 2015 DRMFSS-WDRP assessment report. Due to the lack of a robust and legally binding regulatory framework, corruption in the land market and land grabbing have become commonplace among local officials and property brokers. Accordingly, most court files address land-related charges according to the key informant interviews conducted as part of the study.

2.3.5. Demographic

The Majang zone's population trend indicates a notable increase during the previous few decades. The population of the area nearly doubled, rising from 53,000 in 1994 to 59,248 in 2007 and then to 91,407 in 2023, according to data from Ethiopia's Central Statistics Agency. According to the descriptive statistics, the population of urban areas is growing at a quicker rate than that of rural provinces. Due to its smaller area and fewer communities (14) than Mangeshi (19 villages), the Godere district has experienced a greater rate of population growth (38.36%) during the past 15 years than has the Mangeshi district, which is dominated by rural villages (2.81%). This is partly because Godere is composed of more urbanely and semiurbanely characterized towns and villages, including the zonal capital, Metti town. Given that the economic, social, infrastructural, and service sectors have shown steady growth, the rapid increase in the population implies considerable implications for the food security and nutritional outcomes of traditional local food systems.

2.4. Current State of the Food System

The Majang forest is said to be the community's best source of livelihood security. However, the native people's way of life has been threatened by the shift in qualitative and quantitative dimensions. The zone's current situation demonstrates how unpredictable the weather can be, especially in regard to temperature and rainfall patterns, which greatly hinder agricultural output and food production overall. Due to the low yield per unit plot, cropland must be expanded at the expense of forestland (extensive farming). Furthermore, aquatic bodies are becoming increasingly fewer in quantity over time. The unsustainable use and management of natural resources puts agricultural varieties, animal ranges, and other adaptable species at risk.

In contrast to the few nonexistent wild creatures that are currently available as food sources, the forest was abundant in wild animals thirty to forty years ago, and hunting was quite popular. The yearly decrease in honey quality and quantity, which is connected to a decrease in forest cover and species and accelerates the extinction of honeybee flora, is another concern of the populace. Along with pointing out the region's altered climate patterns and frequent drought episodes, the locals explained that deforestation may have contributed to these changes. The degree of forest loss in the region may have increased as a result of changes in traditional forest ownership and

management. In contrast to today, when anyone can access the forest and clear it for the spread of agriculture and coffee, three to four decades ago, forests were owned by individual people. Furthermore, although its significance is periodically diminishing due to the depletion of the resource base, bush meat remains the primary source of animal nutrition for the Majang people. Due to the scarcity of wild animals, hunting has decreased recently. Additionally, several species that are important for tourism have moved away from the area and are no longer present. Similarly, many wild edible plant species that are utilized in traditional medicine and for sustenance are at risk of becoming extinct. The different plant species used to heal illnesses via traditional medicine are important because the introduction of health centres or clinics remains a challenge.

2.5. Impact on the Food System

Environmental effects on both humans and nature are irreversible as a result of the unsustainable use of the natural resource base. In the zone, the microlevel effects of climate change include irregular rainfall that leads to drought, a serious issue that causes agroecological changes that damage crops and livestock and result in food and income loss, problems with water quality and quantity, health issues for humans and livestock, biodiversity loss, and so on. Waterlogging, inadequate environmental sanitation, and changing climatic conditions in the area are the main causes of human health concerns. Additionally, diseases such as liver flukes, trypanosomiasis, and blackleg, foot and mouth disease, which are frequently observed in these zones, limit the health of animals.

The traditional low-productivity, undiversified agriculture in the area is unprogressive and unable to feed the growing population. Furthermore, the community's level and strength of resilience, as well as its means of subsistence, were severely impacted by the alarming ongoing deforestation and land use change. This is demonstrated by the fact that 39%, 24%, and 19% of the communities have received food aid, *faffa*, and agricultural seeds and tools, respectively. Furthermore, more than 40% of the households stated that they could not raise the Birr 500 in a week, demonstrating their susceptibility to an unexpected wave of disasters due to a decline in revenue from forest-based products. One-third of the households were unable to recover from the losses they incurred during disasters.

Concerning nutrient depletion, there was also a shift in the land's productive potential. Both the quality and quantity of the food variations or diversities that were formerly obtained from the forest have declined. Similarly, the loss of significant native plant and animal species at both the micro- and macrofaematia and flora levels was caused by the destruction of plant genetic resources caused by deforestation. Disturbing the local food chain can also result from a decrease in the quantity, variety, and quality of available water sources. A shift in the food system equilibrium can occasionally be caused by an increase in the variety and frequency of plant and animal diseases. A related issue is the conflict of interest among individuals, institutions, and states due to the absence of sound policy and its implementation.

2.6. Responses of the Food System

Community, government, and nongovernmental organizations have made several attempts to reduce the risks and challenges facing local food systems, but the results do not appear to be consistent. The development of a government-implemented sustainable land management programme (SLMP) that targets reforestation and afforestation, land certification, the generation of alternate income through agro-forestry, the development of capacity, and the increase of awareness at various stages are some of the interventions that have been carried out. Sustainable resource exploitation and management have been greatly impacted by the "Bioreserve," whose success in preserving the sustainability of the natural base is attributed to the designation of the UNESCO forest as a "Majang Biosphere Reserve" by the MELCA-Ethiopia project. Another endeavor the organization is working on is the development of alternate sources of income to lessen the strain on natural resources. TechnoServe, an NGO, has begun focusing on the branding and value-adding of goods such as honey and coffee to increase the community's income. By putting community members into cooperatives, this group also gives them credit. To promote the effective utilization and high quality of water resources, small-scale irrigation projects and stream construction are also being built in the area. It is too early to tell what effect conservation agriculture and resilient food system initiatives had, but their execution has proved tenable.

2.7. Outlook (concluding and recommending remarks)

The first and most important issue that needs to be addressed is the legally defined clarity of who owns, uses, and manages natural resources. Strengthening sustainability can be greatly aided by

implementing land certification. A multisectoral and multidisciplinary approach to the food system is needed to achieve and maintain food and nutritional security in a changing climate. This approach should take into account cross-cutting issues such as gender equality, governance, state fragility, and nutrition, as well as nutrition, agriculture, health, trade, education, water and sanitation, and social protection.

By strengthening the connections between the research and extension sectors, it would be possible to implement sustainable patterns of food production and consumption that are in line with the carrying capacities of natural ecosystems. This can help reduce total dependence on natural resources, alleviate the production and productivity gap, and increase food security. It is also important to think about improving sustainable food systems through the creation of cogent public policies that span relevant industries and cover the entire food supply chain. This in turn ensures year-round access to wholesome food that satisfies people's nutritional needs and encourages safe, varied diets. The branding and value addition of goods derived from natural resources need to be prioritized to maintain the ecosystem's equilibrium.

Building and operating a sustainable food system requires the fulfillment and capacity of institutional and infrastructure services. The construction of weather roads, transit access, and the fortification of formal specialized market segments—especially those associated with product development, price fixing, place (demand), and promotion—are considered essential. Payments for ecosystem services, such as carbon trade shows, should be started. To develop a more specialized value chain, credit, insurance services, and incentive systems are also crucial supplements to the practices of the conventional food system. More specifically, the following points require priority consideration:

- Livelihood diversification should be promoted, accompanied by the adoption of processing technologies to improve product quality and marketing, as part of value chain development.
- The adoption of modern beekeeping, with the introduction of transitional and modern beehives as well as processing technologies to increase production and income as well as improve the quality of the product, is a high priority. This approach will also prevent the

death and disability of farmers engaged in apiculture, which commonly occurs when they fall from long trees (>50meters).

- The skills of indigenous communities should be developed to undertake livestock and staple crop production and for off-farm employment opportunities to reduce direct dependency on natural forests.
- The capacity of government offices at different levels should be built, particularly staff development through on-the-job technical training, to enhance efforts to achieve sustainable improvement of the livelihoods of the community.
- Preparation and implementation of locally adopted and mutually accepted policies. Rural land administration and governance, investment, settlement, and villagization policies formulated by all concerned stakeholders, including the community, are key solutions to the prevailing challenges.

Carrying out applied research that targets the resilient capacity of communities and local food systems and their driving environments, especially on food and nutritional security, coping with stress and shocks, and value chain development and management segments, is important for adapting to dynamic changes in the changing world.

CHAPTER THREE: DETERMINANTS OF FOOD SECURITY AMONG RURAL HOUSEHOLDS IN MAJANG ZONE, GAMBELLA REGION, SOUTHWESTERN ETHIOPIA[2]

Abstract

Attaining food security is a basic human right and a priority development agenda, particularly for the least developed countries, although the challenge remains tough. The research was designed to analyse the food security status of households and its determinant factors in the Majang Zone. Multistage sampling was employed to select the 320 households. The study employed mixed design that uses questionnaires, focus group discussions (FGDs) and key informant interviews (KIIs) to generate data. The data were analysed using descriptive and binary logistic regression. The findings indicated that nearly 53% and 47% of the households were food secure and insecure respectively. Beehives ($p<0.05$), formal education ($p<0.01$), landholding ($p<0.01$), oxen ploughing ($p<0.05$), livestock ownership ($p<0.05$), farm income ($p<0.01$), extension support ($p<0.01$), and family size ($p<0.10$) significantly positively determine household food security status, whereas age ($p<0.05$) and pesticide use ($p<0.05$) have negative relationships. Education, land holding, income, and extension service appeared to very highly and significantly influence food security. Similarly factors including possession of the number of traditional beehive and livestock have high significance in lifting food security. Hence, coordinated effort has to be directed towards enhancing and improving these determinants and reduce the limitations adhered to them. Key elements such as using improved agricultural technologies, broadening small irrigation use, strengthening credit services and cooperatives and infrastructural developments namely wither roads, niche markets, and rural electrification, coupled with diversifying income sources call for holistic and sustainable strategic intervention from concerned bodies of the government and stakeholders at all levels to curb food insecurity challenges.

KEYWORDS: Food security, Logit, Households, Majang, Food Consumption Score

[2] Based on:

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3.1 Introduction

Ensuring food and nutritional security is the human and constitutional right of all citizens, even though globally, particularly in low-income countries, this situation remains an enormous challenge. Food security is achieved when "all people at all times have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (Clay, 2002)

Globally, even if efforts are underway to address food security crises, nearly 690 million people have been hungry, more than 250 million of whom live in Africa (FAO *et al*., 2021b). A preliminary assessment of the same source suggested that the COVID-19 pandemic might have affected 83 to 132 million people worldwide in 2020. In Ethiopia, the number of poor and food-insecure people has remained very high, with an estimated 25 million people at or below the threshold of survival (Diriba, 2020b). Out of these poor people, 8.5 million were estimated to be severely food insecure in early 2020 (FAO *et al*., 2021b). Additionally, nearly 8.5 million people were reported to be highly food insecure due to the impacts of COVID-19, desert locusts, displacement, and high food prices (IPC, 2020).

Approximately 52% and 36% of the rural and urban populations, respectively, consume less than the minimum recommended daily intake of 2100 kcal/person/day (Debebe, 2018). Luminița (2016) also disclosed the lives of approximately 10.2 million people in an emergency food security setting. Indicative of these, the 2018 GHI measure ranked Ethiopia 93rd out of 119 countries, scoring a value of 29.1, an improved but alarmingly categorized country (GHI, 2019). In response, the government tends to augment the food gap with food aid where more than eight million people participate in PSNP transfers (Gilligan *et al*., 2023).

In Ethiopia, natural, social, physical, economic, and political factors are the main causes of food insecurity and unsustainable food systems ((Endalew *et al*., 2015); MoFED, 2010; Word Bank, 2010; Regassa, 2011; Andersson *et al*., 2011; Devereux, 2000; Eneyew & Bekele, 2012). Keller (2009) indicated that policy and program implementation gaps are another problem. For instance, drought, flooding, ecosystems, and biodiversity damage are claimed driving factors of weather variability (Simane *et al*., 2016) that have a great impact on food security in the country. (FAO, 2017b) reported that famine and rain irregularity or seasonal disparities were the main causes of food insecurity in Ethiopia. Evidently, frequent floods and droughts, such as the latest El Niño

damage in 2015 and 2016, have occurred throughout the country's history and have caused enormous life and asset losses (FAO, 2017b; World Bank, 2010; Tadege, 2007; World Bank, 2017). Ethiopia Province has experienced more than 15 drought events in the last 50 years (Kasie, 2017). It was also claimed that the country is structurally food insecure (Vedeld *et al*., 2007) and that food access has been impeded due to factors such as infrastructural, economic, and political instabilities.

Food insecurity challenges have remained relatively severe in communities that rely on natural resources to fulfill their livelihood needs. Usually, in such communities, fulfilling food needs is confined to practices that include traditional apiaries; making small crafts and utensils; hunting; fishing; accessing forest foods; and timbering. Nontimber forest products (NTFPs) contribute to the household, especially for the poorest people, welfare and livelihoods (Ickowitz *et al*., 2022). Forests are important sources of food and energy for 1.6 billion people and 2.4 billion people, respectively, globally living within a 5 km radius (FAO, 2016c). Similarly, wood fuel accounts for more than 80% of the household energy supply, particularly in rural areas of Ethiopia, and in econometric terms, forests generated nearly 16.7 billion USD or 12.86% of the GDP in 2012-13, for instance (Degife, 2020).

The food security situation in the Majang Zone of the Gambella Region is precarious owing to varying natural, socioeconomic, and biophysical factors. Girma & Muluneh (2021) found that land use/land cover changes caused by resettlement, population growth, and increased large-scale agricultural investments coupled with a changing climate have impacted agricultural production in the region. Similarly, human interference was identified as the main factor affecting land use and land cover change in the Majang zone (Seyoum, 2015). Most often, farmland expansion has been secured through deforestation or clearing of dense forests that serve the livelihoods of the local community. Furthermore, migrants and domestic as well as foreign investors have caused serious challenges for the natural resources in the area (Seyoum, 2015; MELCA-Ethiopia, 2013; Guyalo *et al*., 2022). In combination with the above factors, unresponsive, nontransparent, nonparticipatory, and corrupt land and project governance systems or policies were identified as threats and challenges to the natural resources and livelihood security of the population in the study area (DRMFSS, 2015). In addition, drought, poor off-farm employment, diseases, poor access to the market and credit, poor access to drinking water and

sanitation, policy gaps, and price inflation on food items were reported as additional causes of food insecurity (Mathewos & Bewuketu, 2018).

Despite the challenges of ensuring food security in the study area, little research has been conducted to address the core issues that trigger food insecurity. Most of the available evidence on food security comes from routine government documents and emergency assessment reports, which do not provide sufficient research outputs and recommendations. This lack of research has resulted in duplicate efforts, inappropriate prioritization, and irregular planning and implementation of food security interventions. Furthermore, the livelihoods of many households in the area are dependent on forest and forest-related nontimber products; however, these issues are seldom addressed in scientific research. To address these issues, this research investigates the influence of food security determinants on rural households in the Majang zone. The aim is to identify possible intervention measures that can be implemented in a coordinated and efficient manner based on a clear understanding of the spatial and temporal aspects of food security determinants.

3.2. Materials and Methods

3.2.1. Description of the study area

This study was conducted in the Majang zone of the Gambella Region, Ethiopia. The zone is located at latitude 7° 4’ 2.41’’N to 7° 46’ 47.79’’N and longitude 34° 36’ 30.54 E’’ to 35° 38’ 48.00’’ E. The Zone has two districts, Godere and Mangeshi, which constitute the total study area. The climate of the study area is hot and humid. Although there is no meteorological station in the area, the mean annual rainfall is estimated to be approximately 2100 mm. The mean temperature ranges between 20 and 33°C. The area is characterized by a flat to gentle slope, with some rocky steep and deep valleys along major streams and on hills (Guyalo *et al*., 2022).

The total land cover of the zone is 2252.79 km2, 1326.48 km2 (58.88%) is covered with forest, 132.69 km2 (5.89%) is covered with woodland, 304.66 km2 (13.52%) is covered by agricultural land, 147.6 km2 (0.07%) is a water body, 123.33 km2 (5.47%) is a settlement area, and 364.15 km2 (16.1%) is covered with plantation land (CSA, 2007). Mangeshi Districts have greater land cover (73.71%) but lower population density (16.8 hab/km2) than does Godere District (103 hab/km2). According to the CSA projected population census of the year 2022, the zone has a

total population of 89033, of which 46119 are male and 42914 are female (CSA, 2022a). The estimated population density of the zone is 39.5 hab/km2. Godere and Mangeshi Districts each habituated to 12 and 14 villages, respectively, with projected populations of 61079 and 27954, respectively. Approximately 88% of the population is rural, with an average of 5.3 individuals/households and a great proportion under 20 years old (more than 60%).

The major livelihood options of the households include commercial farming (coffee), agriculture, honey production, fishing, hunting, forest fruit and spice collection, and small and petty trades. NTFPs contribute approximately 87% of the total indigenous household income, traditional honey contributes the largest proportion of total cash income (47%), and edible NTFPs and wood products contribute 38% and 2%, respectively. Furthermore, (Girma & Muluneh, 2021) reported that crops (maize, sorghum, and coffee) and honey production are the dominant livelihood domains for food- and income-generating activities in the zone.

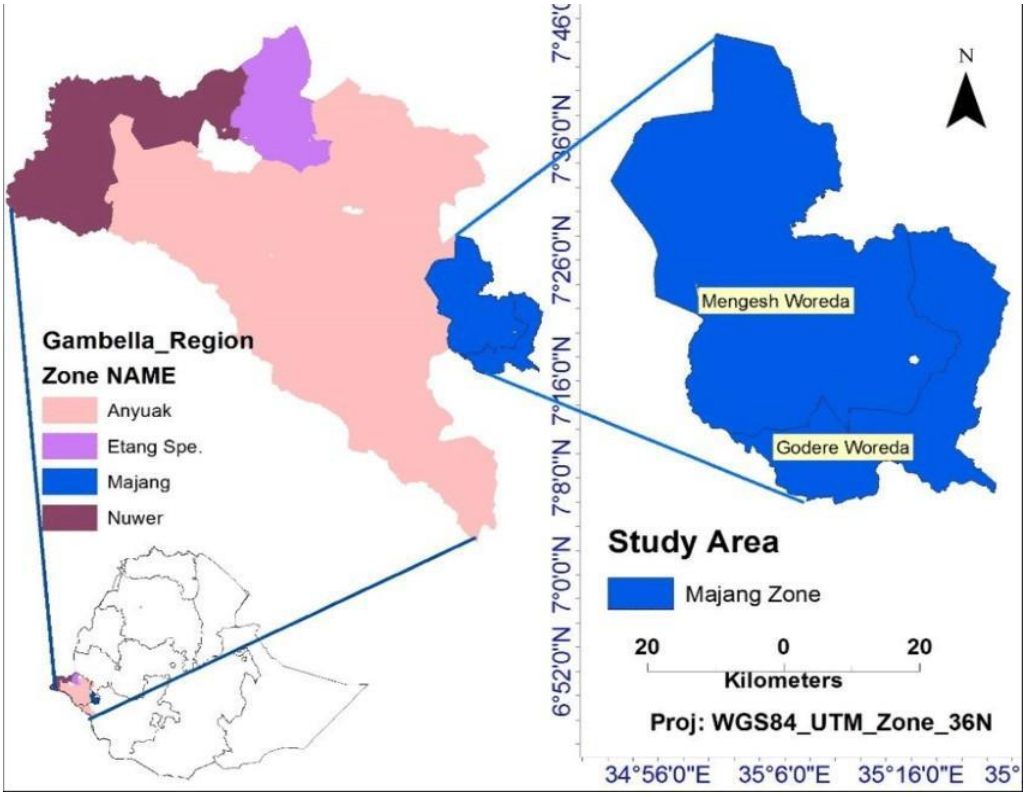


Figure 4 Map of study area (adapted from Mathewos & Bewuketu, 2018)

3.2.2. Study design and tools for data collection

The present research employed an embedded design that aimed to collect qualitative and quantitative data simultaneously or sequentially but to ensure that the quantitative results were consistent with the qualitative results (Creswell, 2009). Degefa (2006) also affirmed the mixed research design as the foundation of food security research because it allows for the analysis of food security in multiple dimensions. The study utilized household-based cross-sectional data. Hence, the data collection involved quantitative and qualitative methods from primary and secondary sources. The data-gathering tools used included structured survey questionnaires, focus group discussions (FGDs), key informant interviews (KIIs), and desk reviews. The food consumption data were collected using the standard survey module of the food consumption score (FCS) developed by the WFP (WFP, 2008).

Primary-type data were collected using structured household survey questionnaires, FGDs, and KIIs from household respondents, rural extension workers, government and nongovernment (NGO) experts, and officials working around food security. On the other hand, secondary data were collected from published articles, periodical implementations, and assessment report documents from government and NGO bureaus and offices. Ten FGD sessions were held in each village using the developed term of reference questions administered to a group of 7-10 individuals. Both in-depth interviews and FGDs were held to triangulate the reliability and validity of the information gathered using other means.

3.2.3. Sample size determination

A multistage sampling procedure was adopted to select the study households. First, the two districts, Mangeshi and Godere, were purposely selected since the zone has only two districts, and these districts share similar livelihoods and administrative boundaries. Second, a systematic random sampling technique was used to select 10 villages—four in Godere and six in Mangeshi—of the 32 villages based on the assumption that a large sampling ratio (approximately 30%) was appropriate for small populations (<1000). The sample villages were included based on prior discussion and assumptions of dwelling on subsistence agriculture, Majang community dominance, and attachment to forest-based livelihoods. Specific to the sample size determination of each village, the 2022 projected population (households) of each village was used to calculate the respondent households from each village based on the total household proportion share

(CSA, 2022a). The total population and households for the 10 villages are projected to be 15826 and 3557, respectively. Finally, household respondents were randomly sampled by applying the probability proportional to size technique for large populations, as described by Cochran (1977).

$$n_o = \frac{Z^2 pq}{e^2} \quad \ldots\ldots\ldots\ldots\ldots 1$$

where no is the sample size and Z^2 is the abscissa of the normal curve that cuts off an area α at the tails (1 - α equals the desired confidence level). For this research, a 95% confidence interval is assumed, and the Z table value equals 1.96; e is the desired level of precision; p (0.6) is the estimated proportion of an attribute or all forms of food insecure households that are present in the zone's population; and q is 1-p, as highlighted in the reports of DRMFSS (2015) and Hailemariam (2012). Based on the above formula, the sample size is 369 households.

Considering sample size correction for sample sizes exceeding 5% of the population, the final sample size was determined based on Cochran (1977) formula.

$$n_1 = \frac{n_o}{1+(n_o/N)} \quad \ldots\ldots\ldots\ldots\ldots\ldots 2$$

where n_o = the required return sample size, n_1 = the final sample size because the sample > 5% of the population and N = the population size. Accordingly, the final sample size was [369/1+ (369/3557)] =334. Owing to incomplete information in some household data, few were omitted, and 320 sample households composed the sampling unit for the final analysis.

3.2.4.Data analysis

The quantitative data on factors determining food security were analysed using both descriptive and bivariate econometric methods with STATA version 13. The qualitative data were analysed contextually to substantiate and supplement the results from the quantitative analysis. The FCS standard module was used to collect the data following the procedures given in (WFP, 2008).

