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VILLAGIZATION PROGRAM: LAND USE LAND COVER DYNAMICS, FOOD SECURITY AND CLIMATE CHANGE ADAPTATION STRATEGY NEXUS:

A CASE STUDY FORM BENISHANGUL GUMUZ REGION, WESTERN ETHIOPIA

BY

AWEKE AYSHESHIM

A DISSERTATION SUBMITTED IN FULFILLMENT OF THE REQUIREMENT OF THE DEGREE OF DOCTOR OF PHILOSOPHY IN "FOOD SECURITY AND DEVELOPMENT"

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ADDIS ABABA, ETHIOPIA

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ADDIS ABABA

ETHIOPIA

2023

DEDICATION

Dedicated to my heavenly mother, Abune Wube, and my heavenly brother, Yaregal Aysheshim, former president of the Benishangul-Gumuz Regional State.

DECLARATION

I thus declare that this dissertation is my original work and has not been submitted to any academic institution for the award of any other degree or professional qualification, in part or altogether. I confirm that the dissertation's contents are entirely the result of my own work. Furthermore, all concepts, arguments, and explanations derived from sources by other authors were proprly acknowledged and cited in the reference section.

Aweke Aysheshim

(Ph.D. Candidate)	**Signature**	**Date**

Addis Ababa University

College of Development Studies

Center for Food Security Studies

DISSERTATION APPROVAL

This is to certify that the thesis prepared by Aweke Aysheshim Berihane entitled "*Villagization Program: Land Use Land Cover Dynamics, Food Security and Climate Change Adaptation Strategy Nexus: A Case Study form Benishangul Gumuz Region, Western Ethiopia*" and submitted to the Center for Food Security Studies in fulfillment of the requirements for the Degree of Doctor of Philosophy in Food Security and Development complies with the regulations of Addis Ababa University and meets the accepted standards with respect to originality and quality.

Approved by Board of Examiners

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ABSTRACT

Current information on food security, land use land cover dynamics, and climate change adaptation approaches is critical for nationa, regional and local planning, natural resource management, and sound decision making. The objective of this dissertation is to assess the determinants of food security and anayze the impact of the villagization program on households' food security status, land use land cover dynamics and climate change adaptation strategies in the Benishangul-Gumuz Regional State. The study employed a mixed research design that incorporated both quantitative and qualitative data sources. Both probability and non-probability sampling techniques were used to determine sample households. Descriptive statistics, logistic and tobit model, and Propensity Score Matching (PSM) techniques were used to analyze the data. The result indicated that 47.96% of the respondents were food secure whereas the 52.04% of the respondents were food insecure. Food security was positively and significantly related with the size of cultivated farmland, irrigation farm size, livestock holding, access to grazing, and participation in off-farm activities. Contrarily, family size, dependence ratio, and distance to market had a negative and significant effect on respondents' food security situation. The results also indicated that non-villagized households' food consumption scores were 3.56 times higher than villagized households. Besides, non-villagized households showed 573.9 times higher kcal/day as compared to the villagized households. Moreover, the study revealed that non-villagized households had an average 0.2 (20%) points higher adaptation strategy to climate change than that of program participants. The land use land cover detection indicated a dramatic decrease at the rate of 27.2 ha of forestland, 17.1 ha of shrub and grassland, and 4.6 ha of water bodies per year, while the share of cultivated land, residential, and bare land have expanded at an average rate of 34.3 ha, 11.7 ha, and 2.9 ha per year respectively between 1999 and 2022. To tackle the food insecurity issues, the regional government and other concerned bodies should fulfill basic infrastructure, provide sufficient agricultural inputs, promote irrigation. In addition, raising local community awareness, reforestation, practicing land use plans, and promoting successful livelihood diversification could help to achieve sustainable natural resource management.

Keywords: Calorie intake, Adaptation strategies, Food insecurity index, Forest depletion, Local coping strategies, Population pressure

LIST OF ACRONYMS

BGBoFED	Benishangul-Gumuz Bureau of Finance and Economic Development
BGDRMC	Benishangul-Gumuz Disaster Risk Management Commission
BGRS	Benishangul-Gumuz Regional State
BGRSBoA	Benishangul-Gmumuz Regional State Bureau of Agriculture
CSI	Coping Strategy Index
EPRDF	Ethiopian People's Revolutionary Democratic Front
ERDAS	Earth Resources Data Analysis System
FCS	Food Consumption Score
FDRE	Federal Democratic Government of Ethiopia
FGDs	Focus Group Discussions
GERD	Grand Ethiopian Renassinece Dum
HFBM	Household Food Balance Model
HRW	Human Rights Watch
IFAD	International Fund for Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
IRR	Impoverishment Risks and Reconstruction
LULC	Land Use Land Cover
MMR	Mixed Method Research
MoFED	Ministry of Finance and Economic Developement
NCFSE	New Coalition for Food Security in Ethiopia
NMA	National Meteorology Agency
OI	Oakland Institute
OLS	Ordinal List Square
PSM	Propensity Score Matching
R&V	Resettlement and Villagization
SNNPR	Southern Nations, Nationalities, and Peoples' Region
UNHCR	United Nations High Commissioner for Refugees
VP	Villagization Program

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CHAPTER ONE

Introduction

1.1. Background of the Study

Villagization is one aspect of a resettlement program usually implemented to provide the rural population with a more applicable and manageable modern means of improving their current livelihoods (Hailu et al., 2016). It is also the term used to describe the process of transferring rural residents who live in dispersed settlements to large, government-designed villages, either voluntarily or forcibly (Gomersall, 2018; Stevenson & Buffavand, 2018). Local and national governments in underdeveloped nations viewed VP as effective means of fostering development (Gebresenbet, 2021; Rogers & Wilmsen, 2020). The majority of nations use VP to encourage: 1) infrastructure development, such as building roads or dams (Asiama et al., 2017; Tilt & Gerkey, 2016), 2) extensive natural resource extraction (Owen et al., 2018; Yang et al., 2017) and 3) preservation of the environment and ecological restoration (Karanth et al., 2018). Additionally, dangers brought on by climate change (i.e., droughts, floods, storms, famine) might lead to widespread villagization (Messay & Bekure, 2011).

Villagization program (VP), has been adopted in many parts of the world most notably in Africa with governments promising greater socioeconomic standards (Grunditz, 2015). The most frequently mentioned African countries who have carried out VP, either forcefully or voluntarily, were Tanzania, Mozambique, and Rwanda (De Wet, 2012; Stellmacher & Eguavoen, 2011). For example, in 1967, Tanzanian VP 'Ujamaa' (family hood) was established to promote the communal welfare of peasants. As a result, around 13 million Tanzanians, or 90% of the rural population, were relocated to new communities by the government (Coulson & Austen, 1983). In Rwanda, the infamous Rwandan genocide in 1994, a VP known as 'Imidugudu' (regrouping all inhabitants in villages) began in 1997 (Hilhorst & Leeuwen, 2000). The program's primary goals were to address housing issues, improve security, contribute to reconciliation, and lead to better land usage (Havugimana, 2009).