The descriptive statistics included the mean, frequency, standard deviation, and percentage used to determine the level of influence of the determinant factors of household food security and to

provide insight into the different socioeconomic characteristics of the households. Equally, econometric analyses were used to investigate determinants of food security and their causative relationships. Binary logistic regression was employed to investigate the correlates of household food security. The binary logit econometric model is specified based on the variables under study and in reference to multiple similar research articles, including those of Moroda *et al*. (2018) and Hailu *et al*. (2018). The functional form of the logit model is specified in the following mathematical presentation.

$$Pi = E(Y = \frac{1}{Xi} = \frac{1}{1+e^{-(ßo + ßjXi)}} \text{……..3}$$

Substituting ($ß_o + ß_jX_i$) by Z_i, equation 3 becomes:

$$Pi = \frac{1}{1+e^{-Zi}} = \frac{e^{Zi}}{1+e^{Zii}} \text{……...4}$$

where Pi = E(Y = 1) is the probability that a household is food secure. Z_i is a set of explanatory variables for the i^{th} household, and $ß_o$ *and* $ß_j$ are the parameters to be estimated. If *Pi* is the probability that a household is food secure, as given in equation 2 above, the probability of food insecurity is then expressed as follows:

$$1 - Pi = \frac{1}{1+e^{Zi}} \text{……..……5}$$

The odds ratio is calculated with equation 6:

$$\text{Li=ln}\left(\frac{Pi}{1\text{-}Pi}\right) = \frac{e^{Zi}/1+e^{Zi}}{1/1+e^{Zi}} = e^{Zi} \text{.....6}$$

Hence, the specific logit model used to predict the odds of household food security is given in Eq. 7.

$$\text{Li=ln}\left(\frac{Pi}{1\text{-}Pi}\right) = Z_i = ß_o + ß_1X_1 + ß_2X_2 + ... + ß_nX_n + u_i \text{.....7}$$

where $ß_o$ is the constant and βi, where i = 1, 2, … j, are the coefficients of the variables to be estimated. *Xi* is a vector of explanatory variables.

The FCS is calculated from the types of foods and the frequencies with which they are consumed during a seven-day period. The FCS is measured on a continuous scale that is subsequently subjected to categorizations of households into predetermined thresholds. Hence, standard statistics such as the mean and variance can be calculated, and trends of means over time and across categories can be determined. Frequencies and cross-tabulations can be determined for food consumption groups. Procedurally, food items are grouped into 8 standard food groups with a maximum value of 7 days/week. Next, the consumption frequency of each food group is multiplied by an assigned weight that is based on its nutrient content. These values are subsequently summed to obtain the FCS. The typical thresholds used by WFP (2008) are 0–21 (poor), 21.5–35 (borderline), and >35 (acceptable); however, for populations that have a high frequency of consumption of oil and sugar (daily or almost daily), alternate cut-offs are proposed as 0–28 (poor), 28.5–42 (borderline) and >42 (acceptable) (Tesafa *et al*., 2022; WFP, 2010). Since oil and sugar are consumed daily by people in almost all parts of Sub-Saharan Africa, including Ethiopia, the latter cut-off categories were used to set the FCS categories of the sampled households.

$$\boldsymbol{FCS_h} = \sum_{i=1}^{n} \quad wiDi \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

where FCS_h is the food consumption score of household h, w_i is the weight of food group i, and D_i is the number of days of consumption for the last 7 days.

3.2.4.1. Definition and measurement of the study variables

Dependent variable

It is well known that the majority of the studies use two approaches to measure food security: the household food balance sheet and the other method for assessing food consumption (food calorie intake in kilocalories/day/AE) (Shiferaw *et al*., 2013). Furthermore, WFP (2008) claimed that the food consumption score (FCS) is among the prominent food consumption measurement tools and proxies of food security because it captures both caloric intake and diet quality at the household level. Hence, this research specified the food security status of households as the outcome variable determined by the FCS. Procedurally, the household food consumption score is compared with predetermined cut-offs to classify the households into three food consumption groups, i.e., 0-28: Poor, 28.1-42: Borderline, and > 42: Acceptable. These groups reflect the food

consumption status of the households surveyed. When the threshold cut-off value for being food secure was fixed or otherwise based on the FCS value, the assumptions of WFP (2010) and Tesafa *et al*. (2022) were considered. Since the value of the FCS falls between 0 and 112, one hardly finds an FCS with a zero value, and an FCS of 112 is the maximum score (which means that all food groups were consumed by all seven days by household members).

Furthermore, to estimate the determinants of the probability that the households under study were food insecured, they were categorized into food secure and food insecure households by taking 42 FCSs as a threshold. Therefore, all households that scored an FCS of 42 or less were categorized as food insecure, and those with an FCS greater than 42 were considered food secure. Thus, the dependent variable, food security status, is assigned a value of 1 (>42) if food security is considered to exist and 0 (≤42) otherwise. The share of the population with poor and borderline food security reflects the prevalence of food insecurity, and an acceptable share indicates being food secure (WFP, 2010).

Independent variables

Age of household head (AGE): Age of households has determinant role in food security endeavors. There is a debate as to whether age at the younger or older stage is more productive (Fikire, 2014). Some claim that older people accumulate relatively richer experiences and asset, putting them in a better position to be more food secure than young people (Awoke *et al*., 2022). Others (Adem, 2021; Sani & Kemaw, 2019; Hailu *et al*., 2018) argue that young heads of household are stronger and more likely to engage in diverse productive activities than older household heads are. This paper assumes that younger households take a better position to remain food secure than their counterparts given the age of the young people reached for production (≥16).

Sex of household head (SEXH): Sex is a dummy demographic variable that influences the state of food security of households. Females are usually devoid of basic resources such as land and have less leadership in household decision-making. Therefore, it is hypothesized that male-headed households are more likely to be food secure than female-headed households.

Family size of households (FSZH): Family size refers to the total number of household members; hence, the variable is continuous. Like age, family size is a highly contested variable that is expressed as having both positive and negative connotations about food security. This recalls the debate between the proponents and opponents of population theories by Thomas Malthus and Ester Boserup, where population increments were perceived to have a negative outcome for Malthus and were incited to foster positive development in Boserup's thought. Given that they are of productive age, a large family is hypothesized to be involved in diverse productive activities on both farms and off-farm farms to support the fulfillment of food security.

Marital status of household (MSTH): This is a categorical variable that categorizes households into married, unmarried, divorced, and widowed. In much of the related research, this variable is perceived as the variable that governs the food security of households. Married people are assumed to be better able to fulfill their food needs than single people are.

Dependency ratio (DEPR): A variable measured on a ratio scale by dividing the total household size by the number of individuals working to support the household. Given that there are more nonworking members, they exert pressure on consumption rather than production. It is hypothesized that the higher the dependency ratio is, the less the household becomes food-secured (Fekadu & Mequanent, 2010; Feleke *et al*., 2003).

Educational Status of Household (EDHH): Education is the key social capital element that defines the development track of a nation. Households with educated members are expected to learn, innovate, and adopt technologies that lead to better production and productivity. Moreover, educated individuals can better understand health and nutritional issues and positions to diversify both the production and income of households for nutritionally safe diets (Agidew & Singh, 2018). The more educated members of a household were hypothesized to remain food secure. The variable was measured on a dummy scale denoted by 1 if the household attended formal schooling.

Income diversity (INCD): This variable is expressed in categorical sales based on the sources of income available to the household. The availability of diverse incomes to a household secures the purchasing power of foods and other necessities. It strongly relates to food security.

Landholding Size (LHSH): Landholding size is measured in hectares. It is the most valued basic asset in rural farming communities and dictates production and productivity (Mequanent & Esubalew, 2015). It is hypothesized that households with large and fertile cultivated land have a greater probability of being food secure than small landholders.

Livestock ownership (TLU): The other crucial assets equally important as land in farming households are the size and type of livestock possessed. Conventionally, the variable is measured in tropical livestock units (TLUs) on a ratio scale. It contributes to a household as a source of food, income, traction power, and fuel. A positive relationship is expected between food security and the TLU of households.

Oxen ploughing of farmland (OXPL): Oxen ownership plays a significant role by smoothing production and ploughing land. This approach enables farmers to gain the advantage of time, labor, and waste of food energy. Hypothetically, in this research, the variable has a positive correlation with the food security of households.

Agricultural extension service (AEXS): Hands-on training and regular technical capacity building support add knowledge and ease the utilization of improved technologies and hence increase the production and productivity of the agricultural sector. Technical visit experts increase the probability of being food secure. The variable is a dummy.

Improved seed use (IMPS): A dummy variable. The harvestable yield is a function of the startup seed (genotype) used at the beginning when other factors are held constant. Those farmers who utilize improved seeds have a greater probability of securing their food than those who are unable to use improved seeds.

Fertilizer use (FRTU): Inputs that include fertilizers have a per unit land yield boosting advantage and, as expected, play a positive role in harnessing food security. It is measured on a dummy scale with values of 1 and 0 for yes and no answers, respectively.

Pesticides/Fungicide Use (PEST): These are crop health care inputs aimed at reducing the potential yield loss from a given genotype during production due to weeds, insect pests, and diseases. Therefore, they are expected to increase the probability of becoming food secure. It is measured on a dummy scale.

Veterinary service (VETS): An important dummy variable takes a value of 1 for yes and 0 otherwise that supports the food security attainment endeavor of households. Vaccines and medications for livestock are key elements in maintaining the production and productivity of the sector and therefore attaining food security, as livestock products are nutrient-dense food staff for humans.

Irrigation use (IRRU): A dummy variable takes the value of 1 if irrigation is used to produce a crop and 0 otherwise. Irrigation reduces the dependency of farmers on rain and enables efficient utilization of resources such as water, time, land, and labor to increase production.

Farmers' Training Center (FTC): This is a center where knowledge and skill-based capacity-building sessions are held regularly to bridge the gap in improved production functions. An institution is hypothesized to make a positive contribution to being food secure. The variable is a dummy variable that is measured as 1 for yes or 0 for no answer.

Beehives possessed (BEHV): A variable that is expressed on a ratio scale based on the number of beehives owned. This segment of the agricultural sector has received less attention but is believed to have great potential to contribute to the national GDP. In particular, forest-dependent households rely on apiary activities as their major source of income. Households possessing a greater number of beehives are expected to become more food secure.

Access to Credit Service (ACSV): ACSV is a dummy variable that takes the value of 1 if the household takes credit and 0 otherwise. The provision of credit services allows farmer households to purchase inputs and technologies that keep them productive and make them involved in diverse nonagricultural activities to fulfill their food needs. Thus, a household that has access to credit is more likely to be food secure.

Cooperative Membership (COOP): This is a dummy variable that takes the value of 1 for a yes response and 0 otherwise. The success of households in terms of food security is partly and largely dependent on the active public services available. Cooperatives create a synergy of collective action that gives individuals bargaining power in the value chain of the production sector. This variable has a positive correlation with food security.

Off-farm income (OFINC): Income is measured in birr and is therefore a continuous variable. In addition, agricultural activities involving nonfarming economic activities significantly contribute to diversifying and lifting the food security needs of households (Tesfaye & Nayak, 2022; Babatunde & Qaim, 2010). Hence, it is hypothesized that the availability of off-farm income is positively associated with household food security.

On-farm income (FAINC): This variable was measured similarly to off-farm income. Household agriculture is the most dependable food and income source. Here, farm income represents the income generated by the crop and livestock subsectors. A priori assumptions about food security are positive.

3.3. Results and Discussion

3.3.1. Socioeconomic characteristics of households

Tables 2 and 3 show the social and economic characteristics of the households. The research involved 320 rural households, the majority of which (90%) relied on agriculture as their major occupation to fulfill their livelihood. Approximately 79% of them were married, and 88% of them were male-headed households, indicating the dominance of male households in the farming community (Figure 5). The mean age of the study households was approximately 40 years, with minimum and maximum ages of 18 and 75 years, respectively. On average, a household is composed of 5 family members, a family size on par with the national average. Moreover, the

mean landholding size (2.63ha) of households in the study area is threefold higher than the Ethiopian Central Statistics Agency (CSA) (Regassa *et al*., 2013) reported national (0.84ha) and regional (0.63ha) averages. The mean annual farm and off-farm incomes of the households were calculated to be 20273 birr and 495 birr, respectively; put in mean per capita per annum, the incomes were 4054 and 100, respectively, for on-farm and off-farm incomes (Table 2). The overall descriptive statistics of the research provided evidence of the prevalence of high levels of food insecurity in the study area, and multiple factors contributed to this difference. The results revealed that 53.12% of the households were food secure and 46.88% were food insecure, as determined by their food consumption measures. The mean percentage of dependent household members was greater (108%) in the study area, with the highest reaching 250%.

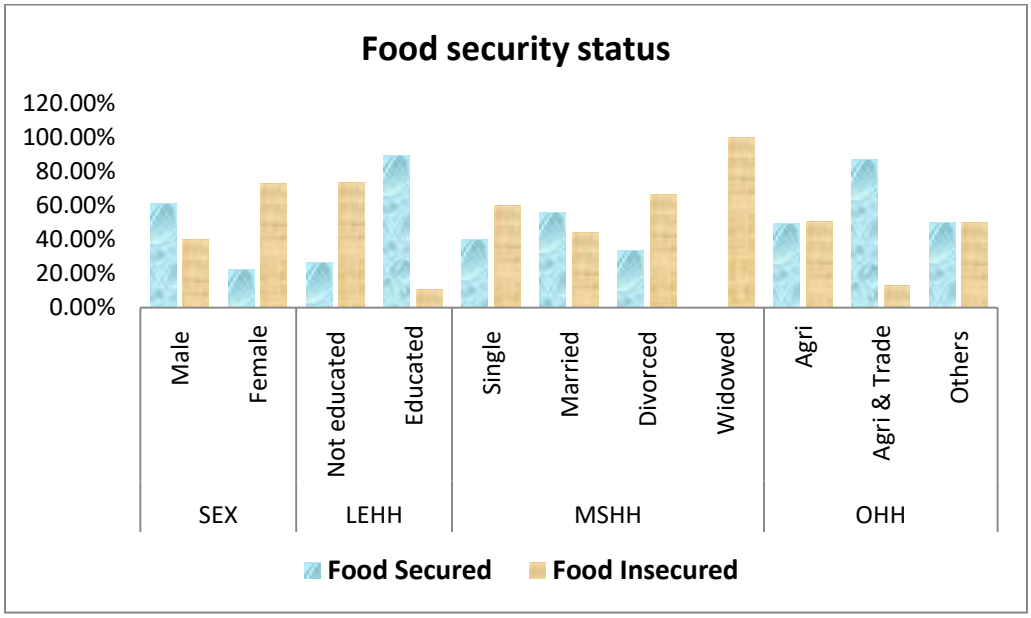
Table 1 Descriptive statistics of the variables on the ratio scale

Variable	Obs	Mean	Std. Dev.	Min	Max
Age of the Household Head	320	40.36	11.33123	18	75
Family Size of the Household	320	4.99	1.80208	1	10
Dependency Ratio (%)	320	108.65	63.48359	0	250
Food Consumption Score	320	44.34	15.43502	9	108
Landholding Size	320	2.63	2.163528	0	13
Tropical Livestock Unit	320	.59	.9519454	0	4.2
Beehives possessed	320	5.00	10.45847	0	50
Off-farm income	320	495	1590.34	0	8000
On-farm income	320	20273.38	14810.23	0	49650

Source: Own survey data

The descriptive analysis results further explained that of the total respondent households, approximately 88% were married, 8% were single, 2% were divorced and 2% were widowed in terms of their marital status. Regarding their occupations, 89.7% of the household respondents solely depend on agriculture, the remaining 9.7% on agriculture and trade, and 0.6% on other forms of income activities. In addition, 57.81% had not attended formal education, and 42.19% had at least attended elementary education (Figure 5). Households were asked about the delivery of agricultural services and technologies; almost three-fourths of the respondents claimed the absence of the services and technologies that support the production and productivity of their subsistence livelihood. Accordingly, approximately 60.94% of them confirmed not receiving agricultural extension service contact, although FTCs were constructed in their villages (60.62%), not provided with improved seeds (74.38%), not able to supplement their crop

production using traditional irrigation schemes (87.19%), not involved in cooperative activities (83.13%), unable to obtain veterinary services (80%), not preparing and applying fertilizers (86.56%), unable to use oxen to plough their land (66.25%), unable to access credit services (82.19%), and unable to purchase and apply chemical pesticides (67.50%) (Figure 6).



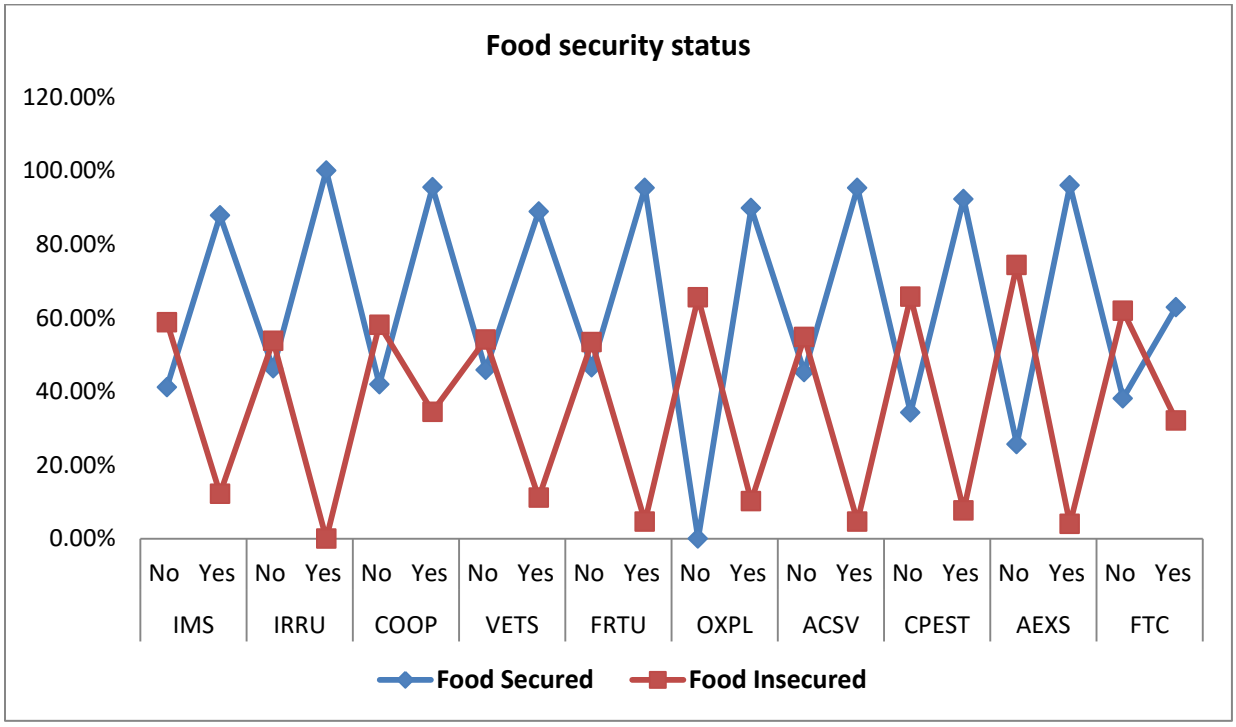
Note: *LEHH-level of education, MSHH-marital status, and OHH-occupation of household head.*

Figure 5 Descriptive statistics on the food security status of households

The cross-tabulation results explicitly showed that among the food-secure households, 91.18%, 92.94%, and 71.18% were male-headed, married, and had formal education, respectively. Within-group comparison ratios indicate that male-headed households (61.26%), married (56.03%) and those who had attended formal education (89.63%) were more food secure than insecure. However, 22.39% of the females were headed, 31.58% were not married (single, widowed, or divorced), and 26.49% of those with no formal education were food secure. Moreover, households with more than one occupation, agriculture or trade (87.10%) had a greater chance of becoming food secure than did those dwelling only on agriculture (49.48%) (Figure 5).

The establishment and distribution of factors of agricultural technologies and services that are assumed to support production and income generation are limited in the study area. A total of approximately 23.65% of the respondents participated and made use of them to secure their food

needs and income. A total of 125 households agreed to participate in extension services; 96% of them claimed food secure, as did those who used improved seeds (87.80%), veterinary services (88.89%), organic fertilizers and credit access (95.35%), pesticides (92.31%), cooperatives (95.52%), traditional irrigation (100%) and ploughing with oxen (89.81%) (Figure 6).



Note: *IMS-improved seed, IIRU-irrigation use, COOP-cooperative membership, VETS-access to veternary service, FRTU-fertiizer use, OXPL-oxen ploughing, ACSV-access to credit service, CPEST-pesticide use, AEXS-access to agricultural extension service and FTC-farmers' training center.*

Figure 6 Food security status of households as determined by dummy variables

3.3.2. Econometric results of food security determinants

The food security status of the households was determined based on the food consumption score categories previously established by (WFP, 2008). In total, 22 explanatory variables were fitted into the specified model, among which 10 showed statistical significance at varying levels of probability and magnitude of influence. The overall fitness of the model was checked with postestimation tests (*linktest*, *estat gof*, *estat classification*, *lsens*, *lroc*). The *link test* result showed significant *_hat* (p=0.000) and insignificant *_hatsq* (p=0.374), indicative of a perfect link between variables with no transformation, and the chi-square test was significant at 1% probability (pro > chi^2 = 0.0001). The *goodness-of-fit* test also estimated the number of

correctly predicted food-secured (95.88%) and -insecure (96.67%) groups sufficiently with the prediction-based correctly classified value (96.25%) (Table 2).

The results involved the use of logit model projected coefficient (b) predictions to evaluate the food security status as determined by the explanatory variables fitted into the model. Moreover, Pearson's correlation analysis was computed to determine the directional statistical relationship between pairs of predictors and the predicted variables. The analytical findings are presented below (Table 2). The results showed that farm income, number of traditional beehives, formal education, size of agricultural land, oxen ploughing land, possession of more livestock herds, access to agricultural extension support, and having more working family members were significantly and positively associated with attaining food security. However, the age of the household head and the use of chemical pesticides had significant negative predictive effects on the probability of determining the food security status of the households in the study area.

Table 2 The maximum likelihood estimates of the binary logistic regression model

Variables	Coef.	Robust Std. Err.
Age of household head	-.1091**	.0483
Sex of household head	-.5101	.9599
Family size	.6119*	.3353
Marital status of household head	.9311	.8595
Dependency ratio	-.0092	.0075
Education level of household head	2.138***	.8174
Occupation of household head	-2.743	2.347
Land holding size of household head	1.489***	.4764
Livestock ownership (TLU)	.9674**	.4936
Oxen ploughing	2.237**	1.023
Veterinary services	-1.061	1.192
Crop pesticides/fungicide	-2.071**	1.001
Farmers training center	-.5206	.6693
Agricultural extension service	2.469***	.9159
Fertilizer use	.7226	1.310
Improved seeds use	-.2208	.6414
Beehive owned	.1014**	.0459
Access to credit service	-1.613	1.518
Cooperative membership	1.872	1.333
Off-farm income	.0006	.0006
On-farm income	.0001***	.00003
_cons	-3.682	3.858

Number of obs = 320 Sensitivity (Food secured) =95.88% Specificity (Food insecured)=96.67% Correctly classified=96.25%	Log likelihood = -35.181077 Pseudo R2 = 0.8409 LR chi^2(2) = 372.00 Prob > chi^2 = 0.0000

Source: Own survey data *** *p<0.01, **p<0.5, p<0.1**

The results presented in Table 2 showed that the age of the household was negatively related to household food security. The negative coefficient indicates the existence of a statistically significant (p<5%) but inverse relationship between age and the food security status of households. With other factors held constant, the odds ratio prediction showed that households become 2.4% less food secure as they aged (one additional year to live). These findings are consistent with those of similar studies (Adem, 2021; Sani & Kemaw, 2019; Hailu *et al*., 2018) conducted in other parts of the country. These groups of people support their assertion that old households increase the dependency ratio in the household, and since the household heads are young, they are more likely to be physically strong and aspire to participate in diverse income-generating activities to secure their food access. In contrast to this research, for example, Awoke *et al.* (2022) reported that age has a positive relation with food security given that the experience gained and wealth accumulated over time enable households to be more food secure.

The association between family size and food security is seldom positive in most food security studies. For instance, research conducted by Awoke *et al.* (2022) in the Central and North Gondar Zone, Hana & Dereje (2016) in Girar Jarso in the Oromiya region, Sani & Kemaw (2019a) in western Ethiopia, and Gazuma (2018) in the Kindo Didaye District in southern Ethiopia showed the inverse relationship between family size and food security. However, the results of this study revealed a positive and statistically significant relationship at the 10% probability level. According to the results, a unit increase in the number of families had increased the food security status of households by 8.86%, while the other variables were held constant. The justification for this could be that households with large family members, given that they are active adults, can supply more labour for agricultural activities, which can increase production and productivity. In line with this, the study results of Alemu (2013) revealed that having more family members helped to provide more labor for production and had a positive association with the food security status of households. Similarly, Meskerem & Degefa (2015) added to the body of knowledge that having a larger active household size increased the

availability of dietary energy (1242.4 Kcal) for a given household more than having a smaller (831.2 Kcal) household.

Education is among the priority factors, as it contributes to the majority of the participants' efforts to improve their attainment of food security. Educated households tend to have more capacity for working efficiently by receiving and adopting improved technologies, participating in diversified income-generating activities, planning their works, keeping records of important events, having knowledge of food and nutrition, and so forth to smoothen their food basket requirements. As previously hypothesized, the education status of the households was significant at the 1% probability, with a predicted positive coefficient and odds ratio of 2.14 and 8.4798, respectively, portraying an almost 48% greater chance of being food secure than people who did not attend school. There was also a strong and positive correlation (0.63) between the two factors. In support of our findings, Dagne (2016), Olayemi (2012), and Olayemi (2012) justified the necessity of formal education to enhance the food security status of households. They found that households who attended school were 11.0057, 1.012, and 2.322 times more food secure than illiterate households were. Meskerem & Degefa (2015) also reported the detrimental role of education in household food utilization and access in smoothing eating habits, food preferences, food rationing, and saving habits, where the mean kilo calorie intake of those who could read and write was relatively greater (1063.7 kcal) than that of illiterate individuals (975.2 kcal).

The availability and size of agricultural land are the most basic and scarce asset endowments of agriculture-based rural livelihoods. In the Majang zone, land ownership is crucial for households not only for agricultural activities but also for providing forest-covered land for traditional beehives, a major component of their income source. Nearly 92% of the sampled households verified that agriculture is the primary mainstay on which to dwell. The model results showed a positive coefficient (1.489) that was statistically significant at the 1% probability level. Interpretively, the odds ratio of the log-likelihood estimates of the model on the landholding variable was 4.4356, explaining that a unit difference in landholding (ha) ownership was predicted to have a very high probability (43.56% times) of becoming more food secure. The correlation analysis results confirm the existence of a positive and strong (72.41%) correlation between food security status and landholding size. Numerous research findings (Tesafa *et al*.,

2022; Agidew & Singh 2018; Ahmed *et al*., 2018; Mequanent & Esubalew, 2015) conducted in rural contexts inseparably support the results of this research.

Like other farming activities, livestock production plays an integral role in the lives of rural households. Ethiopia stands first in Africa regarding its livestock population. In addition to serving food directly, smallholder farmers make large contributions to farming, transportation, and income generation. Even though the average TLU of the studied households remained a few units (0.59), the results showed a significant contribution of livestock ownership to food security. The findings indicated that food security increased by 2.631 if the household owned one additional livestock unit while keeping other factors constant, which is significant at a 5% probability. Similar finding claimed that food insecurity was decreased by factor of 2.092 when the amount of livestock in the household rises by one TLU (Kuach, 2021). Other studies have confirmed the existence of a positive association between livestock size in the TLU and food security (Mohammed & Mohammed, 2021; Misgina, 2014; Indris & Adam, 2013).

Besides possessing large TLU, keeping and ploughing the farm land with oxen expected to yield a positive influence on food security. Nevertheless, few households have access to and experience with ploughing with oxen in the study area; those exercising the practice are benefiting the most comparably. The statistics displayed a positive coefficient that was significant at the 5% level. The result implies that farmers who used to plough their farm with oxen have a 9.36 odds ratio of being more likely to be food secure than those who do not. A research conducted by Meskerem & Degefa (2015) in Oromiya region come up with the result that the existence of wider gap between available dietary energy of households' owing oxen possession where households that owned one ox gained the mean dietary energy of 827.71 kcal while households who owned four oxen have gained up to 1623.61 kcal.

The agricultural sector is the largest domain on which subsistence farmers rely to produce food and generate income. Furthermore, lifted income enables the purchase of improved agricultural inputs, which means boosting agricultural production and productivity. This variable considers the sum income of households from crop production, livestock and their products, and apiary products sold. As has been hypothesized to have a positive influence on the food security of

households, farm income is predicted to be highly significant ($p<0.003$) in influencing food security status in the study area. The odds ratio results showed that the food security status of households tends to increase by a factor of 1.0001. As the farm income increased by one unit, the marginal effect of farm income turned out to be 1.43e-05. Pearson's correlation results revealed a strong and positive (81.10%) relationship between farm income and household food security status. The results of this research are in agreement with the findings of (Awoke *et al*., 2022; Dagne, 2016; Hussein & Janekarnkij, 2013; Etxegarai-Legarreta & Sanchez-Famoso, 2022), who reported the positive and significant influence of on-farm income on the food security of rural households in different parts of Ethiopia.

Most food security studies in Ethiopia have focused less on and incorporated factors related to apiary activities in general, and none have been performed specific to the research area. Beekeeping tends to be an activity that is complementary to agriculture and allows it to generate additional income for its producers (Hussein & Janekarnkij, 2013). Apart from generating income and serving as direct food, the existence of apiary farms in or around crop farms is expected to increase the productivity of crops because of the pollination role of bees. Research in Kenya (Etxegarai-Legarreta & Sanchez-Famoso, 2022) has shown that apiculture has a relatively higher and more reliable monthly income than both animal and crop production. The number of traditional beehives possessed is believed to determine the income and wealth ranking in the Majang community. The traditional forest honey production type (Mutua, 2018) is the dominant and main source of income for indigenous Majang households because the yield and quality of honey are compromised based upon forest tree species and their abundance (Fesseha, 2020).

As was initially hypothesized, keeping the other variables constant at their zero mean and unit standard deviation, the number of beehives owned had a positive and significant effect on determining household food security status at the 5% probability level. A greater probability of having a greater number of beehives increases the odds of being better off in food security status by 1.47%. Empirical evidence from research conducted in southern Ethiopia by Tarekegn & Ayele (2020) agreed that increasing the number of beehives by 1% is likely to increase honey production by 10.14%, increasing the likelihood of becoming food secure. Similar results from

Uganda revealed an increase in honey production with the increasing number of hives kept and colonized per farmer (Mubarik & Buyinza, 2020)

Receiving agricultural extension services has vitality comparable to that of attending formal schooling if not more so in terms of ameliorating the food security needs of agriculture-based households. The extension service is a package of improved technologies of the agricultural sector intended for the transfer of best agricultural practices and technologies to enhance the production and productivity of farmer households. Thus, the factor is expected to have a positive and significant impact on the food security level of households. The results of the logit model indicate that participating in agricultural extension packages is predicted to influence the likelihood of becoming food secure by 0.3435 units plotted against nonparticipating units, which is statistically significant ceteris paribus at 1%. Similarly, Awoke *et al.* (2022) and Sani & Kemaw (2019b) concluded that technical backups to farmers had an important role in enhancing the food security status of smallholders. It was anticipated that inputs such as fertilizers, pesticides, artificial insemination, and improved seeds play a substantial role in improving the output from agricultural production.

This study considered improved seeds, fertilizer, and chemical pesticides to explain the food security status of households where pesticide use was statistically significant, but the remaining two were not. The generated coefficient (-2.071), which is significant at 5% probability, has an inverse relationship with the possibility of becoming food secure. According to the results, keeping other factors constant, a unit increase in the use of chemical pesticides had increased the food insecurity of households by 12.6%. This result contradicts the prior hypothesis set and could be attributed to the high price that farmers incur to purchase, and the input use was confined to nonfood crops such as coffee. The data generated from focus group discussions and key informant interviews indicate that the use of inputs is at its lowest level for crucial agricultural inputs such as chemical pesticides and improved varieties and not for chemical fertilizers or artificial insemination technologies. The existence of incorrect perceptions of using fertilizers and the inaccessibility and unaffordable cost of some of the technologies might have contributed to their low-level adoption and hence reduction in the potential yield of agricultural commodities.

3.4. Conclusion and Recommendations

This research was conducted to identify the determinants and measure the food security status of rural households in the study area. This research has identified the factors that govern food security in the study area. Moreover, the results of this research are consistent with similar research conducted in Ethiopia as well as across the world. In addition to econometric analysis, the cross-tabulation results of key variables that were expected to affect the food security of households are discussed below.

Among the variables considered in this study the education level of household heads, agricultural landholding size, access to agricultural extension services and farm income had very highly significantly determined the likelihood of becoming more food secure. Similarly, highly significantly and positively food security influencing factors in the study area were possession of more number and types of livestock, using oxen to plough farm land, and owning more number of traditional beehives. Besides, having more number of individuals in a family had contributed affirmatively and significantly in increasing the chance to become more food secure in the studied households. Contrarily, age of the household head and use of pesticides as crop protection means were variables that bring about negative implication towards attaining food security among the households.

Although the aforementioned factors have dictated the food security status of the households, their limitation coverage, such as in the instances of presence of less educated households (42.19%), few participated in extension services (39.06%) and few able to plough their farm lands using oxen (33.75%) coupled with the existence of small average tropical livestock unit (0.59), less productive and labour intensive traditional apiary activity were identified as the shortcomings requiring due consideration for improvement to lift their contribution in securing food.

Hence, leapfrogging on the priority and resource smart critical variables, the government and other concerned stakeholders must plan and implement effective, feasible, and sustainable food security strategies, projects, and programs in the study area. The following steps should be taken: installing small-scale irrigation schemes, advocating for the benefit and use of production-

boosting technologies such as certified seeds, modern beehives, and fertilizers through a strengthened extension approach, commencing land certification for better land use; and guaranteeing the welfare of households relying on forest resources. The variables that became non-significant should not be ignored because they are important in the fulfillment of food security; therefore, local development-centered plans need to be incorporated for long-term success.

Equally crucial, traditional apiary activities, being the major income-generating nontimber forest product for most of the Majang community, require due technical backup to increase the honey collected per hive, product quality, and frequency of harvest coupled with the introduction and use of modern beehives. We recommend, as a priority and important research agenda, comparative research be undertaken to determine the food security conditions of the indigenous Majang community and the so-called highlanders as they may have distinctive livelihoods and recommend targeted intervention measures accordingly. In addition, undertaking research that measures the resilience of households to food insecurity is recommended because it provides a new perspective on how to effectively plan for and analyse the effects of shocks and stressors threatening the well-being of households or communities through a longer-term development strategy.

CHAPTER FOUR: RURAL HOUSEHOLD RESILIENCE TO FOOD INSECURITY IN MAJANG ZONE, SOUTHWESTERN ETHIOPIA[3]

Abstract

Due to the shocks and stressors caused by both natural and man-made events, households that depend on subsistence agriculture frequently experience uncertainty about guaranteeing food security. The modern strategy for achieving food security in the face of shocks depends on identifying the variables that affect resilience and working to increase rural households' capacity to withstand shocks related to food insufficiency. The goal of this study was to evaluate how resilient households were to food insecurity and its causes. Cross-sectional data of both quantitative and qualitative types were gathered from primary and secondary sources. The data acquired through surveys from 320 households were analyzed using a multivariate analytical method that included principal component analysis (PCA). To bolster the findings, data from focus group discussions (FGDs) and key informant interviews (KIIs) were utilized. According to the findings of the analysis, 40% and 60% of the households became resilient and non-resilient respectively. All but the stability parameter significantly impacted resilience. This study suggested that to reduce both short-term and long-term shocks and stresses from food insecurity and to increase resilience, government policies and programs and those of other development partners must focus on improving the underlying factors that determine main components of the resilience.

Keywords: Households, Food insecurity, Resilience, PCA, Econometrics

4.1. Introduction

For all living things to survive, food is a basic necessity. Humans rely on outside sources that are controlled by numerous natural and artificial elements to secure their food. From a conceptual standpoint, food security "exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (Sani & Kemaw, 2019b). Despite ongoing efforts, it is still difficult to meet the world's food needs because farm households in developing nations frequently experience a variety of recurrent and unexpected shocks that expose them to food and nutritional insecurities (Ansah, 2020), which are caused by both climate-related and nonclimate-related disasters (Upton *et al*., 2022; Mbow *et al*., 2019). According to Denning & Fanzo (2016) and Eneyew & Bekele (2012), the key factors affecting food and nutritional security are land policies

[3] Based on:

Shibru Zerihun, Messay Mulugeta and Meskerem Abi (2024). Rural household resilience to food insecurity in Majang Zone, Southwestern Ethiopia [version 1; peer review: 1 approved with reservations]. *F1000Research* 2024, **13**:162 (https://doi.org/10.12688/f1000research.142289.1)

and management practices that degrade natural resources. The frequency and intensity of risk exposure among vulnerable people have also increased as a result of unfavorable economic and social pressures (FAO, 2016b). Population pressure (Habtegebriel, 2016; Rockefeller Foundation, 2015; unemployment; violence; and climatic shocks (FAO *et al*., 2019); COVID-19; desert locusts; displacement; and high food costs (IPC, 2020; FAO, 2020; Abebe, 2018) were mentioned as some of the other major causes of food insecurity.

According to a joint FAO and WFP (2021) report, severe food insecurity has increased, affecting 193 million people in 53 countries and up to 49 million people in 46 countries, including Ethiopia. The nation is currently in danger of experiencing famine or famine-like conditions. According to , more than 250 million of the almost 690 million people live in Africa, and an additional 83 to 132 million people are undernourished due to the COVID-19 pandemic (FAO *et al*., 2019). Because of inadequate logistical, institutional, and infrastructure conditions, structural food insecurity issues are also widespread.

To achieve food and nutritional security, it is essential to create a productive, sustainable, and resilient food system as well as households that can handle shocks and pressures. In the face of disruptions, resilient and strong agri-food systems can open doors for innovation and new development paths (Thompson & Scoones, 2009). With global poverty and food insecurity continuing to exist, the idea of development resilience began to gain favor (Upton *et al*., 2022). The majority of studies in the area of food security have concentrated on estimating the likelihood of a future loss of sufficient food (Alinovi *et al*., 2010). According to USAID (2012b), resilience is "the capacity of individuals, families, communities, governments, and systems to buffer against, adapt to, and recover from shocks and pressures in a way that lowers chronic vulnerability and facilitates inclusive growth". As a longer-term development strategy, resilience offers a fresh perspective on how to effectively plan for and analyse the effects of shocks and stressors in line with food security (USAID, 2012b; Alfani *et al*., 2015; Barrett & Constas, 2014), as well as how to design and evaluate programs to build resilience (Kasie, 2017). In areas where there is a risk of food insecurity and susceptibility to recurring shocks, strengthening resilience as a program is essential for sustained social and economic progress (Frankenberger, 2012).

Resilience capability varies among the communities studied according to studies performed at various scales (FAO, 2016a; Barrett & Constas, 2014; Alinovi *et al*., 2010) and levels (Barrett & Constas, 2014). Answering issues such as "resilience of what and to whom," "what livelihood practices are responsible," and "how the shock environment dictates the capacity of resilience in a household" is therefore often significant (D'errico & Smith, 2020). In their study on household resilience to seasonal food insecurity, Guyu & Muluneh (2018) found that 65.25 and 34.75% of the households in the study area were resilient and resilient, respectively. In addition, socioeconomic and institutional factors, including farm size, intensification, asset ownership, income diversification, credit, production of cash crops, and membership in savings and credit societies and labor-sharing groups, have a large impact on building resilience (Tefera *et al*., 2017). In addition, it is claimed that having access to agricultural resources, particularly land, is essential for a household's ability to withstand food insecurity (Ciani & Romano, 2014). Similar studies in Niger revealed that regions with irrigation capability and low reliance on agriculture dependent on rainfall are more robust. According to the same study, female households have lower adaptive capacities and fewer resources than male household leaders, making them less robust. The prevalence of food insecurity is 10% greater among women than among men (FAO *et al*., 2022) due to the gender-related inequities that have been demonstrated. Participation in social safety nets also makes it possible to develop strong resilience. According to Boukary *et al*. (2016), households' ability to cope with food insecurity is negatively impacted by long-term average rainfall. Similarly, Ansah *et al.* (2019) concluded that investments in programs and policies aimed at strengthening households' capacity for resilience can help lower childhood malnutrition and guarantee long-term food security.

Undiversified, subsistence rain-fed agricultural and livestock production in the research region frequently keeps households nonresilient and exposes them to seasonal food insecurity. Most districts had food shortages for 3-6 months on average, and the majority of people (84%) exhibited insufficient resilience during this time. Additionally, more than 40% of the households were unable to raise Birr 500 in a week, and one-third of the households were unable to recoup from their disaster losses (DRMFSS, 2015). According to MoFED (2012), the major causes of climate change include highly increased deforestation, migration, underdeveloped institutions and infrastructure, fragmented holdings, rapid population expansion, limited access to modern

agricultural technologies, and illiteracy. Land grabbing and commercialization were claimed by Girma & Muluneh (2021) to be extremely important issues. Food insecurity was primarily caused by a combination of inadequate off-farm income, disease, poor market and credit access, poor access to drinking water and sanitation, policy gaps, and price fluctuations (DRMFSS, 2015; Seyoum, 2015; MELCA-Ethiopia, 2013). Guyalo *et al*. (2022) identified such difficulties as corrupted, unresponsive, nontransparent, and nonparticipatory land and project governance structures or policies.

Few studies on resilience concerning food security in Ethiopia and none in the study area, both in terms of quantity and location (Debessa, 2018), have been conducted, and therefore additional multidisciplinary studies are needed. According to Frankenberger (2012), a comprehensive resilience assessment must identify the causal causes that resilience programming must address. Furthermore, the limited number of studies on how to quantify resilience to poverty and food insecurity leaves little room for improvement (Barrett & Constas, 2014). Similarly, there are few studies on the resilience concept in Ethiopia, and those that do tend to focus on a small number of specific livelihood arrangements and methodological foundations. In broader geographic contexts, fewer empirical studies concentrate on how households respond to food insecurity shocks and their resilience to future food insecurity (Debessa, 2018). A portion of the research employs panel data sets to analyse data at the national level (Befekadu, 2020). Research outcome evidence has rarely been obtained for the level of household resilience in the study area. This leads to a vacuum in the ability to identify the factors that influence households' dynamic food security, resilience, and coping mechanisms, as well as to plan for and develop intervention strategies.

According to our understanding from what is apparent in the study area, the conventional methods of responding to crises have been insufficient and unsustainable unless they are intended for short-term emergency response due to the high prevalence of food insecurity and the unknown level of household resilience. To determine how many households fall into the resilient or nonresilient category and what underlying natural, social, economic, and environmental variables contribute to this issue, it is necessary to address the problem of food security using the resilience concept. Additionally, it can serve as a starting point for the creation of effective working policies, programs, and strategies by development partners and policymakers.

According to Choularton *et al*. (2015), resilience is currently regarded as a unifying policy instrument. As a result, the study's goal is to evaluate how resilient rural households are to food insecurity in the study area. Specifically, the study examines the resilience status of rural households to food insecurity in the study area.

4.2. Materials and Methods

4.2.1. Description of the study area

The study was conducted in the Majang zone, Gambella People's Regional State, southwestern Ethiopia. Approximately 620 kilometers separate Addis Ababa and the zonal capital of Meti. There are two districts in the area, Godere and Mangeshi, with agro-ecology that is considerably wider and elevations that range from 800 m to 2100 m above sea level. The region is situated between latitudes 7° 4' 2.41" and 7° 46' 47.79"N and 35° 38' 48.00"E to 34° 36' 30.54"E. According to Mathewos & Bewuketu (2018), the zone has a total land area of 2252.79 km2 (hectares). The zone is bordered by the Oromia Regional State in the north, the Southern Western Regional State in the east and south, Abobo in the northwest, and Gog and Jor in the west. The zone has a total population of 89033, with 46119 men and 42914 women, as of the Mathewos & Bewuketu (2018)’s projection for the 2022 census. The 14 villages administered by Godere and Mangeshi Districts are habituated, with projected populations of 61079 and 27954, respectively. With an average of 5.3 people per household, 88% of the population lives in rural areas, and more than 60% of that population is under 20 years old.

One of Ethiopia's few areas with access to natural resources is the Majang zone. The Majang Forest Biosphere Reserve is the name given to the forest and its resources; this reserve serves as the community's primary source of income according to the United Nations Organization for Science, Culture, and Education (UNESCO). Commercial farming (coffee), agriculture, honey production, fishing, hunting, foraging for fruits and spices in the forest, small and petty trades, and commercial farming are the main sources of subsistence in the study region. NTFPs, wood products, and traditional forest honey production provide almost 87% of all household income. Raising livestock is another prevalent habit; however, it is not a significant source of income.

While the Godere district is dominated by other ethnic groups, including Sheka, Kafa, Oromo, Amhara, Sheko, and Tigre, who are frequently referred to as "highlanders" by native Majang populations, Mangeshi district is a Majang community-dominated district and is located in the lowland agro-climatic zone. Some of Godere district's agro-climatic conditions are in the lowlands, but the majorities are found in the mid- and high-altitude regions. The region has a hot, humid environment, and according to Ethiopia's rainfall maps, it is the wettest place in the nation. Approximately 2100 mm and 20–33°C are believed to be the mean annual temperature and rainfall, respectively. A flat to gentle slope, occasional rocky steep slopes, and deep valleys on hills and along important streams define the environment. The majority of the streams are perennial and have relatively significant water discharge, but rural populations worry that deforestation is reducing the amount of water flow. The soils in the region are mostly dystric nitrate and range in colour from red–brown to dark brown. Agriculture, grazing land, woodland, habitation, wetland, infrastructure, and wasteland are the main land cover types. Forestry and agriculture both cover the majority of the zone's land.