In Ethiopian history, villagization schemes were envisioned as a remedy—almost a panacea—for rural people's poverty and suffering (Dessalegn, 2003). In this regard, VP has been incorporated into national poverty reduction and food security programs in Ethiopia (NCFSE, 2003;

(Dessalegn, 2003). The VP in Ethiopia has a lengthy history, dating back to the imperial regime in the 1960s (Dessalegn, 2003; Woube, 2005). During this regime, the schemes were small in scale, ad hoc in nature, and primarily intended to achieve two goals: to rationalize land use on government "owned" land in order to raise state revenue, and to provide additional resources for the hard-pressed northern peasantry by relocating them to the southern regions (Berhane, 2003). However, the imperial regime's resettlement scheme failed to meet the intended objectives due to insufficient program planning, inappropriate settler selection, insufficient budgetary support, inexperienced staff, and a lack of coordination among the government and NGOs (Dessalegn, 2003; Yantiso, 2009).

The VP began in the 1980s in the aftermath of a catastrophic famine in with the goal of moving farmers from famine-affected areas in the north to the southwest, mostly during the Derg regime (Dessalegn, 2003). The program's goal was to relocate farmers from famine-affected areas in the north to the southwestern regions. Apart from minimizing famine risk, the main official legitimate goals for the R&V program were to offer a basic standard of social and economic amenities for the displaced inhabitants (Grunditz, 2015). However, the desired outcome was not realized due to inadequate planning, poor site selection, poor connection with host communities, and hasty and incompetent implementation based mostly on involuntary basis (Piguet & Dechasa, 2004; Yantiso, 2009).

Similar to the previous regimes, the EPRDF government has also implemented a huge VP in several regions of the nation since 2003 primarily to address issues with food insecurity and poverty in rural areas (Daie, 2012; Messay & Bekure, 2011). The program aims at moving people and communities from resource-poor areas (i.e. agricultural and residential land, forest and fish resources, subsoil resources and freshwater,) to locations with better livelihood opportunities and better public infrastructure (Kevin et al., 2016; Luo, 2019). The FDRE has also developed a VP specifically for pastoral and semi-pastoral communities in order to gather 1.5 million people in preset areas by 2013 (Hailu et al., 2016). As a result, it was planned for some 500,000 people in the Somali, 500,000 in the Afar, 225,000 in the Benishangul-Gumuz, and 225,000 in the Gambella regions to be gathered in planned villages (NCFSE, 2003). The program's objectives were to provide fundamental socioeconomic infrastructure and guarantee food security (Hailu et al., 2016). The program was formally launched since 2010 in almost all districts of the BGRS. Accordingly, the region has gathered 45,817 households (almost 229,085 people) into 239 nucleated villages between 2011 and 2018 (BGRS, 2018) which is the focus of this study.

1.2. Statement of the Problem

Many villagization programs have had goals aimed at modernization or development in various countries, but the consequences have been socioeconomically unfavorable (Grunditz, 2015). In China, studies have revealed that VP is connected with a variety of negative impacts on communities, including lower land holdings (Tilt & Gerkey, 2016), reduced access to natural resources and ecological services (Rogers & Wilmsen, 2020; Wilmsen & Webber, 2015). It also has a negative impact on employment, income, and resources, as well as general well-being (Huang et al., 2018; Xu et al., 2022). In addition, despite the fact that the implementation of VP provided significant benefits for rural farmers in Tanzanian, such as greater access to social services and education, the end result showed low agricultural production due to soil fatigue, site selection challenges, and land shortages (Lorgen, 1999). Similarly, in Rwanda, the application of VP has contributed significantly to the resolution of housing challenges. However, the program's implementation has resulted in a scarcity of agricultural land, and socioeconomic facilities have become impediments to the initiative (Havugimana, 2009; Leeuwen, 2001).

Though the Ethiopian government intended to boost socioeconomic growth, modernity, and food security via VP, a review of many empirical studies have revealed that the effects are doubtful. Some academics note that after moving to new villages, rural households' socioeconomic and food security situations were improved (Amare, 2016; Cochrane & Skjerdal, 2015; Labiso, 2020, 2021). To the contrary, VP resulted in multifaceted impacts on the socioeconomic condition of the resettled communities as well as on environmental resources of the host population. These include human rights abuses and land grabbing (done so under the guise of extensive land investment) in the Gambella region (HRW, 2012; Oakland Institute, 2015); rampant food insecurity (Daie & Labiso, 2021; Ferede & Wolde-Tsadik, 2018; Vanclay, 2017), degradation of natural resources, particularly quick loss of forest cover, fertile soil, and wildlife resources (Abera et al., 2020; Gebre & Andualem, 2018; Getahun et al., 2017; Yadeta et al., 2022).

The effect of the VP on food security, LULC dynamics, and households' adaptation strategies to climate change risks in the BGRS, has received very little academic attention to date. For instance Labiso (2020, 2021) has attempted to investigate the socio- economic impact of VP and its challenge in the BGR. This study has a narrow focus on the immediate results (i.e. access to basic services). The program's overarching goal, however, was to eradicate poverty and promote food security. Additionally, Daie and Labiso (2021) have made an effort to evaluate the effect of VP on rural household food security. However, this investigation did not employ enriched methodology, making it challenging to pinpoint the program's impact on food security. In order to close this gap and give strong empirical bases, PSM technique was used to analyze the impact of the program. Another drawback of Labiso (2020, 2021) and Daie and Labiso (2021) studies were their inability to explore the local coping mechanisms employed by households in the study area to mitigate food insecurity, a topic this study has addressed.

Frequently updated LULC information is also necessary for many socioeconomic and environmental applications, such as regional planning and conservation of natural resources (Maina et al., 2020; Tewabe & Fentahun, 2020). In addition, understanding how people perceive climate change and how to adapt to it could have a big impact on the ability to persuade policymaker (Abdela, 2022; Marie *et al*., 2020) because climate change has expanded quickly across the world since the turn of the century and threatens the livelihood of people on the planet (He et al., 2020). To the researcher's knowledge, however, no particular studies have been conducted on how villagization schemes have affected changes in LULC and households' climate change adaptation strategies in the study area.

1.3. Objectives of the Study

1.3.1. The general objective

The general objective of this study is to investigate the impact of VP on food security, LULC dynamics and households' adaptation strategies to climate change risks in Benishangul-Gumuz region, western Ethiopia.

1.3.2. The specific objectives

The specific objectives of the research are to:

- ✓ Assess the food security conditions, the severity of the food insecurity gap and the variables that affect households' food security in the study area.
- ✓ Analyze the impact of VP on households' food security status and local coping strategies in the study area

- ✓ Analyze the impacts of VP on LULC dynamics that covers over two decades (1999 to 2022).
- ✓ Examine the impacts of VP on rural households' adaptation strategies to climate change risks

1.4. Research Questions

The following research questions are answered in this study:

- ✓ What are the food security status of households' and the severity of the food insecurity gap in the study area?
- ✓ What are the factors influencing food security situation of households in the study area?
- ✓ How does VP affect households' food security situation in the study area?
- ✓ What are the local coping strategies opted by households in the study area?
- ✓ What is the dynamics of LULC in villagized sites in the last two decades?
- ✓ How do rural households perceive about climate change in the study area?
- ✓ What are the major adaptation strategies rural households frequently adopt to cope with the effects of climate change?
- ✓ How the VP has influenced households' adaptation strategies to climate change?

1.5. Scope and limitation of the study

Population displacement, resettlement, and villagization can be initiated to promote development (building roads, dams, etc.) or as an ex-post response to combat hunger, food insecurity, and climate change stresses. This study covers the VP undertaken by the BGRS between 2010 and 2018 with the goal of relocating communities from resource-poor areas to areas with higher livelihood options in order to eradicate hunger and achieve food security. Furthermore, this study did not cover development-induced displacement and villagization schemes implemented in the BGRS. Thematically, this dissertation has examined VP and its impact on household food security, climate change adaptation strategy, and LULC dynamics, with the goal of identifying potential issues associated with it. Despite the fact that the VP has been implemented in 18 BGRS districts (BGRS, 2018), this study was limited to the Assosa and Bambasi districts. These districts were chosen on purpose because they had a relatively large number of villagized dwellings and a sizable population. Furthermore, at the start of this study, these districts were less prone to violent conflict and displacement than the region's Metekel and Kamashi zones.

The survey also restricted itself to households that had participated in the VP and residents of neighboring villages or kebeles for comparison purposes. Rural households that took part in the resettlement program under the Derg regime were not included in this study. Because the focus of this study was to examine how the EPRDF villagization program affected LULC dynamics, household adaptation to climate change concerns, and food security. Additionally, because the data utilized in this study were cross-sectional, it was challenging to generalization of the research results and examining the stability, which is a crucial element of household food security. In order to manage this limitation, the study has employed multiple food security measurements such as; FCS, which is a proxy indicator of household food access and diet quality at household level, the HFBM, which is a proxy indicator physical availability of food and the CSI, which captures the element of quantity or sufficiency of food.

1.6. Description of the Study Area

The study was conducted in Bambasi and Assosa woredas of the Benishangul-Gumuz National Regional State. The Benishangul-Gumuz regional state is situated in Ethiopia's northwest. It shares boundaries in the northeast with Sudan, east with Amhara regional state, and south with Oromia regional state. According to the CSA (2022), the region has a total size of 50,698.68 square kilometers and a population density of 22 people per km^2. The name of the region comes from two local ethnic groups: the Benishangul) and the Gumuz. The region had an estimated 1.218 million population as of July 2022, with 49.3% of them being female. In the region, 77% of the populations live in rural areas and 23% live in urban areas. The region is a mosaic to a variety of ethnic groups, including the Benishangul (26.7%), Gumuz (23.4%), Amhara (22.2%), Oromo (12.8%), Shinasha (6.9%), and others (8.0%), each with their own distinct languages, traditions, and socioeconomic structures.

The religious composition of the peoples of the region is Islam 44.1%, Orthodox Christianity 34.8%, indigenous religions 13.1%, and Protestantism of different denominations 5.8% (CSA, 2022). The Benishangul-Gumuz Regional State comprises three administrative zones namely: Metekel in the north, Assosa in the center and Kamashi in the south. In addition, the region has 21 woredas; 1 special woreda; 3 city administrations; and 535 kebeles (Mekonnen, 2021). The absence of transportation and communications infrastructure in the area is a key barrier to the region's economic development. Travel within districts and kebeles can be difficult and vulnerable to delays during the rainy season (UNHCR, 2020). However, BGRS is also rich in natural resources, including water, plants, land, and minerals (gold, marble, coal, copper, zinc, base metal, etc...). The region has also great potential for agricultural economic growth (BGBoFED, 2022). The livelihood of the local communities mainly depends on small-scale crop production based on shifting cultivation using hand and hoe, hunting and gathering, and small-scale livestock rearing (Disassa, 2022). The subsidiary sources of livelihood include; wild food collection, fishing, traditional gold mining, petty trade and production of charcoal (BGRSBoA, 2022). In terms of land use, grasses and shrubs make up the majority of the region's landmass (76.4%) while forestland makes up roughly 11.4 percent. Additionally, around 5.3 percent, 3.2 percent, and 2.3 percent of the land is used for agriculture, grazing, and other purposes, respectively (Bessie et al., 2016)

1.6.1. Assosa woreda

Assosa woreda is bounded by Kurmuk and Homesha in the north, Menge in the northeast, Oda-Buldigilu in the east, Bambasi in the southeast, Mao-Komo special district in the south, and Sudan in the west (Wikipedia contributors, 2021). The woreda is located between 10°04′ N and 34°31′ E (Figure 1.1). Though no current population census has been conducted in the country, the population projection for 2018 was 151,075 (49.14% female) in Assosa woreda (CSA, 2013). There are two agro-climatic zones in the Assosa woreda: Kolla which comprises 85–90% of the lowland (below 1500 meters above sea level) and Weyna-dega, which comprises 10–15% of the midland (between 1500 and 2300 meters above sea level) (Wakwoya et al., 2022).

The Assosa branch of the National Meteorology Agency provided the fifteen years' worth of climate data (2007-2022), which showed that Assosa woreda's mean annual temperature range is 15.2°C -28.1°C. The woreda experiences an annual rainfall range of 78.73 mm to 134.62 mm (NMA, 2022). Agriculture is the main source of livelihood in Assosa woreda, as it is in other parts of Ethiopia. Mixed crop-animal production is a prevalent agricultural practice in the woreda (Wakwoya et al., 2022). Wild food gathering (e.g. wild mushroom, roots, wild vegetables, wild fruits and bamboo shoot), fishing, traditional gold mining, petty trade, and the production of charcoal are some of the auxiliary sources of income (BGRSBoA, 2022).

1.6.2. Bambasi woreda

Bambasi is one of the woredas' in BGRS, in Assosa zone. It is 640 kilometers from Addis Ababa, the nation's capital, and 42 km from Assosa, the regional administrative center (Mulunesh & Menfese, 2021). Administratively, Bambasi woreda shares borders with the Oromia regional state and Mao-Komo special district in the south and southwest, and, Assosa woreda in the west and Oda-Buldigilu district in the northeast (Wikipedia contributors, 2023). Bambasi woreda is located in the region's south, between 09^{o}47 North latitude and 34^{o}47 East longitude (Figure 1.1). The population projection of 2018 for the woreda was 91,455 (49% female) (CSA, 2013). The Bambasi woreda's mean annual temperature range is 14.2°C-30.6°C and it also experiences an annual rainfall range of 83.8 mm to 127 mm (NMA, 2022).