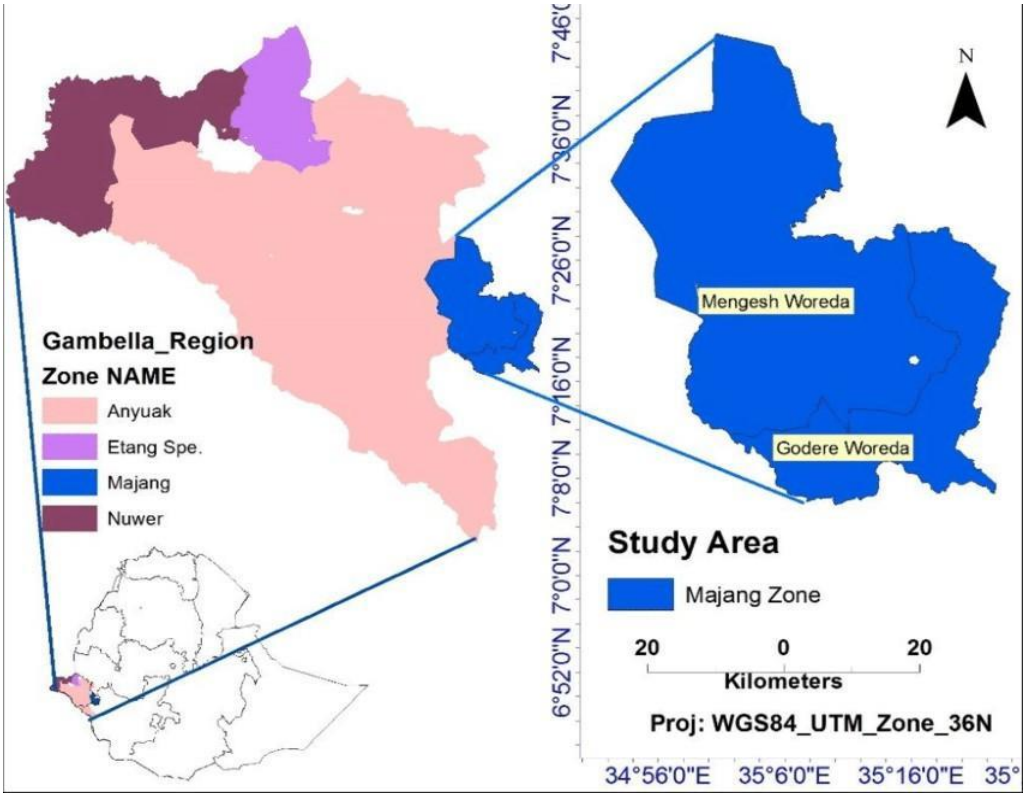


Figure 7**Map of study area (adapted from Mathewos & Bewuketu, 2018)**

4.2.2.Study design and data collection

The study was conducted in the Gambella People's Regional State's Majang Zone. Since combining qualitative and quantitative household data in a single research project enables a thorough and holistic understanding of the issue of interest, a mixed-methods design was utilized for the study (Degefa, 2006). Furthermore, Ciani & Romano (2014) asserted that the pragmatic approach, which combines quantitative and qualitative approaches, is becoming increasingly popular in studies of resilience to food poverty. The Food and Agriculture Agency (FAO) was the first agency to use this idea in food security contexts, and it has extensive experience evaluating resilience using both quantitative and qualitative methodologies (FAO, 2016a). The embedded design was selected for the study out of the six mixed designs that (Creswell, 2012) suggested. The embedded design allows for the simultaneous or sequential collection of both qualitative and quantitative data; however, the quantitative method is employed most often, and the results from the qualitative data are used to support the findings of the quantitative analysis. Cross-sectional data types are best associated with an embedded design.

Cross-sectional household data from primary and secondary sources were used in the present study. Household respondents, elders, experts, officials, extension agents, and NGO employees were the main data sources. Primary data were gathered via structured surveys, focus group discussions, and key informant interviews. The supporting information was gathered from appropriate reports, bulletins, working policies, and program papers. Ten FGDs were conducted with teams of 7–10 people to support the data gathered through questionnaires. The secondary data were gathered from reputable websites and archives, office paperwork, current and pertinent published articles, and other sources.

4.2.3.Sample size determination

The study households were chosen using a multistage selection technique. First, since there are only two districts in the zone and they all have comparable livelihoods and administrative boundaries, Mangeshi and Godere were chosen on purpose. Second, out of the 32 villages, 10 villages—four in Godere and six in Mangeshi—were chosen systematically by random sampling under the premise that a high sampling ratio (approximately 30%) was thought to be adequate for small populations (1000). The sample villages were chosen based on the presumption that they were subsistence farmers, that the Majang community dominated, and that they were attached to

a life reliant on the forest. To compute the respondent households from each village based on the proportion share of the total households, the 2022 estimated population (households) of each village was used (CSA, 2022). The total population and households of the 10 villages totaled 15826 and 3557, respectively. Finally, respondents were chosen at random using Cochran's (1977) processes for large populations and the probability proportional to size technique.

$$no = \frac{z^2 pq}{e2} \quad \text{..... (Eq.1)}$$

Z2 is the normal curve's abscissa, which eliminates a region at the tails (1-α equals the appropriate confidence level), where no is the sample size. e is the desired level of precision, p (0.6) is the estimated proportion of an attribute or all forms of food-insecure households that are present in the zone's population, and q is 1-p, as highlighted in the reports of Hailemariam (2012) and DRMFSS (2015). The 95% confidence interval is assumed for this research, and the Z table value equals 1.96. A total of 369 households composed the sample according to the formula.

The final sample size was calculated using the Cochran's (1977) formula for sample size adjustment for sample sizes greater than 5%.

$$n1 = \frac{no}{1+no/N} \quad \text{..... (Eq.2)}$$

Since the sample size is greater than 5% of the population, the ultimate sample size is n1, where N is the size of the population. The ultimate sample size is therefore [369/1+ (369/3557)] = 334. Data from a few families were omitted due to the incompleteness of some household data, and 320 sample households served as the sampling unit for the final analysis.

4.2.4.Data analysis

In this study, the resilience of households to food insecurity was not measured as a capacity but rather as an indicator of food security, such that higher resilience scores are assumed to be indicative of better food security. Both quantitative and qualitative analytical methods were used based on the characteristics of the variables investigated. Descriptive and inferential statistics were analysed using STATA software version 13. The descriptive results were presented as percentages, means, and standard deviations, and the inferential statistics were calculated via an

econometric method that applies the specified model. The qualitative data were analyzed contextually to validate and substantiate the results from the quantitative analysis.

The results of the descriptive statistics were utilized to determine the degree to which the determinant components' resilience affected the ability of families to withstand food insecurity and to shed light on various socioeconomic traits of the households. The households' resilience capacity was executed applying the principal components analysis (PCA) method as suggested by Field (2010). The following mathematical illustration (Equation 2) provides an estimation of the expected value of the dependent variable Y.

$Yij = \beta 0 + \Sigma j = 1..p\, \beta jXij + \Sigma i$……..…… (Eq. 3)

where yij = Dependent variable "Resilience to food insecurity"

$\beta 0$ = Constant,

β1, β2…βi = Coefficients of variables,

X1, X2… Xi = explanatory variables

εi = Error term

Fitting the resilience components into the model, the working equation takes the following form.

RI = □ + □$_1$ IFA + □$_2$ AC + □$_3$ ATA + □$_4$ AP + □$_5$ ABS + □$_6$ AC + □$_7$ S + □$_{i.....}$Eq. 4

where RI is household resilience; *a* is a constant; b1–7 are the coefficients of each variable (the component indices developed during the PCA); and e is an error term.

In many food security-centered resilience analysis frameworks, such as those developed by Alinovi *et al*. (2010), the quantitative analysis of resilience identifies seven or eight key dimensions of resilience that integrate capital and capacity approaches, including income and food access, access to essential services, assets, adaptive capacity, stability, adoption of agricultural technology, social capital, and/or social safety nets. To account for the study's environment, the components that determined resilience capacity were identified as recommended by FAO (2016a) and Alinovi *et al*. (2010). The PSPN is substituted by its anonymous counterpart, social capitals (SC), as there are no rural social safety net programs deployed in the zone and only urban safety nets start in the zone's capital, Metti town. Guyu &

Muluneh (2015) substituted traditional SSNs that are inherent to and used by the community in the study area for SSNs as a way to help build social capital in places where formal programs are not implemented. The inclusion of observable factors under each component was made based on refined evidence from the literature and the researchers' prior experience in the study area. The PCA creates uncorrelated indices or components from an initial set of n correlated variables (x1, x2, x3, …, xn), and each component is a linearly weighted combination of the initial variables. The mathematical equation takes the following form (Eq. 5):

$$Yi = ai1x1 + ai2x2 + ai3x3 \ \ldots \ ainxn;\ i = 1;\ 2;\ \ldots;\ n \quad \text{..... (Eq. 5)}$$

where Y_i is the household's component score on the i^{th} PCA and a_{in} represents the weighted value for the i^{th} principal component and the n^{th} variable.

Since the pillars are latent and cannot be directly quantified to indicate resilience at the household level, the resilience status of the households to food insecurity was examined using a two-stage analytical model. Each of the pillars can also be measured using socioeconomic and institutional characteristics that have been observed. Multivariate techniques are frequently used in research to quantify outcomes, and cross-sectional data from national demographic and household surveys, as well as individually designed and self-administered surveys, were employed for measuring the level of household resilience to food security (Ansah *et al*., 2019; Beyene, 2016; Alinovi *et al*. (2010)). First, the PCA was used to estimate an index for each component individually across a collection of observable variables (A. P. Field, 2010). The PCA is appropriate tool when the observable variables are of a mix of continuous and dummy types. The resilience index is then derived via factor analysis of the interacting components estimated in the first stage, where the weights are the percentages of variance explained by each factor and the resilience index is a weighted sum of the factors created via Bartlett's scoring method. According to DiStefano *et al*. (2009), the Bartlett technique typically yields latent variable ratings that are univocal and unbiased.

To determine whether PCA is appropriate, model fitness and sample adequacy tests were computed. A KMO value of 0.5 in a decent model is required to pass the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy test. Bartlett's test of sphericity was run concurrently to

demonstrate the lack of multicollinearity or singularity issues. By examining the determinant of the R-matrix, which should be larger than 0.00001, as stated in Field (2010), multicollinearity or singularity concerns can be identified. Since it is analytically impossible to use these variables for factor analysis, or PCA, the best scaling technique was used to estimate the latent components that are related to the dummy or categorical variables by changing the observed variables. All the variables in the transformation are assumed to have a normal distribution with a mean of zero and a unit variance. Each observed variable is multiplied by a negative variable to make it compatible with the meaning of the hidden variable when some of the observed variables are negative indicators of the latent variable.

Varimax or orthogonal factor rotation was used to separate the loadings among variables after PCA factor extraction. Varimax rotation is regarded as a good general strategy that simplifies factor interpretation since it aims to maximize the dispersion of loadings within factors by heavily loading fewer variables onto each factor, leading to more interpretable clusters of factors. Field (2010) claimed that loadings with an absolute value of more than 0.3 were generally regarded as important. However, he recommended that significant consideration be given to taking critical values of factor loadings of 0.722 for a sample size of 50 and that these values should be greater than 0.512, 0.364, 0.298, 0.21, and 0.162 for sample sizes of 100, 200, 300, 600, and 1000, respectively. The following equation represents the development of the household resilience index.

$$Ri = \sum \quad WC[Xi - Xj]/Si \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(Eq. 6)}$$

where Ri = the estimated resilience index for household i, wc = the weight (factor score coefficient) for the X^{th} indicator of resilience in the PCA, and Xi = the ith household's value for the X^{th} variable (indicator) (Note: the X^{th}'s in the current study's context are the variables denoted by *AP, ATA, ABS, S, SC, AC* and *IFA* in equation 1 above) Xj = the mean of the X^{th} variable for overall households. S^i = standard deviation of the X^{th} variable for overall households.

The household combination index for each latent component (covariate of overall resilience) is computed according to equation 5 below, as has been applied in a variety of related studies

(DiStefano *et al*., 2009; Tekalegn, 2022; Dhraief *et al*., 2019; Debessa, 2018; Fikiru Beyene, 2016; Guyu & Muluneh, 2015).

$$RIn = \partial 1\ Factor\ 1\ +\ \partial 2\ Factor\ 2\ +\ \partial 3\ Factor\ 3 + \ldots + \partial n\ Factor\ n \quad \text{(Eq. 7)}$$

where RIn is the resilience index of the nth household and ∂n is the variance explained by each factor, factors 1, 2, and 3. . . n are the respective factors generated by the factor analysis representing each latent dimension.

The next step is to assess each household's overall resilience to food insecurity status after calculating the index for each latent variable for that particular household. The factor technique and principal component analysis were used to obtain the overall resilience index (RI) for each family. As a result, the households were divided into four resilience categories that had been arbitrarily proposed (Beyene & Senapathy, 2022). These groups were considered non-resilient (RI<0.00), moderately resilient (0.00≤RI<0.5), resilient (0.5≤RI <1.0), and highly resilient (1.0<RI). The categories for resilience were coded 1 through 4 in increasing order, with 1 being designated susceptible and 4 being highly resilient.

4.3. Results and Discussion

4.3.1. Socioeconomic characteristics of the households

A total of 320 rural households participated in this study, and the majority (90%) depended on agriculture to meet their dietary needs. The majorities of households (79%) are a male head of family and were married (88%). A total of 89.7% of the households had agriculture as their sole source of income, 9.7% had agriculture plus trade, and 0.6% had income from other sources. The average household size is five family members, which is in line with the national average. The average age of the household is approximately 40 years, with the minimum and maximum ages being 18 and 75 years, respectively. The households had a mean total landholding of 2.63 ha, which is three times greater than the national and regional averages stated by Central Statistical Agency, CSA (2021) but less than 0.5 ha when the net land use is restricted to the production of food crops. According to calculations, the households' average annual farm and nonfarm earnings were 20273 and 495 birr, respectively. When expressed as the mean per capita yearly income, the figures for on- and off-farm incomes are 4054 and 100, respectively. In the research

area, the average household dependency ratio was greater (87.65%), with the greatest dependency ratio approaching 400%.

According to the results of the descriptive statistics, 42.19% of the respondents had at least completed elementary school, while 57.81% had not attended any formal schooling. Additionally, almost three-quarters of the respondents stated that they were not receiving the services and technologies they needed to promote the expansion and productivity of their subsistence agriculture. Only 39% of them receive agricultural extension service contacts as a result. Although FTCs are built in their villages (60.62%), improved seeds are provided to them (25.62%), traditional irrigation systems are used to supplement crop production (12.81%), and they are members of cooperatives and participate in cooperative activities (16.87%). Additionally, they can obtain veterinary services for their livestock (20%), they can prepare and apply fertilizer (13.44%), they can use oxen to plough their agricultural land, and they are able to purchase and apply chemical pesticides (32.50%).

4.3.2.Results-principal component analysis

The analysis outputs of the observable variables explained their respective latent components at varying magnitudes and significance levels. The resilience dimensions used to estimate the resilience status of households include income and access to food, access to basic services, assets, adaptive capacity, stability, agricultural technology adoption, and social capital. The number and expected contribution of the independent variables to resilience to food insecurity under each pillar, the components retained, and the indices produced accordingly are portrayed below.

4.3.2.1. Income and Food Access (IFA)

The income and food access (IFA) pillar is closely related to households' ability to absorb shocks from what they have on hand and from other food access options, which is why it has a positive link with resilience to food insecure circumstances. Income limits a household's access to food by determining how much it can spend on food and how much food it can consume. The household food insecurity access score (HFIAS) and the food consumption score (FCS) of the households, both of which are proxy tools for measuring food access, were used to construct the index for IFA along with the household's farm income, and amount of credit received, and

HFIAS and FCS. Except for the HFIAS, all the variables show a positive correlation because those scores increase when food security increases.

The findings of the main component analysis demonstrate that the variables being investigated were found sufficient to explain IFA because the model adequacy test, measured by the KMO measure of sampling adequacy (0.615), is significantly greater than the cut-off established by Kaiser's rule (0.50). Chi^2 = 538.113, df = 6, and $p<0.01$ for Bartlett's test of sphericity showed that there was no singularity or multicollinearity among the variables. The correlation results show a perfect connection between the converted data and the IFA latent variable, with an R-matrix value of 0.183. All the four factors were loaded onto a single component with an eigenvalue of 2.31 and a total variance of 57.88%. Except for off-farm income, which loaded below the minimum and was eliminated from the analysis following the orthogonal rotation matrix factor loading retention requirement, all the four variables sufficiently scored loadings above the minimum. In terms of importance, the FCS contributed the highest loading (0.6081) evident of how crucial in defining the IFA and therefore resilience capacity of households. The component loadings of the variables utilized in the model are shown in Appendix table 7.

4.3.2.2. Asset Possession (AP)

Assets are the capital that enables households to withstand challenges and shocks. When a household has varied assets on hand, they feel safe and protected from unforeseen events that may otherwise throw their life off balance. The two most important assets for rural households are land and livestock. Both productive and nonproductive assets act as buffer stocks under difficult circumstances as short- and long-term ways to avoid shocks and be robust. The household's jewelry, telephone, television, plough, bike, table, and radio were all considered assets in some areas, although the definition of an asset depends on the context (Boukary *et al*., 2016). Estimates of the agricultural asset components of resilience were based on landholding size, cattle ownership (TLU), beehive ownership, and possession of jewelry, radios, jewelry, televisions, satellite dishes, mobile phones, tables, sofas, beds with sponge mattresses, bicycles, and motorbikes. The TLU was transformed using the conversion equivalents table for sub-Saharan Africa published by Njuki *et al*. (2011) in 2011. Presumably, each factor had increased the likelihood of resilience to food insecurity.

Before performing the PCA, the dummy variables underwent optimal scaling adjustment to be suitable for PCA. The variables' suitability and model fitness for the principal component analysis were assessed after analysis, and the test results demonstrated that the variables were eligible with a KMO test value of 0.79. With Ch^2 = 916.335 and *df* = 55, the factor test was also significant ($p<0.01$), and the correlation matrix value of 0.054 showed that there were no multicollinearity issues among the variables. Using Kaiser's formula to estimate the latent variable AP, four components were considered that together accounted for 64.34% of the overall variability. Five, two, three, and two-component loadings of more than 0.3 were applied to components 1, 2, 3, and 4, respectively. Among the variables subjected to PCA, possession of number of traditional beehives contributed the most in building resilience, and mobile phone ownership had resulted in the least support in building resilience (Appendix table 8). Variables such as the land area, water availability, and the yield of crops had a significant positive role in improving the asset pillar (Moradian *et al*., 2023).

4.3.2.3. Adaptive capacity (AC)

The third crucial component of resilience, adaptive capacity, describes how well a household can adjust to and respond to shocks. According to Dhraief *et al.* (2019), the phrase refers to the circumstances that make it possible for individuals to foresee and react to changes; minimize, cope with, and recover from the effects of change; and seize new possibilities. The latent pillar AC was established using the indicators of educational average, diverse sources of income, and household dependency ratio (Kebede *et al.*, 2016). The adaptability or coping capability of households experiencing food insecurity difficulties is also influenced by the age, size, and marital status of the household. These observable factors, such as sex, age, marital status, family size, education, diversity of income sources, and the dependency ratio of households, were used to explain this pillar. Except for the dependency ratio, all of the variables used to index AC were thought to positively affect resilience to food insecurity. The marital status of the household variables and the sex of the head of the household were transformed using optimal scaling statistics. The sample variables used to determine the AC pillar were found to be sufficient (KMO = 0.616), and the correlation matrix's determinant of 0.096 verifies the model's fitness under all necessary conditions for PCA to be performed without any concerns about multicollinearity or singularity. A chi^2 value of 740.363 and a degree of freedom of 21 led to a significant ($p<0.01$) result for the Bartlett test of sphericity.

The results of the principal component analysis showed that every variable had a significant absolute value greater than 0.3, which indicated that it was important in explaining the AC pillar of resilience. Two components with eigenvalues of 2.25 and 2.11 were retained; these two components together accounted for 32.31% and 30.12%, respectively, of the overall variance (62.40%). The first component is heavily weighted with the factors of household size, age, and dependence ratio, while the second component is heavily weighted with the variables of household sex, marriage status, and years of education. The dependency ratio's inverse relationship with adaptive capacity, which results in a household's adaptive capacity eroding as a result of considerably more nonworking yet consuming household members, accounts for the dependency ratio's negative loading value on component one (Appendix table 9). The number of household members and marital status of households contributed the highest and lowest magnitude in determining AC.

4.3.2.4. Access to Basic Services (ABS)

The infrastructure and institutions that offer services are essential for improving the resilience of rural households. Public service delivery is typically capital intensive and exogenous to households' dependence on governmental and nongovernmental supporting organizations. To increase the effectiveness of a household's access to assets, access to public services is essential (Alinovi *et al*., 2009). Infrastructures such as roads, markets, water points, irrigation systems, and other services, such as farmers' development agents, electricity, educational facilities, telecommunications, health facilities, credit institutions, and transportation, all play crucial roles in supporting the effort to remain resilient. The distance to a source of drinkable water, the distance to the nearest highway, the distance to a school, and the distance to a medical facility were used to calculate the latent variable ABS. In this analysis, accessibility and distance to public services are negatively correlated; thus, each has been multiplied in reverse to change the direction of influence. In addition to the variables, access to telephone services, electric services, and rural credit services was measured on a categorical scale and needed to be transformed into a ratio scale using the best possible scaling technique.

Following the execution of all the statistical tests for PCA, it was discovered that the model is suitable and competent for significantly expressing ABS. The samples were sufficient to support factor analysis, as demonstrated by both the individual and aggregate (.786) KMO tests. The R-

matrix value of 0.058 is greater than the stipulated minimum cut-off level (0.00001), suggesting the absence of multicollinearity or singularity problems among variables. The results of the factory or Bartlett's test of sphericity were significant (chi2 =898.787, df = 28, and p<0.01). Ten explanatory variables were used to determine ABS, but two of them—distance to health facilities and distance to a primary school—were removed due to their minimal loading or inadequate ability to explain the latent variable. The PCA identified three components that explained 37.26%, 19.36%, and 14.56% of the variance, with eigenvalues of 2.981, 1.549, and 1.165, respectively, in ascending order. About 71.19% of the total variance was explained by the variables. The visit by the extension workers followed by access to telecommunication service and access to electric power play the integral role in attaining better resilience capacity position (Appendix table 10).

4.3.2.5. Agricultural Technology Adoption (ATA)

In least-developed countries, practically all rural households depend heavily on agriculture. Given that the agricultural sector is supported by enhanced agricultural inputs and technology that can increase crop and livestock production and productivity, food security, and therefore resilience to shocks and stresses, sixteen variables, including methods and tools for increasing agricultural and livestock output, were taken into account to measure the latent component of ATA. Crop rotation, intercropping, improved seeds, chemical pesticides, synthetic fertilizer, organic fertilizer application, oxen ploughing, constructed crop storehouses *(Gotera)*, coffee drying on beds, mulch application, irrigation, use of modern beehives, veterinary service, artificial insemination, and keeping livestock in separate homes are examples of crop diversification practices. All the variables were transformed using optimal scaling approaches and run in PCA.

The PCA was performed using 12 indicator variables (Appendix table 11) to forecast how the ATA affects households' levels of resilience to food insecurity. To test the variables for variable correlation and multicollinearity and to make them suitable for PCA, an optimal scaling procedure was applied. The results that were subsequently produced showed that the variables are a linear combination of predicted factors used to quantify the pillar for resilience measurement. A KMO statistics score of 0.843 indicates that the sample is adequate; moreover, Bartlett's test rejects the null hypothesis that the original correlation matrix is not an identity

matrix ($p< 0.01$, $Ch^2 = 1306.477$, and df = 66). The correlation matrix's determinant was found to be significantly greater than the minimum significance threshold of 0.016 in the test for the presence of multicollinearity or singularity. Variables with score loadings of 0.3 and components with eigenvalues greater than or equal to one were retained by factor analysis. The three components had eigenvalues of 2.946, 2.173, and 1.995, explaining 24.55%, 18.11%, and 16.63%, respectively, of the variance. While use of improved seed had shared the largest, use of Gotera to store crop products constitute the lowest in determining this dimension of resilience.