The woreda's primary sources of livelihood are agriculture and traditional gold mining. Maize, sorghum, and teff are the main food crops or grains produced in the area. The area also produces oil crops and other crops (BGRSBoA, 2022). Regarding the land use classification, the woreda comprises a total area of 472,817 hectares of land (2032.3 and 1292.3 hectares in Womba and Dabus kebeles, respectively), of which 223,016 hectares were utilized for cultivation. The remaining; 10,000 hectares, 63,756 hectares, 174,820 hectares, 1,200 hectares, 1,797 hectares and 228 hectares of land were pastureland, non-cultivated land, forest area, mountain area, irrigation area, and perennial crop area respectively (Mosissa et al., 2020). The average land holding is 4.65 hectares per household.

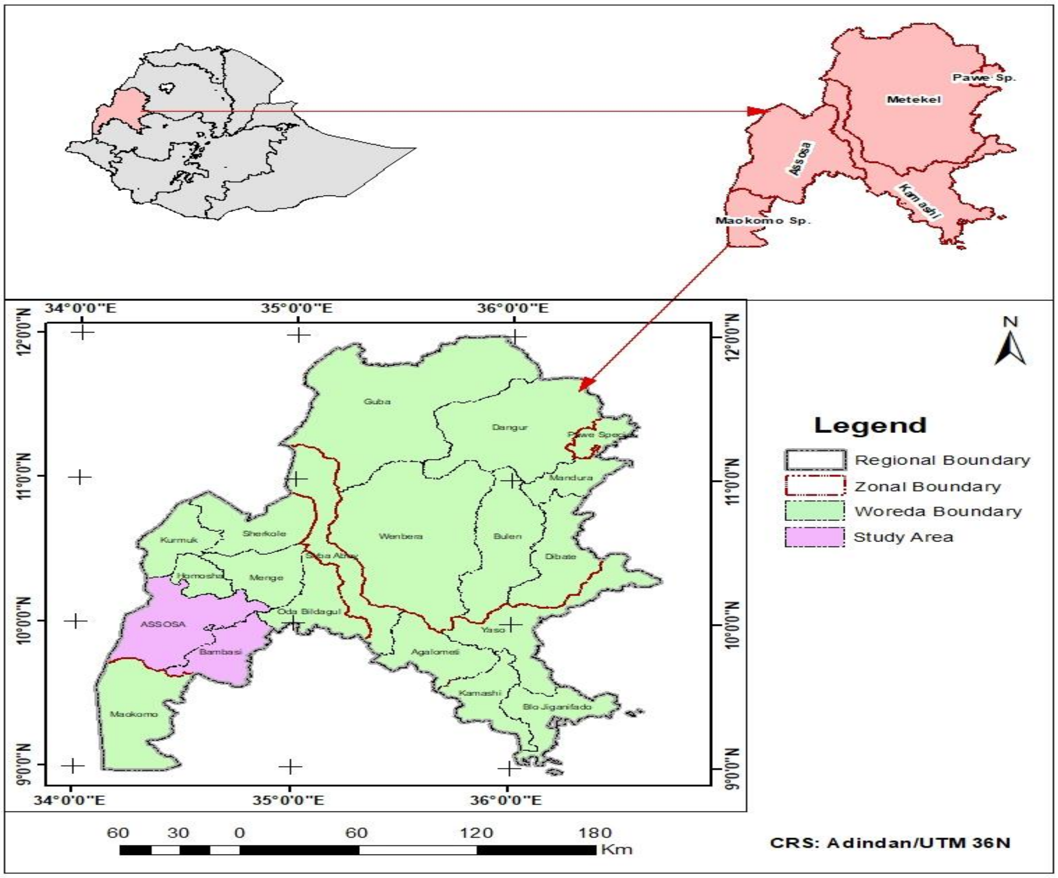

Figure 1.1: Map of the study area

Source: GIS Data (2022)

1.7. Literature Review

1.7.1. Historical background of VP

Local and national governments in underdeveloped nations viewed VP as effective means of fostering development (Gebresenbet, 2021; Rogers & Wilmsen, 2020). The majority of nations use VP to encourage infrastructure development, such as building roads or dams (Asiama et al., 2017; Tilt & Gerkey, 2016), to extensive natural resource extraction (Owen et al., 2018; Yang et al., 2017) and preservation of the environment and ecological restoration (Karanth et al., 2018). Development-include displacement villagization include: infrastructural development (i.e., dam or road construction), large-scale natural resource extraction, and conservation of nature reserves and ecological restoration) (Asiama et al., 2017; Karanth et al., 2018; Owen et al., 2018; Yang et al., 2017). For instance, China has resettled more people than any other country in the world:

since the 1960s, nearly 78 million people have been relocated through several development-induced villagization projects (Wilmsen et al., 2019).

Additionally, in recent years, the permanent R&V of residents from shock- and stress-prone places to less sensitive areas within the same nation has emerged as a viable adaptation to climate change intervention in emerging regions (African and Asian countries)(Arnall, 2019). For instance, many people have been relocated in Bangladesh as a result of climate change and the natural disasters it has caused on riverine islands (Char)(Hossain et al., 2022). In addition, between 1980 and 2018, 450,000 people in South Asian nations (Bangladesh and India) were displaced and due to coastal erosion and flooding brought on by ongoing climate change and relocated to the Indian Sundarban and Bangladesh's south-eastern coast (Barua et al., 2020).

Villagization has a long history of readily emerging as a government-based ‘solution’ to problems of poverty, vulnerability and marginalization amongst rural populations in Africa (Arnall, 2019; Stellmacher & Eguavoen, 2011). De Wet (2012) has demonstrated, for example, that during the 20th century, VP has been imposed in the rural areas of Africa by successive governments, whether in a colonial or independent context, capitalist or socialist context. Apart from Ethiopia; Tanzania, Mozambique and Rwanda for example, were the most frequently mentioned African countries that have conducted VP either involuntarily or voluntarily (De Wet, 2012). For example, in 1967, Tanzanian VP 'Ujamaa' (family hood) was established to promote the communal welfare of peasants. As a result, Around 13 million Tanzanians, or 90% of the rural population, were relocated to new communities by the government (Coulson & Austen, 1983). Despite the fact that the VP has provided certain benefits for rural peasants, such as increased access to social services and education, the final result indicates low agricultural yield due to soil fatigue, site selection issues, and land scarcity (Lorgen, 1999). In Rwanda, after a period of war and the infamous Rwandan genocide in 1994, a VP known as 'Imidugudu' (regrouping all inhabitants in villages) began in 1997 (Hilhorst & Leeuwen, 2000). The program's primary goals were to address housing issues, improve security, contribute to reconciliation, and lead to better land usage. In several cases, the VP has made a significant contribution to resolving housing issues. However, this produced other serious issues: Due to poor planning at the outset, shortage of agricultural land and socioeconomic facilities became hurdles for the program (Havugimana, 2009; Leeuwen, 2001).