4.3.2.6. Stability (S)

The sixth element of resilience was stability, which typically refers to a household's options and ability to resist various socioeconomic and ecological circumstances that could impair resilience. Since they are linked to shock and stress, the factors that were utilized to estimate this pillar typically have adverse effects. Most similar studies use variables such as crop shocks, livestock shocks, human health shocks, climate-induced shocks, and economic shocks to denote pillar S, revealing how it has an inverse relationship with food insecurity resilience. For each observed variable in the relevant scenario, the value was multiplied by -1 to comply with the definition of the stability pillar. Theoretically, stable households are thought to be more resilient to food insecurity. To calculate S, this study considered human health issues such as serious illness, frequent medical visits, and having a family member with a disability; pre- and postharvest crop shocks defined by disease and insect damage; weeds; wind and frost attack; and floods; climatic shocks such as rainfall patterns or variability; socioeconomic variations such as the frequency of DAs' visits and support, commodity price variability, and latrine use; and lives. One of these observable variables, shown in Appendix table 12, was employed in the study; the others were left out due to concerns about the variables' multicollinearity and sample adequacy for PCA.

Since each of the five variables has a ratio scale, PCA is possible. The outcome of the factor analysis demonstrated that the variables are sufficient and that multicollinearity or singularity are not issues. At $Chi^2 = 97.712$ and df = 10, the Kaiser–Meyer–Olkin measure of sampling adequacy was found to be adequate (0.63), and the Bartlett test of sphericity was significant ($p<.001$). The model is appropriate, as indicated by the correlation matrix's (R-matrix) determinant of 0.734. According to Kaiser's criterion, two components were retained, with eigenvalues of 1.56 and 1.21 explaining 31.15% and 24.13%, respectively, of the variance in the

two PCA measurement indicators. In addition, two variables associated with agricultural output were associated with the second factor, whereas the three variables related to human health were grouped under the first component and shared a significantly greater variance. Additionally, according to the component loadings, animal shocks are the most important factor in enhancing the study households' ability to withstand food insecurity. The animal and crop shock variables had the largest share in explaining the S dimension comparably.

4.3.2.7. Social Capital (SC)

Social capital networks are intra- or intersocial group ties that are based on a sense of community or belonging and actively support the resilience of both individuals and groups. They are governed by conventions, ideologies, and institutions developed locally to further common goals and interests. In communities, social capital is crucial because it offers support and support that increase a household's or a group's ability, especially in times of stress and shock. In more advanced situations, these platforms can be turned into opportunities for business ownership and wage employment, as well as official and informal loans, cash advances, inputs on credit, talent, and shared resources for production and marketing. *Idir*, members of religious organizations, *Iqub*, *Debo*, and people's readiness to help are among the most popular.

The willingness of people to help one another in difficult circumstances, *Idir* membership, and religious group participation were used to represent the SC component for this study (Table 10). The variables underwent an optimum scaling adjustment before PCA because they are categorical in nature. The samples were found to be suitable in the subsequent PCA, with a KMO value of 0.664, and the model was found to be appropriate and fit (R-matrix = 0.201) according to the significant Bartlett test of sphericity ($p< 0.01$, $Ch^2 = 506.984$, df = 15). Since all six variables have component loading values greater than the criterion of 0.298, they are all statistically significant. The two components that were retained explained 63.33% of the total variance, with eigenvalues of 2.22 and 1.58 (Appendix table 13).

4.3.3. Households' RI estimation

The latent component indices from the principal component analysis of the latent components computed earlier in stage one are used to create the overall resilience index (RI) of the households. The indices of the seven pillars, ATA, IFA, ABS, AP, AC, SC, and S, were subjected to PCA at stage two of the resilience analysis under the assumption that all the blocks

are normally distributed with mean zero and unit variance. At the second stage of the analysis, factor analysis using the principal component factor approach may have been used in several research articles (Kebede *et al*., 2016) that focused on resilience-centered topics. The suitability and appropriateness of these variables for the model were examined, and all necessary measures were determined. Accordingly, the KMO measure of 0.859 indicated that the samples were enough, and the value of the correlation matrix's determinant, which is 0.045, indicates that multicollinearity or singularity concerns are not present, becoming significant ($p< 0.01$) with a Chi^2 value of 977.339 and a degree of freedom of 21.

According to Kaiser's criteria, one component explaining 53.07% of the total variance and having an eigenvalue greater than one (3.715) was retained. All variables had acceptable factor loadings except for the variables measuring adaptability and social capital. The largest factor loadings were found for income and food access, followed by the adoption of agricultural technology, asset ownership, access to basic public services, and stability, in that order, showing that the relative contributions made by each block in helping households in the study area become resilient to food insecurity. The stability component, on the other hand, is loaded with a negative value (Appendix table 14). The observed variables are, in fact, indicators of instability because of the nature of the variables used to evaluate stability, which requires that there be a negative association with resilience to food insecurity.

4.3.4.Household resilience to food insecurity

Based on two analytical outputs, the determination of families' food insecurity resilience status was carried out. First, the total resilience index was used to determine the category or resilience status of the households. The importance of these pillars in determining household resilience capacity was covered in the second analysis, which was econometric.

4.3.4.1. Resilience status of households

Table 3 below lists the groups of households in the research area that are resilient to food insecurity. The findings showed that the population's level of resilience is only moderately stable, with approximately 47.5% of families being vulnerable and an additional 12.19% being uncertain, bringing the percentage of weak resilience to almost 60%. These findings are in line with those of studies with nearly identical controls, with 23.13% and 17.19% each (Table 3).

Table 3Household resilience capacity spectrum in the study area

Household categories	N	Proportion (%)	Cumulative proportion (%)
Vulnerable (RI<0.00)	152	47.50	47.50
Mildly resilient (0.00≤RI<0.5)	39	12.19	59.69
Resilient (0.5≤RI <1.0)	74	23.13	82.81
Highly resilient (1.0<RI)	55	17.19	100
Total	320	100	

Source: own survey results.

Additionally, as in the works of Debessa (2018), Ciani & Romano (2014), Alinovi *et al*. (2010), and Alinovi *et al*. (2008), the relative importance of the covariates in indicating the resilience capacity of households was determined via the size of loadings of the components (pillars) as an alternative path to detect the substantive importance of each. According to Field (2009), the factor loadings in a particular analysis can take the form of either correlation coefficients or regression coefficients, providing two different avenues for analytical comparison. As a result, the factor loadings of the pillar components used to explain the combined resilience index (Figure 8) showed diverse magnitudes and directions of effect, suggesting that one contributes considerably to building resilience but not significantly more so than the other. In light of this, ABS, AC, and SC played relatively few roles despite having a positive correlation, whereas IFA, ATA, and AP significantly and positively contributed to families' resilience ability. Similar research reported that the components of asset and adaptive capacity had a significant role in increasing the resilience of rural households (Moradian *et al*., 2023). In terms of relative relevance, it was determined that the IFA pillar contributed more than the ATA and AP pillars did. The study area is heavily dominated by commercial crop production, such as coffee and apiary operations, and these considerably contribute to the well-being of the households. As a result, the income and food availability dimensions were shown to be crucial in the resilience-building process. The stability pillar of the resilience component showed a negative correlation with the outcome index, indicating that the research area experienced a high occurrence of food security shocks. Animal and crop-related biotic and abiotic problems account for the majority of the shocks, in particular. Both the key informants and the focus group participants saw how large crop shocks such as heavy rain, snow, wind, insect pest attacks, weeds, and illnesses have limited the amount of food that can be produced from crops. Notably, shocks, including

trypanosomiasis, foot-and-mouth disease, and a lack of fodder, have been identified as contributing to the decreased productivity of livestock output.

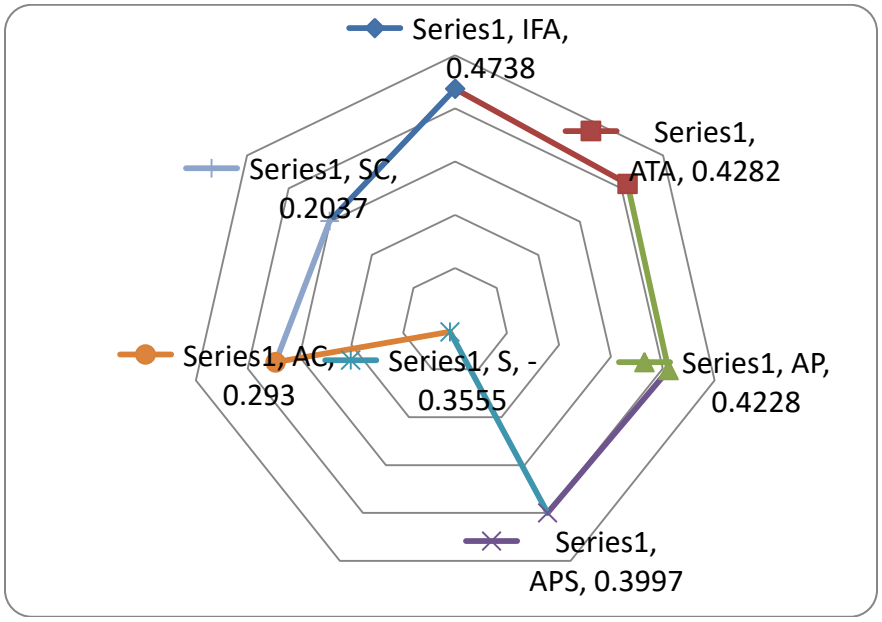


Figure 8 Component loadings of the resilience dimensions

4.4. Conclusion and Recommendations

This study looks at how resilient households are to food insecurity and how much of an impact determinant factor has on that resilience. In contrast to well-known short-term food security research and treatments, resilience in food security studies enables us to efficiently plan for and assess the consequences of shocks and stressors through a longer-term development strategic approach.

In the study area, it is argued that households' resilience to food insecurity is unstable. Families that have access to food and income, build wealth, use agricultural inputs and technology, and have superior adaptive capacity are more likely to withstand the shocks and pressures of food insecurity. Those who have access to public services are also more likely to do so. To decrease the number of vulnerable households and increase the abilities of those who are resilient, it is crucial to enhance these characteristics. Agricultural technology use, asset ownership, and access to essential services have all helped people become more resilient, whereas social capital has

made a negligible difference in this regard. On the other hand, a household's level of resilience to food insecurity was negatively impacted by stability or sensitivity.

The study suggested that to bring about long-lasting changes and improve the positive aspects of resilience-building components. A major policy objective is suggested to work on the following crucial points:

- Methods that aim to ensure production and nutritional sensitivity and maintain resistance to frequent and unforeseen shocks in the agricultural sector, including the livestock and crop subsectors, should be developed. In particular, it is necessary to identify and work on mitigation techniques to lessen the impact of typical crops and livestock-related shock and stress as well as unexpected onsets of damage.
- Installing early warning systems that automatically launch adaptable response mechanisms at the necessary scale through the development of coordination and links among institutions engaged in food and nutritional security analysis, early warning, and response; offering technical support to raise awareness; and starting vulnerable targeted life-supporting programs, such as rural safety nets, are necessary in this regard. Currently, a low number of farmers have been reached with tailored weather information services yet there is a huge potential of hazard in Ethiopia (Ogola, 2021).
- It is thought that bolstering local institutions and public services such as research facilities, cooperatives, credit and saving institutions, veterinary services, input suppliers, farm loan providers (banks), crop insurance provisions, and comparable others will significantly help to increase household resilience over the long term.
- Given that this study's social capital dimension of resilience revealed poor relationships among households, it is worthwhile to build social cohesiveness as a long-term strategy. Adequate technical and political participation is necessary at the right moment to create opportunities for activities that diversify revenue.

The study generally advises that any efforts by the government and other development actors to implement policies and programs should prioritize and build on the critical aspects of food security resilience so that households can successfully avoid short-term shocks and stresses and strengthen their long-term development plans and their implementation success.

CHAPTER FIVE: PREVALENCE OF FOOD INSECURITY AND ASSOCIATED COPING STRATEGIES AMONG RURAL HOUSEHOLDS IN THE MAJANG ZONE: SOUTHWESTERN ETHIOPIA[4]

Abstract

Food security is a fundamental human need that is rarely met and is given increased attention in developing country strategies. To bridge the gap in food security, households with food insecurity adopt a variety of coping mechanisms. The objective of this research was to analyze the prevalence of food insecurity and related coping strategies in households in the Majang zone. A total of 320 randomly chosen participants were included in the cross-sectional study. Primary and secondary data that were later subjected to descriptive statistics and economic regression models were gathered. According to the study's findings, 14.76% of households were determined to be food secure, whereas 36.87%, 37.11%, and 11.26% of households were mildly, moderately, or severely food insecure, respectively. The prevalence of food insecurity was positively correlated with coping mechanisms, but the food consumption score, annual income, and availability of credit services had negative effects. In addition, 2.81%, 38.75%, 31.56%, and 26.87% of the households were classified as adopters of less severe, mildly severe, moderately severe, and highly severe coping strategies, respectively. The government and concerned implementers are advised to carry out recommendations such as broadening food consumption options, improving rural credit institutions, and diversifying income-generating segments. A policy agenda should also address measures that aim to strengthen coping mechanisms, such as reliance on forest foods, and avoid those that risk jeopardizing longer-term prospects, such as the commercialization of farmland.

Keywords: Households, Food insecurity, Cross-sectional data, FCS, CSI, HFIAS.

[4] Based on:

Shibru Zerihun, Mesay Mulugeta and Meskerem Abi (2024). Prevalence of Food Insecurity and Associated Coping Strategies among Rural Households in the Majang Zone: Southwestern Ethiopia. BMC Nutrition (Under Review)

5.1. Introduction

Food security is achieved when all people at all times have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (Clay, 2002). Due to perceived and unanticipated linked causes, the issue of reducing hunger, food insecurity, and all types of malnutrition continues to be a daily phenomenon. In addition to the frequently mentioned socioeconomic, political, physical, and environmental reasons, the residual effects of the COVID-19 pandemic and the disruptions caused by international and intranational conflicts were also determined to be antagonistic realities to the efforts made to address food insecurity. The COVID-19 epidemic and its effects had continued to obstruct efforts to meet SDG 2 by 2030, according to the Food and Agriculture Organization (FAO) and associated partners' assessments of food security and nutrition conditions worldwide for the year 2022 (FAO *et al*., 2022).

Despite the focus being on the top development priorities of these countries, the food and nutritional security situation in the least developed countries is becoming increasingly alarming. Food and nutrition insecurity in Ethiopia is a problem that is worsening despite ongoing economic expansion (Haile *et al*., 2022). According to reports from the FAO and other organizations, 2021 would see one in five Africans experiencing hunger. Approximately 690 and 250 million people worldwide and in Africa, respectively, are experiencing a food crisis, and more than 25 million Ethiopians live below the poverty line (Diriba, 2020a). Up to 60 million people in East Africa, including 10 million people in Ethiopia, may experience food insecurity by 2024, according to World Bank predictions (World Bank, 2023). For instance, the prevalence of undernourishment has significantly decreased over the past fifteen years, but the prevalence of severe food insecurity has significantly increased over the past five years (FAO *et al*., 2022). As of 2021, 5.5 million individuals had experienced severe food insecurity, and 3.1 million people were considered to require immediate assistance (IPC, 2021). The COVID-19 outbreak has led to desert locust population displacement and rising food costs (IPC, 2020; Goshme, 2019). The failure to meet projected development objectives was also cited as a shortcoming (Eneyew & Bekele, 2012). Severe drought and continued insecurity are frequent phenomena impacting the battle to feed people (WFP, 2023). Climate change-induced impacts have also been reported to be challenging (WFP, 2023; Srinivasan, 2019). In these situations, households may adopt a variety of coping mechanisms to lessen the shocks and pressures they experience and meet their nutritional demands (Kyaw, 2009; Maxwell & Richard, 2008; Endalew *et al*., 2015; Mohamed, 2017; Meskerem & Degefa, 2015).

Due to various ecological, socioeconomic, and biophysical shocks and stresses, the food security position of the study area has remained tenuous. Some of the factors claimed to cause shocks in food security include population pressure (Girma & Muluneh, 2021) and declining landholding (Degife, 2020). Additionally, frequent drought, poor off-farm employment, diseases, poor access to markets and credit, poor access to drinking water and sanitation, and price inflation on food items were reported (DRMFSS, 2015). Unresponsive, nontransparent, nonparticipatory, and corrupted land and project governance systems or policies were also reported (Guyalo *et al*., 2022). Despite the prevalence of all of these and other unidentified shocks and stresses in the study area, little to no scientific research has been conducted regarding food security and coping mechanisms. According to Berlie (2015), there is little research on coping and adaptation strategies in Ethiopia. In addition, tackling such a research agenda results in a scientific proposal that can close the gap in problem prioritization, planning and implementation of offered solutions, and enabling efficient resource usage. The results of this analysis can also be used as input by researchers, decision makers, and development partners who are attempting to lessen the problems associated with food insecurity in similar contexts. Therefore, the objective of this study was to evaluate the prevalence of household food insecurity and associated coping strategies in the study region.

5.2. Materials and Methods

5.2.1. Description of the study area

The study was carried out in the Majang zone of the Gambella region. It is located between 7° 4' 2.41' and 7° 46' 47.79' N and 34° 36' 30.54' and 35° 38' 48.00' E. The Zone had an estimated 89033 residents, 46119 of whom were men and 42914 of whom were women (CSA, 2013). The livelihoods of the households in the study area included commercial farming (coffee), agriculture, honey production, fishing, hunting, forest fruit and spice collection, and small and petty trades. NTFPs contribute approximately 87% of the total indigenous household income; traditional honey contributes the largest proportion of total cash income (47%); and edible NTFPs and wood products contribute 38% and 2%, respectively.

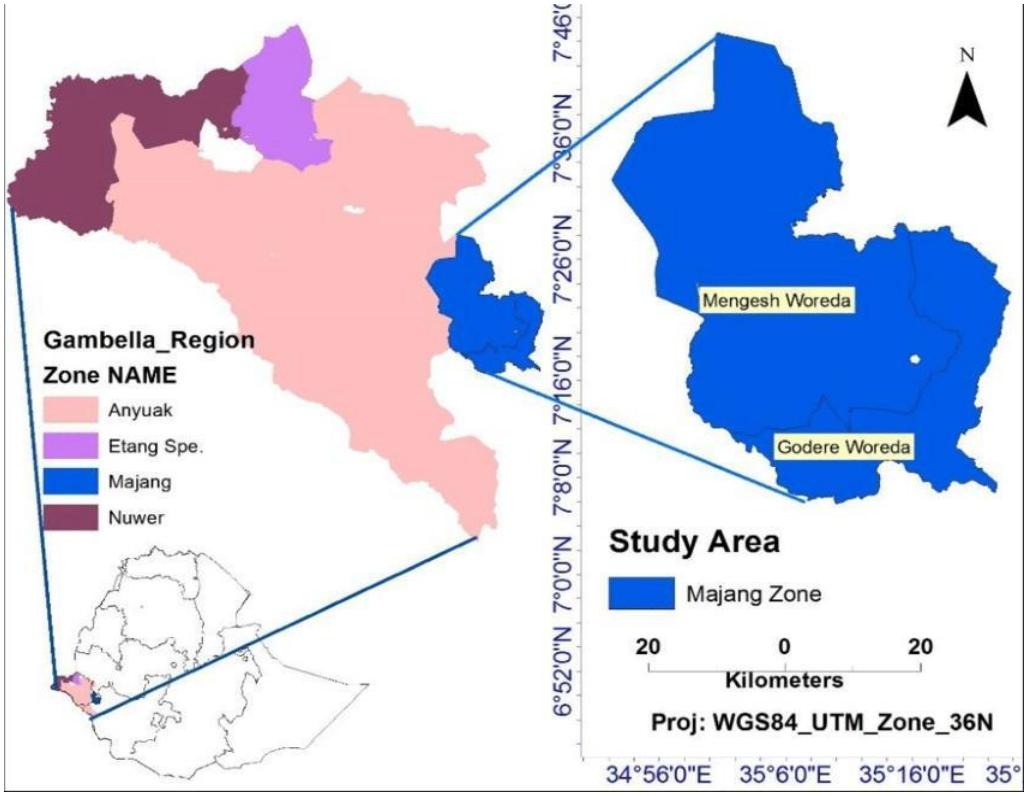


Figure 9 Map of study area (adapted from Mathewos & Bewuketu, 2018)

5.2.2.Study design and tools for data collection

By gathering qualitative and quantitative data from primary and secondary sources, the research used a pragmatic approach. Focus groups, key informant interviews, and structured survey questionnaires are some of the approaches used to collect data. Using the standard Coping Strategies Index (CSI) Field Methods Manual Second Edition created by Maxwell & Caldwell (2008), data on coping strategies were gathered to document household consumption-related coping reactions to insufficient availability of food. Similarly, information on the HFIAS was gathered using the common HFIAS questionnaire created by the Food and Nutrition Technical Assistance (FANTA) project (Coates *et al*., 2007). The primary data sources were households and key informant interviews with rural extension workers, government and NGO specialists, and officials involved in work related to food security. Secondary data were gathered from in-depth reviews. Ten focus group discussion sessions with six to eight participants were also conducted (Maxwell *et al*., 2003).

5.2.3.Sample size estimation

The study households were chosen using a multistage sampling technique. Since the zone has two districts, Mangeshi and Godere were chosen for the study. These districts were selected based on

previous discussions and assumptions that they were inhabited by subsistence agriculture, a high prevalence of food insecurity, the Majang community, and an attachment to a livelihood based on the forest. Second, out of the 32 villages, 10 villages, 4 in Godere and 6 in Mangeshi, were chosen by a systematic random sampling technique, assuming that a high sampling ratio (approximately 30%) is adequate for small populations (1000). The sample respondents were chosen at random using Cochran (1977)'s processes for large populations and the probability proportional to size technique.

$$n_o = \frac{Z^2 pq}{e^2} \quad (1)$$

where no is the sample size and Z^2 is the abscissa of the normal curve that cuts off an area α at the tails (1 - α equals the desired confidence level). For this research, a 95% confidence interval is assumed, and the Z table value equals 1.96; e is the desired level of precision; p (0.6) is the estimated proportion of an attribute or all forms of food insecure households that are present in the zone's population; and q is 1-p, as highlighted in the reports of Hailemariam (2012) and DRMFSS (2015). Based on the above formula, the sample size is 369 households.

Considering Cochran (1977)'s sample size correction for sample sizes exceeding 5% of the population, the final sample size is determined as follows:

$$n_1 = \frac{n_o}{1+(n_o/N)} \quad (2)$$

where n_o = the required return sample size, n_1 = the final sample size because the sample > 5% of the population and N = the population size. Accordingly, the final sample size was [369/1+ (369/3557)] =334. Owing to incomplete information in some household data, few were omitted, and 320 sample households composed the sampling unit for the final analysis.

5.2.4.Data analysis

Descriptive and econometric statistics were used in the data analysis, and contextual analysis of the qualitative data was subsequently performed. Means, standard deviations, frequencies, percentages, and confidence intervals were calculated via the descriptive technique. The econometric approach used multivariate regression of an ordered logistic model fitted with socioeconomic variables, the prevalence of food insecurity, and coping mechanisms. Software called STATA version 13 was used to analyze the data. To determine the significance of categorical variable relationships with the

frequency of household food insecurity, a chi-square test was performed (Masahudu, 2019). Since the dependent variable, HFIAS, classifies families into four food security thresholds, the ordered logistic regression model is chosen. Numerous research papers on food security apply the same methodology (Ambaye *et al.*, 2021; Yano *et al.*, 2021; Ayele *et al.*, 2020; Pudjihardjo, 2020; Desalegn, 2019; Fullerton, 2009; Williams, 2006). The specifications of the working model are given in the following equations.