The climate change-induced displacement and villagization is the one that occurs most frequently in Ethiopia (Messay & Bekure, 2011; Walelign et al., 2021). The Ethiopian government has conducted a number of R&V programs since the 1970s to relocate people from places most vulnerable to adverse climatic consequences (Dessalegn, 2003; Woube, 2005). In reaction to the 1984 drought that led to widespread hunger, especially in northern Ethiopia, the greatest R&V operation in Ethiopian history took place between 1984 and 1991during the Derg regime (Messay & Bekure, 2011). In addition, in response to the drought that had ravaged the lowlands in the SNNP, Tigray, Oromia, and Amhara regions, the current (FDRE) government created a new villagization plan in 2003 as part of the food security strategy (Hammond, 2008; Wayessa & Nygren, 2016).

In order to relocate approximately 2.2 million of the afflicted people to areas with fertile soil and plentiful rainfall inside each region, the government has planned to launch a more intense and protracted villagization scheme (Hammond, 2008). In two ways, at least in theory, the present VP appears to be distinct from the situations of the two preceding governments (the Haile-Selassie and the Derg)(NCFSE, 2003): 1) the VP is based on the principle of "voluntarism," and 2) it is implemented intra-regionally to avoid conflicts between resettlers and the host community. Up until recently, Ethiopia saw little displacements brought on by development-induced projects. However, the country's recent "changes in economic progress" have encouraged the development of sizable built-up regions (mostly hydroelectric power plants, roads, manufacturing industries, and urban slum upgrading), forcing many residents to abandon their familiar neighborhoods. For instance, the GERD project in the Guba district of the Benishangul-Gumuz region displaced 5,391 households (or almost 20,000 people) from 14 kebeles and relocated them to 17 new village sites(Vaughan, 2020).

The FDRE has specifically designed VP for four pastoral and semi-pastoral regions (Afar, Somalia, Gambella, and Benishangul-Gumuz) with a target population of 1.5 million people (225,000 in the Benishangul-Gumuz region)(FDRE, 2013). The underlying presumptions were that Ethiopia's pastoral and semi-pastoral regions experienced a more severe set of social, economic, and environmental challenges, including the poor provision of essential infrastructure and services (such as education, health, water supply, transportation, and electricity), high vulnerability to recurrent droughts, and environmental hazards (such as invasive species, flash floods), high dependence on extensive livestock production with underdeveloped support services, and a need for natural resources (BGRS, 2011; NCFSE, 2003).

1.7.2. Theory of rural development

There is no commonly acknowledged theory of rural development that can explain the current situation and forecast its future direction. As a result of changes in the perceived mechanisms and aims of development, the definition of rural development has evolved over time (Nejadrezaei & Ben-Othmen, 2019). According to the World Bank (1975), rural development is "a strategy designed to improve economic and social living conditions in a rural area, focusing on a specific group of disadvantaged people." It enables the most vulnerable rural residents to benefit from development." The contemporary definition of rural development includes economic and social initiatives aimed at encouraging principles of retention, growth, and expansion in places outside of cities, as well as increasing the quality of life for rural populations through such activity (Atkinson, 2017).

Several theories have been created to address the issue of rural development, despite the fact that there are no universally accepted body theories. As a result, basic resource theory and growth center theory are the theories that drive rural development (Chukwuma & Olorunfemi, 2021).

1.7.2.1. Basic resource theory

The basic resource theory is a rural development theory that is based on a certain area's basic natural resource or environmental resources. The idea assumes that the presence, quality, and size of basic natural resources within a specific area determine the development of that locality (Chukwuma & Olorunfemi, 2021). The development of natural resources (soil, water, forest resources, fisheries, minerals, and scenery) attracts investment capital and improves income and employment in the rural areas (Essang, 1975). The availability of natural resources in a certain region or locality is critical to the overall development of the area. The presence of this valued asset in a community serves to improve people's quality of life. Natural resource extraction in any given area generates employment. Residents of the area have greater incomes and grow faster in terms of development than those with limited natural resources (Chukwuma & Olorunfemi, 2021). This was observed in Nigeria, where cocoa, groundnut, and cotton growing areas, as well as the palm belt and mineral-rich areas of the country, had more faster growth than less endowed places (Adesina et al., 2022). On the contrary, Kurecic and Kokotovic (2017) found evidence of the "natural resource curse," particularly in economies that rely heavily on easily substitutable resources with volatile pricing.

Resettling a specific number of rural people residing in the drought-prone regions of Ethiopia through R&V in locations where there are sufficient resources (land, water, etc...) was also a strategy to achieve food security situations in Ethiopian context (MoFED, 2003), which is alongside this theory.

1.7.2.2. Growth centre theory

The growth center is a region defined by the supremacy of a regional center (growth space) to which all flows of products, services, capital ideas, or political allegiances are primarily directed (Boudeville, 1967). A growth center is a region defined by the dominance of a regional center (growth space) to which all flows of products, services, capital ideas, or political allegiances are primarily directed and it promotes rural development through the 'trickle down' effect (Böventer, 1975). The density of interaction between two cities determines the growth potential of an area located along an axis between them. As a result, the strength of interaction between the growth center and its surrounding region assists in determining an area's growth potential (Chukwuma & Olorunfemi, 2021).

According to Gana (1977), the spread mechanism may take the form of stimulating food production for the urban industrial market; increased production of industrial raw materials for processing industries; employment opportunities for any surplus rural labor resulting from agricultural mechanization within the growth-space; financial remittances to rural areas by migrant workers; diffusion of innovations into the 'growth space' and subsidiary investments made by rich people. The growth generated in the growth center 'trickles down' to the surrounding area. However, Manyanhaire et al. (2011) revealed that despite its extensive application, most growth center theories have never been successful due to a natural-social-economic set of factors that responsible governments have not adequately articulated.

1.7.3. Empirical literature review

Empirical investigations have shown that VP has both beneficial and negative effects on communities that have been relocated around the world. For instance, Huang et al. (2018) attempted to evaluate the societal effects of dam-induced VP in China. The findings demonstrate that villagization due to dam-induced displacement improved living circumstances and made rural cooperative medical insurance more acceptable. However, it has detrimental effects on employment, income level and resource, as well as general well-being. In addition, a comprehensive analysis of Chinese development-induced VP related to "sustainability" was done by Xu et al. (2022). They discovered that creating sustainability through development-induced VP will not be as simple as expected and may result in new poverty traps that hurt villagized communities. Only if there is adequate consensus among all stakeholders on a transparent, responsible, and collaborative approach can development-induced VP become a tool for just governance to create sustainability. Potential hazards and difficulties may trump sustainable development in the absence of inclusion and equality in transitions.

More crucially, Aboda et al. (2019) have attempted to investigate the risks associated with displacement and VP caused by the construction of dams, roads, highways, and industrial facilities in developing countries by examining grey literature from 1980 to 2018. The results of the review using the IRR model showed that while relocation and villagization expose project-affected people to some opportunities, they are also significantly more likely to run into risks. Examples of these risks include a lack of compensation for lost property and a lack of experience and capacity to manage villagization processes.

Except for a handful, numerous empirical findings suggested that VP practice had a detrimental impact on rural households' livelihood and food security situations in many regions of Ethiopia. For example, VP has led to widespread food insecurity in new village sites (Daie & Labiso, 2021; 2015; Hailu et al., 2016; Wayessa & Nygren, 2016). Approximately 67% of households in the villagization sites studied by Daie and Labiso (2021) in the BGR, were food insecure, and just 33% were food secure, indicating that VP did not improve their food security situation. The percentage of households with food insecurity is significantly higher than the most recent national statistic of 40%. Additionally, Buzuayew et al. (2016) attempted to analyze the effectiveness of VP in the Afar region. He discovered that several villagization sites continued to offer insufficient fundamental social services.

The VP program's under-implementation was primarily caused by lack of awareness, implementation incapability, less access to clean water, and lack of distribution of farmland. Furthermore, a study by Degefu et al. (2020) in the pastoral and agro-pastoral communities in the

Middle Awash Valley revealed that while villagization has generally provided infrastructure and services and offered income diversification to those able to access irrigated agriculture, its implementation has been patchy and uneven, and it has produced resource scarcity and introduced new risks and vulnerabilities.

Ethiopia's government has undertaken development-induced (large hydroelectric dam and plantation schemes) VP to hasten the country's economic expansion and gradually realize the socio-economic rights of rural households in the form of new economic opportunities and advantages from the "trickle-down economy". Nevertheless, a number of empirical findings showed that the initiatives were implemented at the expense of rural communities, who jeopardized their means of subsistence by receiving insufficient or unworkable benefit packages. For instance, Stevenson & Buffavand (2018) have attempted to evaluate the impact of development-induced VP in enhancing the food security situation of the Bodi pastoralists in south Omo by comparing villagized with non-villagized pastoralists. The two methodological techniques (quantitative and ethnographic) produced different findings. The quantitative analysis designated that access to household food was limited in both villagized and non-villagized sites but was better in villagization sites than in other areas. Whereas, the ethnographic results showed that villagized pastoralists were dependent on food assistance because they were unable to feed themselves. They complained about physical agony, social isolation, and demeaning treatment.

Similarly, Zikargie & Cochrane (2022) have made an effort to investigate how South Omo's Bodi and Mursi pastoralists have responded to the development-induced (Omo Kuraz Sugar Factory) VP. According to the findings, the development-induced VP exhibited conflicting objectives, flawed presumptions, bad design, disrespect for the intricate social and environmental elements of the pastoralists, and disruptive social mobilization and execution techniques. It prevents the Bodi and Mursi pastoralists from effectively taking into account their way of life, traditions, and knowledge, which has the effect of destroying their socioeconomic rights.

Other empirical studies also revealed VP’s detrimental effect on the environment outweigh its beneficial aspects. For instance, a study by Yonas et al. (2016) in the Meinit-Shasha district of the SNNPR of Ethiopia found that due to VP, grazing pastures and rangeland vegetation were reduced to a greater extent in villagized sites than in non-villagized one. Similar to this, a study conducted in southwest Ethiopia by Getahun et al. (2017) found that consecutive VP caused the area to lose significant portions (80%) of its forest cover. Additionally, the implementation of VP in Abobo district of Gambella region between 2002 and 2009 led to a 1.27 ha and 10 ha annual decline in forestland and grassland, respectively. Moreover, a research by Abera et al. (2020) revealed that population pressure as a result of VP caused a significant decline in woodland (34.6%), forest (59.9%), and grassland (50.5%) between 2000 and 2018 in Chewaka district of Oromia region. Additionally, a research by Yilak and Getahun (2019) in the same district found that between 2004 and 2016, resettlers cleared nearly 58% of the district's remaining forest acreage. The primary underlying causes of the identified issues were the growth of farmland and settlements, deforestation, and forest fires triggered by huge VP and the loss of forests and grasslands will have significant effects on the remaining biodiversity and ecosystem services (Hailu et al., 2020; Yadeta et al., 2022).

1.7.4. Conceptual Framework

This section describes the study's conceptual framework and elaborates on the sorts of impact linkages between VP and key impacts (food security, LULC dynamics and climate change adaptation strategies) using Figure 1.2. At the top of the conceptual framework, the intervention of VP is conceptualized to bring immediate outcomes such changes in access to land and natural resources, basic services (school, health service, water, and financial institutions, market), infrastructure service (road, electricity, and mobile network) and better adaptation strategies to climate change risks such as crop diversification, livestock diversification, income source diversification, harness of social capital, soil and water conservation and small scale irrigation. As intended by its objectives, the immediate outcomes brought by the VP intervention were further conceptualized to increase households' climate change adaptation strategies and household food security. On the other hand, due to the strong demand for construction materials, crop production, charcoal, and firewood, population pressure brought on by VP in new villages would affect the dynamics of land use and land cover.