$y_i^* = ß'x_i + \varepsilon_i \quad -\infty \leq y_i^* \leq \quad$ ……..(4)

$-\infty$

where y_i^* = HFIAS categories, β_i = parameters to be estimated, x_i = observed vector of explanatory variables that shows the characteristics of the i^{th} household, and ε_i =residual error that is logistically distributed. If Yi is considered a discrete (countable) and observable variable that reflects different levels of household multidimensional poverty, the relation between latent variable Yi* and observable Yi is obtained from the ordered logit model as follows:

$y_i = 1 \quad \text{if} \quad -\infty \leq y_i^* \leq \mu_1, \quad i=1,\ldots, n$
$y_i = 2 \quad \text{if} \quad \mu_1 \leq y_i^* \leq \mu_2, \quad i=1,\ldots, n$
$y_i = 3 \quad \text{if} \quad \mu_2 \leq y_i^* \leq \mu_3, \quad i=1,\ldots, n$
$y_i = 4 \quad \text{if} \quad \mu_3 \leq y_i^* \leq \mu_4, \quad i=1,\ldots, n$
. . . .
. . . .
. . . .
$y_i = j \quad \text{if} \quad \mu_{j-1} \leq y_i^* \leq +\infty, \quad i=1,\ldots, n$ ----------(5)

where n= value of the sample size, μ and ∞ = thresholds that define observed discrete answers and should be estimated.

The probability of $y_i = j$ should be calculated by the following relation

$$\Pr(y=j) = \Pr(y_i \geq \mu_{j-1}) = \Pr(\varepsilon_i \geq \mu_{n-1} - \beta x_1) = F(\beta x_i - \mu_{j-1}) \quad \text{----------(6)}$$

In terms of cumulative probability, the ordered logit model estimates the likelihood of household "i" being at the 'j^{th}' level or less (1…, j-1). The answer groups in the ordered logit model are ordered. The ordered logit model is expressed as follows:

$$\log\left[\frac{\gamma j(xi)}{1-\gamma j(xi)}\right] = \mu_j - [\beta_1 x_1 + \beta_2 x_2 + \beta_k x_{ki}] \ldots\ldots\ldots\ldots \quad j=1\ldots, j;\ i=1,\ldots, n \qquad \text{----------(7)}$$

Construction of the coping strategy index

The CSI was analyzed based on an accurate list of coping mechanisms used in the study region. The frequency of these specific activities during the previous seven days was then noted. According to Andersson *et al.* (2011), Mjonono (2008), and Maxwell *et al*. (2003), the magnitude frequencies of the strategy that are attributed as never, hardly ever, occasionally, pretty often, and always are designated as 0, 1, 2, 3, and 4, with average frequency values of 0, 0.5, 1.5, 4.5, and 7, respectively, attached to them. Finally, household-level focus groups ranked the severity of each of these distinct coping techniques under study to provide a weight for the perceived severity of each strategy. The ten focus groups, one in each village, were permitted to score the degree of coping methods used in the study area on a scale of 1 to 4, with 1 denoting less severe, 2 denoting moderately severe, 3 denoting severe, and 4 denoting highly severe (Table 4). The severity weights assigned to each behavior's index score were then multiplied by the frequency values, and the resulting individual behavior scores were subsequently summed to produce the household's overall index score (Eq. 4). The resulting index score is a comparative indicator of how frequently and severely the household engages in coping mechanisms, leading to food insecurity. According to Maxwell & Caldwell (2008), lower scores imply less extensive coping, indicating less food insecurity.

However, since the CSI scores do not have universal thresholds for different levels of coping strategies for food-insecured households, categorizing households as either implementing less severe or highly severe means of coping is vague. Nevertheless, Tefera *et al*. (2022) tried to assign categorical cutoffs to CSI scores computed for households based on evidence from recent studies. Accordingly, they categorized household food security as food secure (CSI score 0), mild food insecure (CSI score 1-12), moderate food insecure (CSI score 13-50), or severe food insecure (CSI score ≥51). This, in turn, has a direct corresponding value to the less severe, mildly severe, moderately severe, and highly severe CSI categories. Kruger *et al*. (2008) used a similar methodology but divided families into two categories, classifying those with a CSI greater than 55 as more food insecure and those with a score less than or equal to 55 as more food secure. Additionally, some unnamed sources frequently determine the proportion of families falling under each coping category using cutoffs for the following four categories: 0–3 (less severe), 4–18 (mildly severe), 19–42 (moderately severe), and 43 and above (very

severe) (https://fscluster.org/handbook). This study considered the CSI cutoff classifications of households cited in published research and the computed household score of the field survey data adjusted for the CSI cutoffs as 0–3 (less severe), 4–18 (mildly severe), 19–50 (moderately severe), and 51 and above (severe).

$$CSI\ score = \sum_{i=1}^{k=14} FiSi - - - - - - - - - - - (4)$$

where
Fi = Frequency of the i[th] coping mechanism taken by a household in the past seven days
Si = the severity weight associated with the i[th] coping mechanism, and
k = maximum number of coping strategies

Computation of household food insecurity access prevalence:

Different approaches are used to measure the level of food insecurity experienced by households using indices such as the HFIAS. As an illustration, Pakravan-Charvadeh *et al*. (2021) attempted to classify food insecure families based on the HFIA score of households as anxiety and uncertainty (2–9), insufficient quality (4–14), or insufficient food intake (15–27). In a similar vein, Desalegn (2019) classified households in his thesis research according to their HFIAS score as either food secure (score 0), mildly food insecure (scoring 1-9), moderately food insecure (score 10-18), or severely food insecure (score 19-27). Salarkia *et al*. (2014) divided households into those that were food secure (0-1), mildly food insecure (2-7), moderately food insecure (8-14), and severely food insecure (15-27) based on their HFIAS ratings. The methods in Table 4 and Equation 5 were used to determine the prevalence of household food insecurity.

Table 4 HFIA incidence category computation table

HFIA category	Responded HFIAS questions
1-Food Secure	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]
2-Mildly Food Insecure	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]
3-Moderately Food Insecure	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]
4-Severely Food Insecure	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]

Source: Coates *et al*. (2009)

$$\text{HFIA prevalence} = \sum_{i=1}^{4} \frac{Number\ of\ households\ with\ HFIA\ category = i}{Total\ number\ of\ households\ with\ a\ HFIA\ category} X\ 100 \ldots\ldots (5)$$

5.2.4.1. Study variables

The HFIAS-measured level of food security serves as the dependent variable. The measure divides families into four categories: those with adequate access to food and those with severe food insecurity. The four levels of food insecurity were classified as follows: 3 for food security, 1 for mild food insecurity, 2 for moderate food insecurity, and 4 for severe food insecurity (Desalegn, 2019). The household coping strategy index, food consumption score, age, sex, family size, dependency ratio, education, income diversity, land ownership, livestock ownership, input use, number of beehives, access to credit, and income are among the explanatory variables taken into account in this study.

Age of the household head: The age of the household head is used as a measure of their level of experience in agricultural production because older people are more likely to have more farming experience and resources, as a result, produce more, which lowers the likelihood that their families were going hungry and makes them more resilient to shocks and stresses (Faustine, 2016). However, age may have a detrimental impact on food security, showing that as a household head becomes older, his or her ability to manage difficult farm tasks declines, leading to low farm productivity and production. Young and vivacious family heads are expected to grow larger farms than older and weaker ones, as well as to seek out and get off-farm employment to reduce their level of food insecurity (Faustine, 2016). As a result, this study seeks to stick to the 18 to 65 age range, which is considered to be an active working group where there is a strong positive association between family age increment and food security.

Sex of household head: The gender of the head of the household is a dummy variable that has a value of one (1) for households with male heads and zero (0) otherwise. Since most female-headed households in developing countries have limited access to capital and assets like land, less social regard, fewer employment opportunities, and comparable off-farm activities, female-headed households are expected to have lower food security status than their male-headed counterparts in many development research studies, including food security scholarly investigations (Faustine, 2016). Therefore, when controlling for other confounding factors, male household leaders had a higher likelihood of having access to food than their male counterparts.

Household size: The variable household size's impact on food security is hotly debated in numerous academic works, either favorably or unfavorably. The size of the household may have an impact on

labor availability and food consumption, which may then affect the level of food security in the home. Larger households have a mixed relationship with food security because they require more resources to meet their demands, but some see it as a positive because it means there is a larger labor force available (Abera & Manfred, 2009). Faustine (2016) by synthesizing the opinions of others, claimed contradictory scene about the role of family size in ensuring food security. She noted that in developing countries with a surplus of labor, the marginal productivity of labor is zero, making a small household better off than a larger one, while a larger family size was supposed to contribute to production increases and enable a household to produce more. However, Kidane *et al*. (2005) hypothesized that households with greater labor availability are better positioned to raise the productivity of their land, provided that the available labor force is employed in other income-generating activities, particularly when it comes to subsistence farming. Large family sizes affect food consumption in households by increasing the number of mouths to feed (Meskerem & Degefa, 2015). In general, this research assumes that the size of the family has a negative link to household food security based on the social realities and resources (such as land) that are now in place.

Literacy status of household head: The entire resource production of the household is negatively impacted by literacy level. The introduction, adoption, and use of new agricultural technology are challenging due to the lower level of formal education among households, which has a detrimental effect on food security. The well-being of households is also affected by food security, as uneducated households may react negatively to food safety and quality even when there is a surplus of food. They can also lack the skills necessary to manage their finances or resources to guarantee access to food. Education affects a variety of factors that affect food security, therefore it makes sense that households with educated heads would be more likely to be food secure than those with little to no education.

Land size: The size of the land is a continuous variable. One of the most crucial components and tools for agricultural output is land. For both individuals and households, access to land allows for the production of both food and cash crops. Due to its favorable effects on food availability, the amount of land that a household owns is also a significant determinant of the level of food security in that household. Additionally, in some regions of the nation, land can be leased in exchange for goods or cash, increasing the household's financial resources and improving access to food (Faustine, 2016). As a result, households with more land are probably more likely to have access to enough food than those with less or no land.

Livestock ownership: The quantity of livestock a household has is a continuous variable that measures its level of wealth. According to Kidane *et al*. (2005), having livestock contributed positively to household economics by serving as a source of pulling power, a source of additional revenue, a supply of food, and a mode of transportation. Additionally, livestock is a valuable asset that can provide a reserve that can be turned into cash when needed, especially during periods of low output. The quantity of tropical livestock units (TLU) possessed by households was used to calculate the number of households' livestock holdings. Therefore, households with more livestock have a higher likelihood of experiencing less food insecurity than households with less or no livestock.

Agricultural input use: The term "inputs" refers to the materials required for agricultural production, which include pesticides, improved seeds, fertilizers, building supplies, veterinary preparations, animal feed, breeding stock, planting material, farm implements, and other tools and materials typically used in the industry. Utilizing inputs is meant to raise a household's degree of food security as well as its production and productivity. However, the viability of the farmers is in question given the present price inflation and the fact that Ethiopia imports some of the inputs, like fertilizers and pesticides. The likelihood that a household have access to enough food is positively correlated with fertilizer application (Kidane *et al*., 2005). The research's input variables are assessed in dummy units with a value of 1 if the household uses inputs and a value of 0 otherwise. It is expected that these dummy units were positively correlated with achieving food security.

Occupation diversity: Farmer earnings are diversified and stabilized by off-farm activities, which also provide funds for technology investments and the purchase of essential supplies (Ahmed & Melesse, 2018). According to studies, farm households must have employment in off-farm activities in order to diversify their income sources. This may allowed them to increase their productivity through the use of better technology and make them more resilient to abrupt unforeseen events through food purchases. Off-farm activities are dummy variables; families participating in them assigned a value of 1, while households participating in none did so assigned a value of 0. It is anticipated that households participating in off-farm activities had greater food security than households who do not. According Bitana *et al*. (2023), rural farm households' food security status is significantly and positively influenced by livelihood income diversification activities.

Beehives owned: A continuous variable is the number of beehives a person owns. Production of honey is the primary source of income for households in communities in the study region that are

located near and in forests. The expectation was that household heads who produce honey were able to supplement their food needs, particularly when crop production is unsuccessful, by making money off of the sale of honey and its products. Because of this, beekeeping is regarded as a means of supplying households with food and generating revenue.

Access to credit service: Formal credit services were reported to have significant contribution in improving food security (Shirko, 2023; Hussen & Mohamed, 2023; Bocher *et al.*, 2017).

Annual income: Economic access dimension of the food security is mainly influenced by the cash the household has and the market value of food items. This factor affects food security positively.

Dependency ratio: A variable measured on a ratio scale by dividing the total household size by the number of individuals working to support the household. Given that there are more nonworking members, they exert pressure on consumption rather than production. It is hypothesized that the higher the dependency ratio is, the less the household becomes food-secured (Fekadu & Mequanent, 2010; (Shiferaw *et al.*, 2013).

5.3. Results and Discussion

5.3.1. Descriptive analysis

To assess the prevalence of food insecurity among households and the related coping mechanisms used by these households in response to local food security shocks and stresses, the study included 320 households. According to the descriptive data, 47 families (14.76%) were found to have food security according to the HFIAS access prevalence, whereas the remaining 118 households (36.87%), 119 households (37.11%), and 36 households (11.26%) were determined to have mild, moderate, and severe food insecurity, respectively (Figure 10).

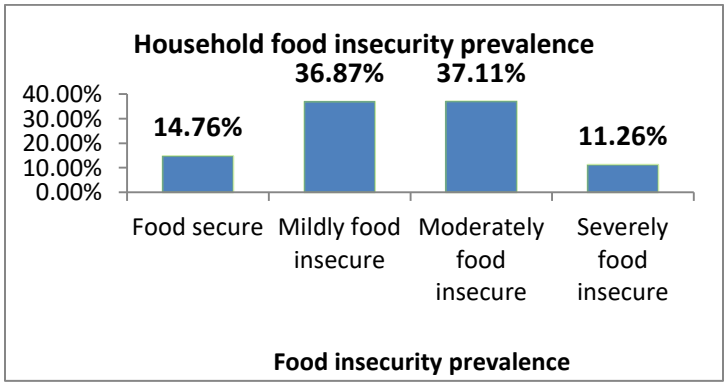


Figure 10 Food insecurity access prevalence for households

The average age of the households was 40.36 years, with the majority of people (66.88%) falling into the middle-aged group, followed by those who were younger (27.81%) or older (5.31%). Comparatively, even though male households make up the majority of the sample (81.88%), more female households (19%) than male households (9.5%) fall into the category of severe food insecurity (x^2= 34.99; df=3; p<0.01). The results of the Ch^2 test revealed a significant (x^2= 142.40; df=9; p<0.01) role for education in predicting the severity of food insecurity, with approximately 87.29% and 83.33% of illiterate individuals experiencing moderate and severe food insecurity, respectively, compared to those who attended formal schooling. On the other hand, 89.36% of people who reported being food secure had gone to school. The average household size is 5 people, with 5 to 7 people making up more than 59% of all population. The percentage of households with severe food insecurity increases from 9.43% to 16% as the average family size tends to increase.

Table 5 Descriptive statistics of continuous demographic and socioeconomic characteristics

Variable description	Obs	Mean	Std. Dev.	Min	Max
Coping Strategy Index Score	320	33.87	28.35	.5	134.5
Age of the Household Head	320	40.36	11.33	18	75
Family Size of the Household	320	5	1.80	1	10
Dependency Ratio (%)	320	108.62	55.23	0	250
Farm size (ha)	320	.59	.397	0	1.75
Tropical Livestock Unit	320	.59	.86	0	4.63
Beehives possessed	320	7.13	15.30	0	65
Credit received (Birr)	320	4382.81	10796.54	0	50000
Gross Income (Birr)	320	43639.41	25752.04	1302.4	97550

Source: Field survey data

Farming activity accounted for the largest part of family income diversity (88.13%), followed by farming and commerce (8.44%), and few households had both farming and work (3.44%). Similarly, approximately 18.75% of the households had access to credit services, while approximately 81.25% of them did not. Although there is generally minimal access to financial services (18.75%), those that did have access to such services continue to have improved food security. Among those who took out loans, 35%, 48.33%, and 16.67% were found to have food security, mild to moderate food insecurity, and moderate to severe food insecurity, respectively. Conversely, 10%, 34.62%, 41.54%, and 13.85% of individuals without access to food continue to experience food security, mild food insecurity, moderate food insecurity, and severe food insecurity, respectively. (x^2=39.70; df=3; p<0.01). The households' average annual gross incomes, landholding, and livestock are 43,639 Birr, 0.59 Hectares,

and 0.59 TLU, respectively. None of the households with more than 1 hectare of agricultural land experienced acute food insecurity; 18.85% of the households with 0.5 or fewer hectares experienced acute food insecurity (x^2=153.57, df=6, p<0.01). On the other hand, the descriptive results demonstrated the existence of a high reliance ratio that significantly contributed to the prevalence of food insecurity and varied from 108% on average to a maximum of 250% (x^2=125.57, df=9, p<0.01). While 80% of the households classified as severely food insecure had a dependency ratio of more than 100%, 97.87% of the households in the food security group did not.

Additionally, both the study area's food consumption pattern (x^2=392.22, df=6, p<0.01) and coping mechanisms (x^2=245.73, df=9, p<0.01) were significantly impacted by the prevalence of food insecurity. In contrast to 75% of poor households and 25% of borderline households, which were judged to have severe food insecurity, the results showed that all households within an acceptable range of FCSs were found to be food secure. In contrast, families with access to enough food employ fewer and milder coping mechanisms on average (14.89%) and more severe coping mechanisms on average (70.21%) than households with a high incidence of food insecurity (94.44%) (Table 6).

Table 6 Chi-square test result of food insecurity access against demographic and socioeconomic variables

Variables	Category	HFIA prevalence				Ch^2 test
		Food secure	Mildly insecure	Moderately Insecure	Severely Insecure	
		N (%)				
Age of household	(18-35)	12 (25.53)	38(31.19)	29(24.58)	10(27.78)	x^2= 2.42
	(36-60)	32 (69.08)	74(62.18)	84(71.19)	24(66.67)	*df*=6
	>60	3(6.4)	7(5.90)	5(4.23)	2(5.55)	*Pr* =0.877
	Total	**47**	**119**	**118**	**36**	
Household Size	(1-4)	15(31.91)	50 (42.02)	31(26.27)	10(27.78)	x^2= 12.92
	(5-7)	32(68.09)	61(51.26)	74(62.71)	22(61.11)	*df*=6
	>8	0(0.0)	8(6.72)	13(11.02)	4(11.11)	*Pr*=0.044
	Total	**47**	**119**	**118**	**36**	
Input use	Yes	21(44.68)	77(64.71)	104(88.14)	0(0.0)	x^2= 51.71
	No	26(55.32)	42(35.29)	14(11.86)	36(100)	*df*=3
	Total	**47**	**119**	**118**	**36**	*Pr*=0.000
Level of education	Illiterate	5(10.64)	32(26.89)	103(87.29)	30(83.33)	
	Elementary	26(55.32)	53(44.54)	11(9.32)	4(11.11)	x^2= 142.40
	Secondary	15(31.91)	24(20.17)	3(2.54)	2(5.56)	*df*=9
	Certificate & above	1(2.13)	10(8.40)	1(0.85)	0(0.0)	*Pr*=0.000
	Total	**47**	**119**	**118**	**36**	
Income source(s)	Farming	40(85.11)	91(76.47)	115(97.46)	36(100)	
	Farming & Trade	5(10.64)	20(18.81)	2(1.70)	0(0.0)	x^2= 30.54
	Farming & Employment	2(4.25)	8(6.72)	1(0.84)	0(0.0)	*df*=6
	Total	**47**	**119**	**118**	**36**	*Pr*=0.000
Credit access	Yes	21(44.68)	29(24.37)	10(8.47)	0(0.0)	x^2= 39.70
	No	26(55.32)	90(7663)	108(91.53)	36(100)	*df*=3
	Total	**47**	**119**	**118**	**36**	*Pr*=0.000
Sex	Male	42(89.36)	114(95.80)	81(68.64)	25(69.44)	x^2= 34.99
	Female	5(10.64)	5(4.20)	37(31.36)	11(30.56)	*df*=3

Variables	Category	HFIA prevalence				Ch^2 test
		Food secure	Mildly insecure	Moderately Insecure	Severely Insecure	
	Total	**47**	**119**	**118**	**36**	*Pr*=0.000
Agri. Land(ha)	0 to 0.5	6(12.66)	41(34.45)	10(91.52)	36(100)	x^2=153.57
	0.5 to 1.0	27(57.45)	60(50.42)	8(6.78)	0(0.0)	*df*=6
	1.0 to 2.0	14(29.79)	18(15.13)	0(0.0)	0(0.0)	*Pr* =0.000
	Total	**47**	**119**	**118**	**36**	
Food consumption	Poor (0-28)	0(0.0)	0(0.0)	10(8.48)	27(75)	x^2= 392.22
	Border (28.5-42)	0(0.0)	6(5.04)	98(83.05)	9(25)	*df*=6
	Accept (>42)	47(100)	113(94.96)	10(8.47)	0(0.0)	*Pr* =0.000
	Total	**47**	**119**	**118**	**36**	
Dependency ratio (%)	0-50	19(40.43)	46(38.65)	7(5.93)	2(5.55)	x^2= 152.86
	51-100	27(57.45)	58(48.74)	25(21.19)	3(8.33)	*df*=9
	101-150	1(2.13)	11(9.24)	51(43.22)	17(42.22)	*Pr* =0.000
	>150	0(0.0)	4(3.36)	35(29.66)	14(38.89)	
	Total	**47**	**119**	**118**	**36**	
CSI	Less severe (score 0-3)	7(14.89)	2(1.68)	0(0.0)	0(0.0)	x^2= 245.73
	Mildly severe (4-12)	33(70.21)	81(68.07)	10(8.47)	0(0.0)	*df*=9
	Moderately severe (13-50)	7(14.89)	34(28.57)	58(49.15)	2(5.56)	*Pr* =0.000
	Highly severe (≥51)	0(0.0)	2(1.68)	50(42.37)	34(94.44)	
	Total	**47**	**119**	**118**	**36**	

Source: Field survey data

5.3.2. The coping strategies of food insecure households

The study's households use 13 consumption-based coping mechanisms and one nonconsumption-based mechanism. Three of these coping mechanisms were ranked as less severe (category 1), four as mildly severe (category 2), four as moderately severe (category 3), and three as severely severe (category 4) based on the focus group discussions. As a result, eating less variety of foods, purchasing food on credit, and reducing portion sizes at mealtimes were given the least severe weights. In addition, relying on less preferred and less expensive foods, borrowing food, and asking a friend or relative for help, reducing the number of meals eaten per day, and feeding working members of the household at the expense of nonworking ones were given mildly severe weights. Moreover, selling an asset, limiting consumption by adults to feed children, gathering wild food, hunting, or harvesting immature crops and sending a household member to eat elsewhere were assigned a moderately severe coping weight. Furthermore, sending household members to beg, consuming seed stock held for next season and skipping meal for the whole day were given the highly severe weight.

The analytical findings showed that food-insecure households typically use consumption-based coping mechanisms that compromise food quality and, to some extent, quantity. The two most often utilized coping mechanisms were consuming a smaller variety of foods and depending more on less desired and cheaper foods, which were both used fairly regularly. On the other hand, sending family members to beg and having them skip the entire day without eating were significantly more common weighted

copings that were used less frequently in the research area. In light of this, the food consumption score results demonstrated that due to their affordability and accessibility, maize and sorghum are commonly consumed foods. Some of the participants in the focus groups claimed that renting out or selling all or a portion of their agricultural land to pay for food during hard times is a commonly used coping mechanism. In addition, households often gather wild items, including leafy vegetables, root crops, forest honey, and hunted meat from pigs and antelopes, during times of extreme food stress. Locals are usually harvested crops such as "*Acho*", a leafy vegetable, and "*Shakoy*", a root crop.

5.3.3.Results of the ordered logit analysis

Based on readings of related papers and discussions with key informants in the study region beforehand, the research modeled 14 explanatory variables and a categorical response variable. Four of these factors had statistically significant effects on the prevalence of food insecurity in households in the research area. The link test and the log likelihood ratio (LR) test were used in postestimation testing to confirm the model's goodness-of-fit. As _hat was transformed into a highly significant variable ($p<0.01$) and _hatsq was not ($p=0.259$), the link test results showed that no transformation was needed. The LR test also revealed that the model could accept the covariates well ($chi^2=-169.013$, $p<0.01$). Additionally, robust logistic regression was used to reduce the impact of any potential heteroscedasticity. While household food insecurity incidence was negatively and significantly influenced by the variables of food consumption score, agricultural landholding, access to credit services, and gross annual income, the level of coping strategies had a positive and significant impact on the food insecurity status of households (Table 7).

The primary industry on which subsistence farmers rely to produce food and make money is agriculture. Diverse income sources enable the purchase of improved agricultural inputs to boost agricultural production and productivity. This variable takes into account the revenue from the production of crops, animals, apiary operations, and off-farm sources. The amount of food insecurity in households was considerably and significantly ($p<0.01$) influenced by agricultural income, as predicted to have a negative impact. When other parameters are held constant, a rise in income of one unit results in a 0.9999 reduction in the likelihood of falling into one of the more severe categories of food insecurity. The prevalence of food insecurity access and household income have a very strong and negative correlation (-0.8293). The findings of this study are consistent with those of Awoke *et al.*, (2022), Girum, 2016, and Hussein & Janekarnkij (2013), all of whom found that income has a favorable and significant impact on rural households' access to food.

The amount of arable land a household has is also the fundamental asset that determines its position in terms of collective food security. At the 10% likelihood level, the size of the land held has a negative and significant impact on the household's prevalence of food insecurity. A negative sign indicates that households with larger farms are more likely to have access to enough food than are those with smaller farms or no larger farms. In the absence of any other changes, a hectare increase in landholding permits a decrease in food production. Several studies (Assefa & Abide, 2023; Woleba *et al*., 2023; Muluneh, 2021; Mequanent & Esubalew, 2015) have claimed that positive contributions from land have been made to enhancing the food security of households.

By offering financial services to the agricultural sector, production is improved, and inputs may be purchased and used more effectively. The analysis's findings supported the initial hypothesis that having access to credit can reduce the likelihood of food insecurity. A negative coefficient indicates that there is an inverse association between the prevalence of food insecurity and the accessibility of credit services. At a likelihood level of less than 10%, the use of credit services was shown to be significant. According to the odds ratio, if all the other variables remain constant, expanding access to credit services reduces food insecurity by a factor of 0.4652. The work of researchers such as Woleba *et al*. (2023 and Muluneh (2021) has confirmed that financial support does play a role in reducing household food insecurity.

Table 7 Ordered logistic regression analysis of household food insecurity prevalence

Variables	Coef.	Robust Std. Err.	Odds ratio
Tropical livestock unit	.2499	.1804	1.2839
Beehives owned	.0005	.0098	1.0006
Gross annual income	-.00007***	.00001	.9999
Dependency ratio	.1792	.2100	1.1962
Age category	.0911	.3521	1.0954
Household size	-.1709	.3488	.8429
Agri. Landholding	-.4669*	.2722	.6269
Sex of household head	.6662	.4649	1.9468
Level of education	.2705	.2486	1.3106
Occupation of household	-.1778	.3228	.8371
Access to credit service	-.7653*	.4009	.4652
Use of improved inputs	-.1467	.4270	.8636
/cut1	-11.0198	1.7244	-7.6399
/cut2	-6.0622	1.6879	-2.7538
/cut3	.5671	1.6864	3.8724

Number of obs = 320	Log pseudolikelihood = -169.6646
LR chi^2(2) =470.46	Pseudo R^2 = 0.5803
_hat (Pr=0.000)	Wald chi^2(14) = 193.23
_hatsq (Pr=0.259)	Prob > chi^2 = 0.0000

Source: Field survey data *Note: ***p<0.01; ** p<0.05 and * p<0.1*

5.4. Conclusion and Recommendations

This study was conducted to address the presumptions that food insecurity is alarmingly common and that households use a range of coping techniques when faced with challenging conditions. The results indicated a significant incidence of food insecurity, with households falling into all of the categories with variable degrees of prevalence. The majority of the families were categorized as mildly or moderately food-insecure households, with a small number falling into both the food-secure and severely food-insecure categories. According to the study, factors that negatively influence the occurrence of food insecurity include increasing food consumption, owning relatively extensive and fertile farmland, engaging in a variety of revenue-generating activities for a higher annual income, and having access to credit services. Nevertheless, rural land is becoming more limited due to demographic and socioeconomic limiting factors, so it is logical to diversify productive revenue activities by encouraging off-farm and nonfarm work options.

Again, in response to the shortage of food availability and access, households frequently make decisions by adopting a variety of consumption-soothing strategies to fill the food gap. The findings revealed that a pattern of shifting coping strategies from less severe to highly severe domains is a sign of an escalation in household food insecurity challenges. Therefore, a strategy for reversing some coping mechanisms, including renting or selling assets such as commercializing land to meet food demands, needs to be developed so that households are best positioned to engage in production activities as a long-term response to the onset of food crises rather than as either selling or renting as an immediate solution. Similarly, improving the preservation and appropriate use of forest resources, a key coping mechanism through the availability of wild edible plants, forest honey, and animals, would ensure Majang communities' access to food and expand their consumption stably. Therefore, it is necessary to establish appropriate legislative measures to limit open land access and commercialization, including implementing community participatory forest management practices to make use of the opportunities where the natural resources present are key recommendations.

CHAPTER SIX: SYNTHESIS OF THE MAJOR FINDINGS, CONCLUSIONS, IMPLICATIONSAND FUTURE RESEARCH AREAS

6.1. Introduction

This dissertation was designed to address food system and food security issues in the Majang Zone that were organized into four major objectives ordained under the title “Analysis of the food system drivers, food security, and resilience situations in the Majang Zone, Southwestern Ethiopia." In line with each objective, it has proven hypothetical assumptions and questions by applying specific analytical methods. In general, the dissertation engaged its capacity to answer the questions of which food system drivers mainly affect its food and nutrition security outcomes. Among these identified drivers, which were identified to have contributed to determining food security and the resilience capacity of the households in the study area? Furthermore, the options available to families facing severe food insecurity conditions and how frequent and severe these coping alternatives were the delimits of the dissertation. The following objectives were formulated and tested:

- ☞ Identify and analyze the main drivers of the food system that affect food and nutrition security outcomes in the study area.
- ☞ Examine the food security status and factors determining in the study area
- ☞ Evaluate the resilience status of households to food insecurity in the study area
- ☞ Investigate the coping strategies employed by food insecure households in the study

6.2. Major findings of the research

i. Which food system drivers and pressures mainly affect the food and nutrition security outcome conditions? (Chapter 2)

The result of the preliminary assessment that was presented in Chapter 2 of this dissertation showed how seriously those local food system driving factors and pressures interfered with efforts to improve the community's food security condition and standard of living. Among the factors, intense deforestation-led land use, land cover change, climate change, population increase, corrupt administration, less productive agriculture, the absence of locally adjusted land administration and governance policies and proclamations, low educational quality, poor health coverage, poor infrastructure and services such as credit and market institutions, and natural factors such as climate change-induced challenges were the main factors driving the food system of the communities.

The high deforestation rate, which led to the conversion of 70% of the forest cover in 1985 to 49.7% in 2018, according to Girma & Muluneh (2021), directly impacts the food security and income of the local community through the loss of biodiversity that is a source of food for man and indirectly through its effect on soil degradation and alteration of the weather elements, which in turn reduce agricultural productivity. Particularly, the indigenous local communities are highly affected by forest loss as the income. It was reported that the significance of the forest for local communities shown too high to which contributes 90.85% of the total income and have a long history of the link between the livelihood and forest (Fekadu *et al*., 2021). The population increase accelerated by the influx of people to the area is putting pressure on natural resources, including land, and contributing to extensive settlement and urbanization. Moreover, the traditional way of agricultural production driven by such drivers of the food system has further worsened food security and nutrition conditions. Poor road access, unsatisfactory market linkage, limited access to electric and communication services, and few and poorly functioning social institutions such as cooperatives and microfinance institutions have not been bringing about the desired outcome.

ii. Which factors determine the food security situation in the study area? (Chapter 3)

The study that aimed at identifying the factors that determine the food security status of households, discussed in Chapter 3 of the dissertation, enabled us to sort out the key variables. Accordingly, attending formal education, engaging in more than economic activities, having more active working household members, adopting improved production practices and use of inputs, accessing credit and involving cooperatives, possessing large farm sizes, keeping different breeds and numbers of livestock, and owning more traditional beehives contributed positively to becoming more food secure comparatively. Nevertheless, although these variables had significant contributions, their coverage and services remained below average. For instance, looking into some relevant and positive contributing factors, only 39%, 27%, and 33.75% of the households studied had access to extension services, attended formal education, and plowed their farmland using oxen, respectively.

iii. How the resilience capacity of the households is affected by the stress factors? (Chapter 4)

The third objective that aimed at measuring the resilience capacity of the study households in Chapter 4 of the dissertation has indicated that among the 320 respondents under study, 47.5% and 12.19% of the households were categorized as non-resilient and mildly resilient, summing the vulnerable groups

into 60%, and only 40% of them remained resilient. The weak resilience in households is driven by the underlying factors identified by the food system's assessment work in Chapter 2, not ignoring other factors that may have contributed. Loss of biodiversity directly affects the lives of the community by diminishing food access and putting pressure on the abundance of NTFPs, the major livelihood source of the local community. The amount and variety of traditionally produced honey, one of the major NTFP-based income sources, are affected by the loss of plant flora due to deforestation. Besides traditionally managed and low-productive agriculture, the factors that directly affect resilience capacity include engaging in limited income-generating activities, poor off-farm employment, malfunctioning institutions, poor infrastructure, and policy gaps. The low input utilizing agriculture that suffers from pre- and postharvest pest attacks, is hit by climate change-induced weather variability, and is constrained by improved production techniques has remained very low in productivity. As the crop sub-sector did, the livestock production segment faced challenges of not being backed up by breed improvement, medication and vaccination, feeds, and related management drawbacks.

iv. How the households respond to or cope with severe food insecurity condition? (Chapter 5)

Furthermore, the research outcome that addressed the food insecurity prevalence and coping strategy nature of the households in Chapter 5 confirmed the existence of only 14.76% of those who were food secure, leaving 36.87%, 37.11%, and 11.26% of the households as mildly, moderately, or severely food insecure, respectively. Besides, 2.81%, 38.75%, 31.56%, and 26.87% of these food-insecure households tended to implement diverse coping strategies that put them in less severe, mildly severe, moderately severe, and highly severe copings, respectively. These households respond to severe food insecurity by implementing diverse coping strategies, including dietary changes such as reducing the variety of foods they usually take and relying more on less desired and cheaper foods, which are both used fairly regularly. Selling and contracting assets such as poultry and farmland, making pottery, collecting wild edible plants such as root crops, leafy vegetables, fruits, and spices, and collecting wild honey were also used to skip crisis conditions. Rationing strategies such as limiting the portion size and reducing the number of meals eaten are usually implemented while skipping the entire day without food is a rare phenomenon. Severe coping mechanisms like begging are hardly exercised, as it is uncommon in the culture of the Majang community.

6.3. Key issues emerging from the findings

Therefore, although there have been efforts to improve the food system and security conditions thereby building the capacity to withstand shocks and stresses by implementing some development interventions such as the adoption of conservation agriculture (CSA), registration of the local forest at UNESCO as "Majang Forest Biosphere Reserve," profiling the quality of the coffee product as "organic forest coffee," and initiation of cooperatives working on honey and other income-generating activities through credit provision, based on the results of the dissertation the following areas of development need a strong link among the development sectors, policymakers, and nongovernmental sectors to aggressively and strategically work to improve the current and future food system and food security conditions.

The agriculture sector (crops, livestock, and apiculture), which is the dominant food basket, requiring immediate adjustments in terms of production and productivity enhancement. Adoption of research and extension package-bound agro-ecologically and socio-culturally proven innovative technologies such as improved varieties, fertilizers, productive breeds, medications, and vaccines with their added complements is a timely recommendation of this dissertation. Small-scale irrigation production is also another segment that has to be worked on, as the area has ample potential for irrigable rivers and land terrain. Irrigation production particularly of vegetable crops to diversify nutritional needs and able to generate more income from large volume, high-value and market demanded crops, and the potential of producing for more than three times per annum is worth to note. Equally crucial is improving the productivity of the apiculture sector, as it is the largest NTFP income-generating activity for the Majang community. The Majang are accustomed to climbing to more than 50 meters of trees to hang and collect honey, a situation that usually exposes them to life-threatening falls besides its low productivity. Hence, packages that minimize danger and improve productivity, such as using modern beehives, need to be put in place. The extension services, besides strengthening in the introduction and adoption of emerging agricultural technologies, must firmly work on attitudinal and cultural shifts that change the ways traditional apiary activities improved and modern way of productions gradually introduced.

In connection with NTFP production, the forest is the sole source of economic activity. In this regard, implementing participatory and sustainable forest management and utilization, land certification, and above all, land administration and governance strategies and laws is an essential deed. Improving the

infrastructural and social service sectors is also believed to play a key role. Implementing life-supporting programs such as rural safety nets is also important in spots where the severity of food insecurity is found to be high to reduce adopting life-jeopardizing coping strategies such as selling assets (land and forest) as an alternative. Last but not least, installing early warning systems and response mechanisms to mitigate the damage caused by both natural and human-induced shocks and stresses requires due consideration. The reception, organization and dissemination of daily metrological information and data; and regular documentation of events including unforeseen ones for later planning alternative interventions and trend analysis is required.

6.4. Implications of the study

The overall research result implies that a multi-sectorial and multi-discipline coordinated effort is required to respond to existing food system drivers and pressures effect, bring improvements to those important determinant factors governing food security, thereby build the resilience capacity, and reduce the options households implement in conditions of severe food insecurity.

The adoption of rural land use, governance, and administration policies and laws must contextualize and incorporate the local communities' intent and culture and address the mutual interests of both the government and the communities targeting the sustainable utilization and protection of natural resources. Alignment is required among emerging food security projects and programs of either government-run or non-government organizations managed with the government's policies and strategies in line to the priori needs of the communities, preferably centering those identified drivers of the food system (Chapter 2). Further, as it has been witnessed from the output of the assessment work, apart from bounded by several driving factors, the local food system are not well developed and organized into value-chains for important commodities. Therefore, profiling and initiating value-chain development on selected agricultural commodities, preferably on food items and NTFPs, is a timely takeoff that can strengthen the income thereby the food and nutrition security segment of the food system.

The result further indicated that the number of farmers' training centers and health posts were found constructed in almost all villages but with limited services. Hence, revisiting this is a timely task to the government. Targeting on some of the potential villages based on needs and resources available and capacitating them for full-fledged functioning that can be recommended and scaled out to the other villages. It was seen that those few farmers using inputs and applying improved agricultural

technologies such as oxen plowing (Chapter 3) had better position of food security status, therefore replicating these practices through strong extension approach is important. It was indicated that development interventions aiming at increased income diversification, improved supply of fertilizer, increasing land and livestock productivity had significantly contribute to the attainment of food security (Fekadu & Mequanent, 2010). The extension service and research centers have to work integrally to test and apply emerging technologies and their recommendations in this regard. A policy sphere that strengthens the establishment of service-providing institutions such as veterinary services, inputs for both crops and livestock and rural financial institutions deserves due attention for that they have had positive response towards food security attainment. The government has to encourage the involvement of private sectors to the industry by providing incentives. Moreover, supporting and encouraging the communities to deploy on diverse income generating activities and develop the habit of saving and accumulating assets, both in cash and kind, as a long-term solution to survive severe conditions and build resilient than selling their assets as a coping method are ways forwarded based on the results obtained (Chapter 4 and 5).

6.5. Overall conclusions

The research, with its aforementioned limitations in consideration, has answered to the raised questions in the four chapters (Chapter 2 to 5) to finally come to conclusions. Therefore, addressing the issues of the key food system drivers, investing on the key determinant factors of food security and insecurity and thereby enhancing the resilience capacity of the households is the whole tale the conclusions are all about. The following overall conclusions are drawn from the findings of the dissertation.

Food system encompass broad area of activities that surrounded by environment interacting and shaping the activities for its outcome, in our case the food and nutrition outcome. The study concludes the communities, the government and development partners address the issues linked to the socio-cultural; bio-physical and environmental; innovational, technological and infrastructural; political and economic, and demographic drivers identified. Besides, the planning and implementation tasks have to center those significant factors determining the food security in the study area. The extension services with its aim of receiving, testing, and disseminating technologies; encouraging service delivering institutions such as rural credit and saving, veterinary services, crop inputs; and infrastructure development such as rural electrification, telecom services, and rural roads are key areas of interventions. Given the food system and food security issues potentially dealt with a coordinated and

integrated manner the underlying factors dictating the resilience capacity and conditions that force the households to go for undesired copings be gotten better-off concurrently.

6.6. Limitations of the current study and areas for Future research

In undertaking this dissertation work, both perceived and unforeseen limitations were encountered. Methodologically, the research lays its unit of analysis, guided by the livelihood classification of Ethiopia, at households' level irrespective of the perceived livelihood variations existed between the indigenous Majang community and the so-called "highlanders". The dominant livelihood of the Majang are connected with non-timber forest products together with experience of shifting cultivation of cereals such as maize and sorghum on small plots, and growing root crops and leafy vegetables around their homesteads. They seldom handle livestock production except poultry. But, the highlanders dominantly depend on sedentary agriculture growing food crops such as cereals, vegetables, fruits, and coffee. They have the habit of keeping livestock, both large and small ruminants, donkeys, and poultry but little attached apiary activity. A study by Fekadu *et al*. (2021), in an area characterized by similar livelihood, showed that while forest provides the largest food and income for the indigenous community, a considerable income for the new resettled community coming from elsewhere in the area was observed non-forest income. The constraint of COVID-19, time and finance might have limited the number of sample villages and households particularly those located at the borderline, and may be experiencing more severe food security conditions. While conducting the research, we observed issues of a shift in access and consumption of pattern of the Majang community, an issue that did not addressed by this research. Another limitation of the research work is that the use of few food security measuring indices that target only the access and utilization leaving the availability dimension. The food system drivers' assessment (Chapter 2) also did not incorporate the food system activities as part of the analysis making it incomplete to recommend about the whole food system given specific value-chains were not studied.

The research area is endowed with abundant resources—some call it an area of green famine—that can feed beyond the community with development endeavors and some policy gaps that have been filled. Among the suggested future lines of work:

- Researching on similar topics to further strengthen the findings or make adjustments to the existing knowledge to increase its wider replication and application;

- It is also suggested that comparative research be undertaken between the indigenous Majang community and those of the so-called highlanders, for they likely have sociocultural and socioeconomic distinctions;
- An independent food system based study that address the whole system as a unit of analysis is required to have comprehensive recommendation about the local food system;
- Initiating research on dietary changes occurring over time in the Majang community as their strong attachment to forest-product-based livelihoods is shifting.

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Appendix

Appendix table 1 Questionnaire on socio-economic characteristics of the respondent households

No	Description	Possible answer options						
	Name of village							
	Age of the household head							
	Religion	Orthodox	Muslim	Catholic	Protestant	Others		
	Marital status	Single	Married	Divorced	Widowed			
	Household size	Male	Female	Total				
	Education level of household	Attended formal education	Not attended formal education					
	Number of household members with age of 65 and above							
	Number of household members with age of below 15							
	Number of household member(s) with disability							
	Number of household member(s) with serious illness							
	Occupation of the household head	Agriculture (1)	Trade(2)	Agriculture and trade				
	If others (specify)							
	If farming is your major occupation, which activities?	Crop (1)	Animal(2)	Beekeeping(3)	1&2	1&3	2&3	All
	If crop production your activities, which crops do you produce?	Cereals ☐	Pulses and oil crops ☐	Coffee ☐	Fruit ☐	Vegetables ☐	Spices ☐	
	Others, list them….							
	Do you have agricultural land?	Yes ☐	No ☐					
	If yes, what is your land holding size in hectare?							
	How much ha of this is suitable for farming?							
	Do you have coffee farm?	Yes ☐	No ☐					
	• How many hectares?							
	• How much of it is harvestable?							
	How many quintals do you harvest per hectare per year for each?							
	• Cereals							
	• Fruits							
	• Vegetables							
	• Legumes/Oil crops							
	• Spices and condiments							
	• Coffee							
	How many quintals of each do you sold in the past cropping year?							
	• Cereals							
	• Fruits							
	• Vegetables							
	• Legumes/Oil crops							
	• Spices and condiments							
	• Coffee							
	What is the selling price (birr) of a kilogram each commodity?							