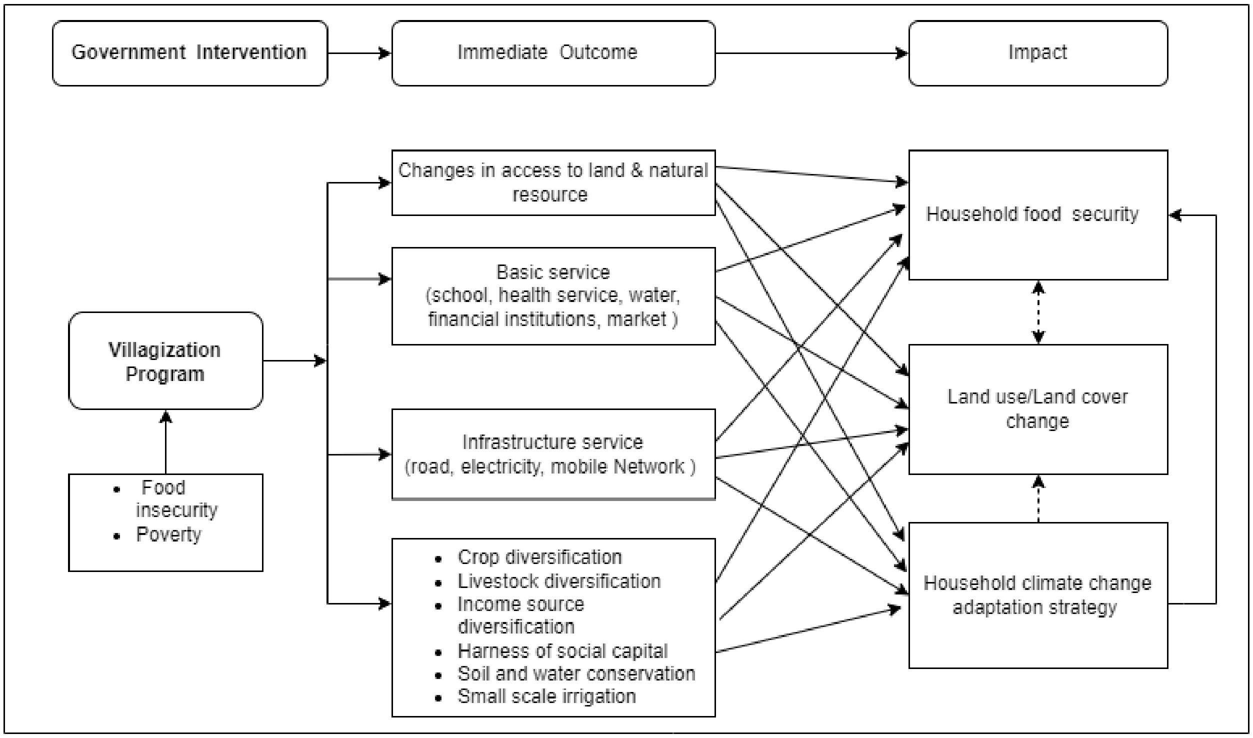

Figure 1.2: Conceptual framework

Source: Own construction (2022)

1.8. Research Methodology

1.8.1. Research Philosophy

Philosophical worldview/paradigms are frequently used as the foundation of research, and in order to undertake significant research, the major philosophical tenets supporting the investigation must be known (Creswell & Creswell, 2018; Shuhong & Creswell, 2016). A research paradigm is a theoretical framework made up of a collection of principles and values that directs how scientific communities construct knowledge and conduct research (Rehman & Alharthi, 2018). Paradigms are crucial because they offer ideas and rules that guide what should be investigated, how it should be studied, and how the findings of the study should be understood by academics in a given field (Allemang et al., 2022). Paradigms have a substantial impact on every decision made during the research process, including the choice of approach and methods (i.e., the research questions, participants' selection, data collection tools, and collection procedures, as well as data analysis) (Davies & Fisher, 2018; Kivunja & Kuyini, 2017; Park et al., 2020).

According to Creswell and Creswell (2018), there are four paradigms/worldviews that are widely discussed in the literature: post-positivist, constructivist, transformative and pragmatic. Each paradigm has a distinctive point of view regarding the axiology, ontology, epistemology, methodology, and rhetoric of research (Kaushik & Walsh, 2019). For instance, post-positivism frequently focuses on precision, generalizability, reliability, and replicability through the use of quantitative methodology and extremely formal terminology (Habib, 2021). The post-positivist paradigm is based on scientific evidence, objectivity, and the quest for universal rules that describe the natural world. It presumes that reality is objective and can be explored quantitatively (Kivunja & Kuyini, 2017). For a long time, the post-positivist paradigm has been the dominating approach in many areas of research (i.e. medical research). This paradigm, however, fails to appreciate the subjective and interpretive nature of research, as well as the influence of the researcher's prejudices and preconceptions (Glazier & Mehdizadeh, 2019). Furthermore, the post-positivist paradigm is characterized by a restricted concentration on observable phenomena and a disregard for the broader social, cultural, and historical contexts in which research is conducted. This paradigm also frequently ignores the complexity and diversity of human experience, as well as the subjective meaning and interpretation that individuals attach to their experiences (Panhwar et al., 2017; Pidgeon, 2019).

Constructivism is frequently associated with qualitative methodologies and literary and informal rhetoric, in which the researcher depends on the participants' perspectives and produces subjective meanings of the phenomena (Kaushik & Walsh, 2019). The constructivism paradigm contends that knowledge is a subjective interpretation of reality built by individuals through their own experiences, interactions, and interpretations, rather than an objective depiction of a pre-existing reality (Adom et al., 2016). The use of the constructivism paradigm has several critics: it can lead to relativism and subjectivity; it ignores the role of objective reality and the possibility of uncovering objective truths through empirical observation and measurement (Gannon et al., 2022). Furthermore, the constructivism paradigm might be unduly focused on individual experiences while ignoring the larger social and cultural elements that impact those experiences(Creswell & Clark, 2018).Unlike earlier worldviews, transformative paradigm is performed with a reform and empowerment agenda, i.e., the emphasis is on altering the lives of socially marginalized populations (e.g., racial and ethnic minorities, people with disabilities, and indigenous communities)(Creswell & Clark, 2017).

Finally, pragmatism incorporates both quantitative and qualitative methods, and hence serves as the foundation for the mixed method philosophical approach (Žukauskas et al., 2018). Pragmatism provides researchers with a wide range of options: they are free to choose the study approaches, techniques, and processes that best meet their goals and objectives (Creswell & Creswell, 2018). Pragmatism is pluralist in the sense that, unlike post-positivism and constructivism philosophy, it is not confined by a particular philosophical theory (van der Molen & Muzata, 2021). In terms of mode of inquiry, pragmatism is located somewhere in the center of the paradigm continuum. Post-positivism traditionally favors quantitative methods and deductive reasoning, whereas constructivism favors qualitative approaches and inductive reasoning; nevertheless, pragmatism accepts both extremes and provides a more flexible and reflective approach to research design (Morgan, 2014). This study is grounded upon the pragmatic paradigm due to the aforementioned benefits and its freedom in allowing the researcher to address research questions using different sources of data (quantitative and qualitative) and multiple data collection methods (surveys, interviews, FGDs, etc...).

1.8.2. Research approach and design

The three most prevalent research approaches are quantitative, qualitative, and mixed methods. MMR approach, entails combining several approaches in a single research work and it has several advantages since it blends philosophical frameworks of both post-positivism and constructivism, interweaving qualitative and quantitative data in such a way that research issues are effectively explained (Creswell & Creswell, 2018). Employing either qualitative or quantitative data may not provide a complete picture of the research phenomenon. To provide a comprehensive picture, a researcher may employ both qualitative and quantitative research approaches (Creswell & Clark, 2018; Teddlie et al., 2021). The use of MMR allows researchers to answer research questions such as 'what,' 'why,' and 'how' in a single study with adequate depth and breadth (Ngulube & Ngulube, 2022).