No	Description	Possible answer options	
	• Cereals		
	• Fruits		
	• Vegetables		
	• Legumes/Oil crops		
	• Spices and condiments		
	• Coffee		
	Do you own/keep/ livestock?	Yes ☐	No ☐
	If yes, how many of each of the following do you have?		
	• Cows/oxen		
	• Milking cows		
	• Poultry		
	• Sheep		
	• Goats		
	• Equines		
	If you have milking cow(s)		
	• How many liters are lactated per day per cow?		
	• How much of the milk product is sold?		
	• What is the selling price of a liter of milk?		
	If you possess poultry		
	• How many laying hens do you have?		
	• How many eggs are collected per day		
	• What is the selling price of an egg?		
	Do you have beehives?	Yes ☐	No ☐
	Number of modern beehives		
	• Kilograms of honey collected per hive per one round		
	• No of rounds honey is collected in a year		
	• Price of a kilogram of honey		
	Number of traditional beehives		
	• Kilograms of honey collected per hive per one round		
	• No of rounds honey is collected in a year		
	• Price of a kilogram of honey		
	Is there a farmers' training center in your village?	Yes ☐	No ☐
	If yes, are you getting agricultural extension service?	Yes ☐	No ☐
	Do the DAs provide trainings and regular supervisions?	Yes ☐	No ☐
	What else capacity building trainings do you get in the past one year?		
	Do you use oxen to plow your farmland?	Yes ☐	No ☐
	Do you get veterinary services in your locality?	Yes ☐	No ☐
	To avoid crop loss, do you apply chemical pesticides (PES)?	Yes ☐	No ☐
	Regarding the following what is your response?		
	• Use of artificial insemination	Yes ☐	No ☐
	• Application of chemical fertilizer use	Yes ☐	No ☐
	• Preparation and application of organic fertilizer	Yes ☐	No ☐
	• Irrigation use	Yes ☐	No ☐
	• Use of improved seed	Yes ☐	No ☐
	• Use of modern beehives	Yes ☐	No ☐
	• Do you practice crop diversification	Yes ☐	No ☐
	• Do you practice intercropping	Yes ☐	No ☐
	• Do you plow your farm with oxen	Yes ☐	No ☐
	• Do you apply mulch	Yes ☐	No ☐

No	Description	Possible answer options	
	• Do you use small scheme irrigation	Yes ☐	No ☐
	• Do you have separate cattle house	Yes ☐	No ☐
	• Do you crop storage house/"Gotera"	Yes ☐	No ☐
	Indicate the number of income sources available to your household		
	Do you have access to Credit Service?	Yes ☐	No ☐
	What is your on-farm income?		
	What is your off-farm income?		
	Are you the user of microfinance institutions?	Yes ☐	No ☐
	Is your landholding certified?	Yes ☐	No ☐
	Do you possess the following assets?		
	• Mobile phone	Yes ☐	No ☐
	• Table	Yes ☐	No ☐
	• Bed with sponge mattress	Yes ☐	No ☐
	• Television and satellite dish	Yes ☐	No ☐
	• Motorbike	Yes ☐	No ☐
	• Jewelry	Yes ☐	No ☐
	• Radio	Yes ☐	No ☐
	• Jepass	Yes ☐	No ☐
	What is the distance in minute of the source of potable water for human?		
	What is the distance in minute of the nearest wither road?		
	What is the distance in minute to the secondary school?		
	What is the distance in minute to the high school?		
	Do you have access of telecommunications?	Yes ☐	No ☐
	Do you have access of electricity service?	Yes ☐	No ☐
	Is there a household with worrisome health condition?	Yes ☐	No ☐
	If yes, how many?		
	How frequent you or any family member visits health services per year?		
	Is there a household with disability?	Yes ☐	No ☐
	If yes, how many?		

Appendix table 2 Standard food consumption score data gathering questionnaire

How many days in the past week your household has eaten the following foods?

No	Food groups	Food items	Weight	No. of days eaten over the past 7 days	Source of foods	
					Own production	Others (purchase, aid, borrowed etc.)
1.	Grains	Made of Maize	2			
		Made of Teff				
		Made of Wheat				
		Made of Rice				
		Made of Sorghum				
2.	Tubers	Enset (Kocho)	2			
		Potatoes				
		Sweet potatoes				
		Cassava				
		Yam (*kachi*)				
3.	Vegetables and leaves	Cabbage	1			

No	Food groups	Food items	Weight	No. of days eaten over the past 7 days	Source of foods	
					Own production	Others (purchase, aid, borrowed etc.)
		Carrot and related				
4.	Pulses	Bean	3			
		Groundnut				
		Pea				
		Haricot bean				
5.	Fruits	Avocado	1			
		Pineapple				
		Orange				
		Papaya				
		Banana				
6.	Meat and fish	Meat	4			
		Egg				
		Fish				
7.	Milk related	Milk	4			
		Yoghurt				
		Powder milk				
8.	Sugar related	Sugarcane	0.5			
		Sugar				
		Honey				
9.	Oil and fat	Butter	0.5			
		Processed oil				
	Total					

Thresholds

Poor	1-28	An expected consumption of staple 7 days, vegetables 5-6 days, sugar 3-4 days, oil/fat 1 day a week, while animal proteins are totally absent
Borderline	28.1 -42	An expected consumption of staple 7 days, vegetables 6-7 days, sugar 3-4 days, oil/fat 3 days, meat/fish/egg/pulses 1-2 days a week, while dairy products are totally absent
Acceptable	> 42	As defined for the borderline group with a greater number of days a week eating meat, fish, egg, oil, and complemented by other foods such as pulses, fruits, milk

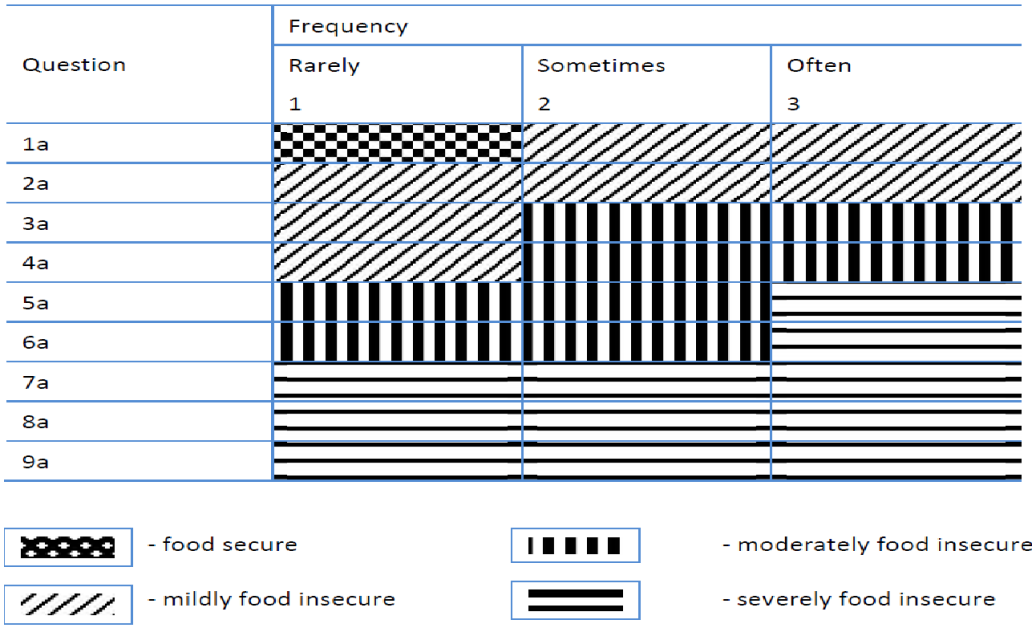
Appendix table 3 Standard household food insecurity access scale data gathering questionnaire module

	HFIAS generic questions	Response options	Code
1.	In the past four weeks, did you worry that your household would not have enough food?	0 = No (skip to Q2) 1=Yes	….|___|
1.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
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 (skip to Q3) 1=Yes	….|___|

	HFIAS generic questions	Response options	Code
2.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No (skip to Q3) 1=Yes	….|___|
3.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q3) 1=Yes	….|___|
4.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q3) 1=Yes	….|___|
5.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
6.	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q3) 1=Yes	….|___|
6.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
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 (skip to Q3) 1=Yes	….|___|
7.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q3) 1=Yes	….|___|
8.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
9.	In the past four weeks, did you or any household	0 = No (skip to Q3)	….|___|

	HFIAS generic questions	Response options	Code
	member go a whole day and night without eating anything because there was not enough food?	1=Yes	
9.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|

Appendix table 4 **Categories of food insecurity**



Appendix table 5 Generic List of Coping Strategies

No	*In the past 30 days, if there have Relative Frequency been times when you did not have enough food or money to buy food, how often has your household had to:*	**Relative Frequency**					*Severity Ranking*	*Score*
		All the time? Every day	*Pretty often? 3-6 */week*	*Once in a while? 1-2 */week*	*Hardly at all? <1 */ week*	*Never 0*/week*		
1.	***Dietary Change***							
A	Rely on less preferred and less expensive foods?							
B	Consume less variety of food?							
2.	***Increase Short-Term Household Food Availability***							
C	Borrow food from a friend or relative?							
D	Purchase food on credit?							
E	Depend on aid from outside the household?							
F	Use part of savings to buy food?							
G	Send children to work for food?							
H	Sell assets to buy food?							
I	Reduce health or education expenditure to buy food?							
J	Skip a loan payment?							
K	Gather wild food, hunt, or harvest immature							

No	*In the past 30 days, if there have Relative Frequency been times when you did not have enough food or money to buy food, how often has your household had to:*	**Relative Frequency**					*Severity Ranking*	*Score*
		All the time? Every day	*Pretty often? 3-6 */week*	*Once in a while? 1-2 */week*	*Hardly at all? <1 */ week*	*Never 0*/week*		
	crops?							
L	Consume seed stock held for next season?							
3.	***Decrease Numbers of People***							
M	Send children to eat with neighbors?							
N	Send household members to beg?							
4.	***Rationing Strategies***							
O	Limit portion size at mealtimes?							
P	Restrict consumption by adults in order for small children to eat?							
Q	Feed working members of HH at the expense of non-working members?							
R	Ration the money you have and buy prepared food?							
S	Reduce number of meals eaten in a day?							
T	Skip entire days without eating?							
	Total							

Appendix table 6 **Some of the definitions of resilience described by different organizations**

Organization	Year	Definition
TANGO International Inc.	2012	The ability of countries, communities, and households to efficiently anticipate, adapt to, and/or recover from the effects of a potentially hazardous occurrences (natural disasters, economic instability, conflict) in a manner that protects livelihoods, accelerates and sustains recovery, and supports economic growth
USAID	2012	The ability of people, households, communities, countries, and systems to mitigate, adapt to, and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth
DFID	2011	Disaster Resilience is the ability of countries, communities and households manage change, by maintaining or transforming living standards in the face of shocks or stresses such as earthquakes, drought or violent conflict – without compromising their long-term prospects
IFRC	2012	The ability of individuals, communities, organizations, or countries exposed to disasters and crises and underlying vulnerabilities to: anticipate, reduce the impact of, cope up with, and recover from the effects of adversity without compromising their long-term prospects
UNDP	2013	A transformative process of strengthening the capacity of women and men, communities, institutions, and countries to anticipate, prevent, recover, adapt, and/or transform from shocks, stressors, and change
EU	2016	The ability of an individual, a household, a community, a country or a region to withstand, to adapt, and to quickly recover from stressors and shocks
FAO	2013	The ability to prevent disasters and crises as well as to anticipate, absorb, accommodate or recover from them in a timely, efficient and sustainable manner. This includes protecting, restoring and improving food and agricultural systems under threats that impact food and nutrition security, agriculture, and food safety/public health
Resilience Measurement Technical Working Group	2014	The capacity that ensures stressors and shocks do not have long-lasting adverse development consequences
Lutheran World Relief (LWR)	2016	The capacity of a system (e.g., a community) to absorb the impacts of shocks and stressors, to adapt to change and to potentially transform, in a manner that enables the achievement of development results (e.g., sustainable livelihoods, well-being, poverty alleviation)
Barrett and Costas	2013	Development resilience is the capacity over time of a person, household, or other

Organization	Year	Definition
		aggregate unit to avoid poverty in the face of various stressors and in the wake of myriad shocks. If and only if that capacity is and remains high, then the unit is resilient
Mercy Corps	2015	The capacity of communities in complex socio-ecological systems to learn, cope, adapt, and transform in the face of shocks and stressors
Oxfam	2015	The ability of women and men to realize their rights and improve their well-being despite shocks, stressors, and uncertainty
Rockefeller Foundation	2017	The capacity of individuals, communities, and systems to survive, adapt, and grow in the face of stress and shocks, and even transform when conditions require it
Tulane University		The capacity of the affected community to self-organize, learn from, and vigorously recover from adverse situations stronger than it was before
OECD	2014	The ability of households, communities, and nations to absorb and recover from shocks, whilst positively adapting and transforming their structures and means for living in the face of long-term stressors, change, and uncertainty
Béné, C., Frankenberger, T., & Nelson, S.	2015	The ability of individuals, households, communities, institutions or higher level systems to adequately deal with shocks and stressors, where the terms ‘‘adequately” refers to the ability to avoid short and longer term negative impacts
The Ethiopian Humanitarian Country Team	Undated	The ability of countries, communities, and households to anticipate, dapt to, and recover from the effects of hazards (natural disasters, economic stability, conflict) in a way that protects livelihoods, accelerates and sustains recovery, and supports economic and social development.

Appendix table 7 Component loadings of variables used to estimate the IFA component

Variables	Component loadings
	1
Food Consumption Score	0.6081
Household Food Insecurity Access Score	-0.5896
Total income (birr)	0.3590
Amount of credit received (birr)	0.3922
Eigenvalue	2.31
Variance (%)	57.88
Cumulative (%)	57.88

Source: own survey results.

$$IFA = 0.5788 * Factor\ 1 \ldots\ldots\ldots\ldots\ldots \text{(Eq. 8)}$$

Appendix table 8 Component loadings of variables used to estimate the AP component

Variables	Component loadings			
	1	2	3	4
Agricultural land holding (ha)	0.4786			
Livestock ownership (TLU)	0.4390			-0.4532
Mobile phone possession (yes=1)	0.3299			
Possession of table (yes=1)	0.4361			
Possession of bed with sponge mattress (yes=1)	0.4395			
Possession of television and dish (yes=1)		0.6354		
Possession of motorbike (yes=1)		0.7470		
Possession of jewelry (yes=1)			0.3259	
Possession of radio (yes=1)			0.5620	
Possession of gepass (yes=1)			0.7463	
Traditional beehive (number)				0.8155
Eigenvalue	3.254	1.395	1.248	1.179
Variance (%)	29.59	12.69	11.35	10.72
Cumulative (%)	29.59	42.27	56.63	64.34

Source: own survey results.

$$AP = [0.2959 * Factor\ 1 + 0.1269 * Factor2 + 0.1135 * Factor3 + 0.1072 * Factor4]/4 \ldots..$$ (Eq. 9)

Appendix table 9 Component loadings of variables used to estimate the AC component

Variables	Component loadings	
	1	2
Sex of household head (male=1)	0.4823	
Marital status of household (married=1)	0.3473	
Education of household head (years)	0.4905	
Number of income sources	0.5156	
Dependency ratio (inactive/active)	-0.3719	0.3136
Household size (number)		0.6231
Age of household head (years)		0.5750
Eigenvalue	2.25	2.11
Variance (%)	32.31	30.12
Cumulative (%)	32.31	62.40

Source: own survey results.

The equation for estimating the AC latent variable is:

$$AC = [0.3231 * Factor\ 1 + 0.3012 * Factor\ 2]/2 \ldots\ldots\ldots\ldots\ldots..$$ (Eq. 10)

Appendix table 10 Component loadings of variables used to estimate the ABS component

Variables	Component loadings		
	1	2	3
Distance to potable water (minutes)	0.4308		
Distance to nearest wither road (minutes)	0.4494		
Distance to secondary school (minutes)	0.5133		
Distance to high school (minutes)	0.5073		
Access to telecommunication service (yes=1)		0.7221	
Access to electric service (yes=1)		0.6391	
Access to rural credit service (yes=1)			0.4906
On-farm visit by Das (frequency/month)			0.8660
Eigenvalue	2.987	1.550	1.155
Variance (%)	37.26	19.36	14.56
Cumulative (%)	37.26	56.63	71.19

Source: own survey results.

$$ABS = [0.3726 * Factor\ 1 + 0.1936 * Factor\ 2 + 0.1456 * Factor\ 3]/3 \ldots\ldots\ldots\ldots$$ (Eq. 11)

Appendix table 11 Component loadings of variables used to estimate the incidence of the ATA component

Variables	Component loadings		
	1	2	3
Exercising crop diversification (yes=1)	0.3669		
Use of chemical pesticide (yes=1)	0.4288		
Application of organic fertilizer (yes=1)	0.4633		
Practicing crop intercropping (yes=1)	0.4522		
Crop storehouse/'Gotera' (yes=1)	0.3263		
Ploughing farm with oxen (yes=1)		0.3722	
Use of improved seed (yes=1)		0.6069	
Applying mulch (yes=1)		0.3303	
Use of irrigation (yes=1)		0.4694	-0.3342
Use of veterinary service (yes=1)			0.5444
Use of Artificial insemination (yes=1)			0.4748
Having separate livestock house (yes=1)			0.5331
Eigenvalue	2.946	2.173	1.995
Variance (%)	24.55	18.11	16.63
Cumulative (%)	24.55	42.66	59.28

Source: own survey results.

$ATA = [0.2455 * Factor\ 1 + 0.1811 * Factor\ 2 + 0.1663 * Factor\ 3]/3$…….. (Eq. 12)

Appendix table 12 Component loadings of variables used to estimate the S component

Variables	Component loadings	
	1	2
Clinical visits, human (frequency)	0.5244	
Household with worrisome illness (number)	0.6198	
Household with disability (number)	0.5625	
Animal Shock (number of shocks)		0.7466
Crop shock (number of shocks)		0.6388
Eigenvalue	1.56	1.21
Variance (%)	31.15	24.13
Cumulative (%)	31.15	55.28

Source: own survey results.

$S = [0.3115 * Factor\ 1 + 0.2413 * Factor\ 2]/2$…… (Eq. 13)

Appendix table 13 Component loadings of variables used to estimate the SC component

Variables	Component loadings	
	1	2
Neighbors will to feed one's children (yes=1)	0.5430	
Neighbors assist during serious illness (yes=1)	0.5769	
Iddir membership (yes=1)	0.5105	
Member to religious group (yes=1)	-0.3170	0.4107
People are supportive during bad times (yes=1)		0.6926
People lend money during bad times (yes=1)		0.5819
Eigenvalue	2.22	1.58
Variance (%)	36.98	26.34
Cumulative (%)	36.98	63.33

Source: own survey results.

$SC = [0.3698 * Factor\ 1 + 0.2634 * Factor\ 2]/2$……. (Eq. 14)

Appendix table 14 Component loading resilience dimensions for estimating the RI

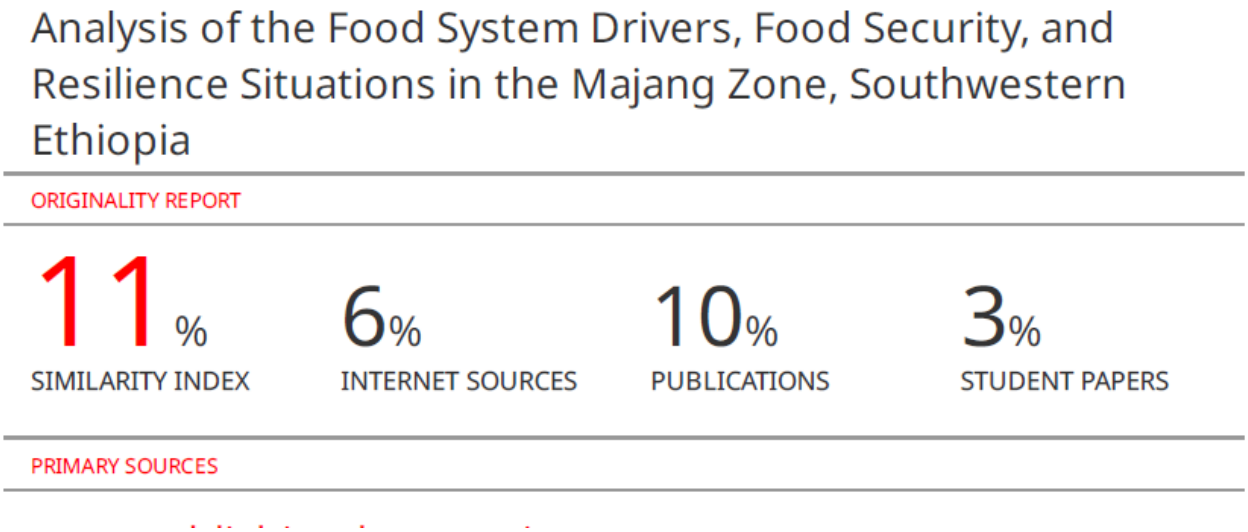
Variables	Component loadings
	1
Income and food access	0.4738
Agricultural technology adoption	0.4282
Asset possession	0.4228
Access to public services	0.3997
Stability/Sensitivity	-0.3555
Adaptive capacity	0.2930
Social capital	0.2037
Eigenvalue	3.715
Variance (%)	53.07
Cumulative (%)	53.07

Source: own survey results.

Hence, the overall resilience index is generated as shown in equation 13:

$RI = 0.5307 * Factor\ 1$…….. (Eq. 15)

Appendix table 15 Dissertation plagiarism test result



Analysis of the Food System Drivers, Food Security, and Resilience Situations in the Majang Zone, Southwestern Ethiopia

ORIGINALITY REPORT

11%	6%	10%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

Term of Reference (ToR) for Focus Group Discussions (FGD)

1. Let's start with the food security condition in your community? What the food security condition looks like in your village?
2. Do you plan your monthly, biannual and annual activities? If you plan, do you document the progress and the outcome of the implementation?
3. What are the dominant food items produced and consumed in the community? Details of this question is aligned with the details described in the food consumption score (FCS) module.
4. What are the main sources of income in the community? Please mention them in order of their importance with the prevailing detail of SWOTs.
5. Do you get improved technologies/inputs such as certified seeds, improved breeds, fertilizers, pesticides, livestock vaccination and medications, trainings etc.? who is providing those inputs?
6. Does your land have been certified? If not certified why? Who owns the land administration?
7. What are the drivers and causes that affect the food security in your locality? How would you describe the food insecure in your community? (social, economic, natural and environmental, legal and pollical, infrastructural and services).
8. What are the possible mechanisms you exercise/adopt to respond to severe food insecurity conditions?
9. What kind and types of supports and backups you receive from the government and other stakeholders? How do you describe them in terms of their significance and sustainability?
10. What comments and suggestions do have to improve the current food insecurity challenges and build the resilience capacity of the community?

Key informants interview questions

1. What is your understanding that the contribution of your organization has towards attaining food security in the community?
2. Are there policies and strategies formulated or adopted by your organization to exercise the mandates and responsibilities of your organization? Please mention the types and what the specific objectives, implementation status, challenges of implementation and remedies suggested to the challenges.
3. Do have strategic plan? How do you monitor and evaluate the implementation of your plan? What are the factors that affect the implementation, and measures taken?

4. Are there organizations supporting your plan? How do you integrate their plan to that of yours?

Key informants interview questions (Agriculture and natural resources sector)

- What are the major crops produced in the zone? How you describe the gap between the production potential and the actual production (planned vs achieved)?
- How frequent the experts visit and provide support to the development agents and farmers? What improved technologies have been transferred and how effective they are?
- Is there land administration and governance policy in the zone? If yes, how do you evaluate the implementation, the gaps, and possible corrective measures taken?
- Do you have natural resources use and management policy and guide? What are the SWOTs of the implementation?
- In your view, what constraints the agriculture sector (crop and livestock), and the natural resources faced (resources, planning, implementation, financial, linkage, technologies, policy)? What specific factors affect the agricultural production and productivity in the zone?
- At last, what is your suggestion to improve the agricultural sector to potentially support the food security needs of the community?

Key informants interview questions (Education sector)

- How do you understand the contribution of education to attain food security at the community level?
- What the educational status (number of schools, enrolment rate, drop rate, class to student ratio, book to student ratio, percent of students joining higher institutions) looks like in the zone?
- What major challenges and gaps you observed in the education sector and what measures taken?
- Forward your comment and suggestion on key points as future line of work to be considered.

Key informants interview questions (Health sector)

- What are the major diseases risking human health in the zone? What the medical services looks like?
- How many health (hospitals, health centers, health posts, clinics) and professionals (doctors, HOs, nurses, anesthesia, midwives) are found in the zone? Do you think that these numbers and disciplines are suffice to provide full services?
- What challenged the health sector in the zone?
- Please put your remark to engage on as a recommendation.

Key informants interview questions (infrastructure and institutions)

- Is telecommunication service being reachable in all villages of the zone?
- Are the villages accessible to weather roads?
- Is there credit providing institutions in the area?
- How many of the villages are provided with electricity?
- How many of the villages are accessible to niche markets?
- How many of the villages are accessible to potable water?