Despite the fact that this study relied mostly on quantitative method, the qualitative method was also employed. Using the qualitative method in addition to the quantitative, allows for a more in-depth understanding of the subject under inquiry while also valuing the perspectives of the participants (Moser & Korstjens, 2017). In addition, qualitative approach was utilized to triangulate quantitative results in order to generate a thorough knowledge of a study problem.

This shows that the researcher believes that employing MMR approach that combines quantitative and qualitative procedures to address the research questions is preferred.

To perform effective research, selecting the type of research approach (qualitative, quantitative, or mixed methodologies) is not enough; the research design that offers particular direction for processes should also be mentioned. Based on the paradigm and research approach mentioned above, a MMR design is applicable for this study. This is due to the fact that MMR design can be used to gain a better understanding of the connections or contradictions between qualitative and quantitative data; it can provide opportunities for participants to have a strong voice and share their experiences throughout the research process; and it can facilitate different avenues of exploration that enrich the evidence and allow questions to be answered more deeply. As multiple viewpoints enlighten the issues being examined, mixed methods can allow better scholarly interaction and enrich the experiences of researchers (Shorten & Smith, 2017). While there are various kinds of MMR designs, several academics agree on three types: convergent parallel mixed methods design, explanatory sequential design, and exploratory sequential design (Creswell & Clark, 2018; Plano Clark & Ivankova, 2017; Wilkinson & Staley, 2019).

Convergent parallel mixed method: which is a type of mixed methods design in which the researcher converges or merges quantitative and qualitative data in order to provide a comprehensive analysis of the research problem (Creswell & Creswell, 2018). Initially, two types of data sets are collected concurrently, and then they are independently analysed utilizing quantitative and qualitative analytical methodologies (Schoonenboom & Johnson, 2017; Shorten & Smith, 2017). Convergent parallel mixed method design can be effective in some circumstances, such as when a researcher has limited time and needs to collect both qualitative and quantitative data at the same time (Creswell & Clark, 2018). It has also the following challenges: the possibility of having different sample sizes when collecting quantitative and qualitative data, the difficulty of merging data based on texts with data based on numbers to investigate the same issue (Fàbregues et al., 2020), and it may add an additional layer of complexity (i.e. it may require collecting qualitative data, quantitative data, or both again) (Dawadi & Giri, 2021).

Explanatory sequential design: explanatory sequential design takes place in two separate interactive phases, beginning with the collection and analysis of quantitative data to expand the first phase quantitative outcomes, and ending with the design of the second, qualitative phase based on the quantitative findings (Ngulube & Ngulube, 2022). This type of design is common in fields with a strong quantitative orientation. In this design, qualitative data is used to explain certain quantitative outcomes, including unexpected findings, in greater depth (Dawadi & Giri, 2021). Creswell and Clark (2018) suggest that when using this design in a study, a researcher should transition from post-positivist to constructivist theoretical assumptions. The researcher begins with the post-positivist assumption and progresses to the constructivist assumption as they appreciate many views and in-depth inquiry. This design's challenges include the difficulty in identifying a suitable sample size for qualitative data collection and the lengthy time required for completion (Wilkinson & Staley, 2019).

Exploratory sequential design: is a three-phase design in which a researcher applies constructivist principles. A researcher investigates a topic in depth during the first phase, and when they reach the second phase, they use the post-positivist principle to identify and measure the variables (Creswell & Clark, 2018).

This study used an explanatory sequential design based on the behaviour of the research question and the dominance of quantitative data (greater weight was placed on quantitative data). As a result, quantitative data were first gathered from both villagized and non-villagized respondents. Second, qualitative data were collected from selected respondents to explain quantitative results for the purpose of complementarity (elaboration, augmentation, demonstration, and explanation).

1.8.3. Sampling techniques and sample size determination

In this study, multi-stage sampling techniques were used to collect data. Because, multi-stage sampling reduces costs and saves time, and it is also useful in overcoming variation within clusters (Mohsin, 2016; Sedgwick, 2015). In the first stage, out of 21 districts in BGRS, two districts (Assosa and Bambasi) were deliberately selected. Because these districts are the largest in population size (CSA, 2013) and host a huge number of settlers (BGRS, 2018) in the region. In the second stage, eight villages (kebeles) were randomly selected from the lists available at each district. Finally, systematic random sampling technique was employed to obtain program participant and non-participant respondents from the available lists of each sample kebeles. The size of interval for selection is determined by using the formula $(k = N/n)$ where; N is the total population, n is the required number of sample size and k is the size of interval for selection

(Mota et al., 2019). As indicated in equation (1), a total of 109 villagized and 112 non-villagized households were chosen from a total population of 256 and 263 villagized and non-villagized households, respectively. To determine the number of sample respondents for this study, a formula developed by Kothari (2004) was used. Therefore, when the population is finite, its mathematical notation is given by:

$$n = \frac{Z^2 \times p \times q \times N}{e^2 (N-1) + Z^2 \times p \times q} \tag{1.1}$$

Where: n= sample size, Z=1.96 (confidence interval of 95%), N=population size, P=the population proportion (assumed to be 0.5), $q = 1 - p = 0.5$, e= 5% error. Overall, there are 263 non-villagized and 256 villagized households, with a sample size of 112 and 109 households, respectively.

The sample size of non-villagized households; $n = \frac{(1.96)^2 \times 0.5 \times 0.5 \times 263}{(0.05)^2 (263-1) + (1.96)^2 \times 0.5 \times 0.5} = 112$ and the sample size of villagized households; $n = \frac{(1.96)^2 \times 0.5 \times 0.5 \times 256}{(0.05)^2 (256-1) + (1.96)^2 \times 0.5 \times 0.5} = 109$. Totally, 221 samples were drawn.

Table 1.1: Distribution of sample households by village centers

Woredas	Village sites	Total No. of HHs in the study area		Sample HHs	
		Participant HHs	**Non-participant HHs**	**Participant HHs**	**Non-participant HHs**
Assosa	Aberhamo	61		26	
	Abende Mengida	47		20	
	Ogusha		85		36
	Tsetse		56		24
Bambasi	Dabus	42		18	
	Womba	106		45	
	Afa Bergenare		42		18
	Afa Genare		80		34
	Total	**256**	**263**	**109**	**112**

Source: Own computation, 2022

1.8.4. Sources and tools of data collection methods

The required quantitative and qualitative data were obtained from both primary and secondary sources based on the research paradigm (pragmatism) and research technique (mixed method) mentioned above. To gather demographic, socioeconomic and relevant quantitative information about food security, local coping strategies, LULC dynamics, households' perception about climate change; structured questionnaire, and focus group discussions (FGDs) were used. Specifically, to collect quantitative information about the food security situation, an interviewer-administered questionnaire was used to ask household heads about the total amount of food/grains they produced, purchased, received through aid, gift, or remittance, as well as the amount of grains they sold, distributed to others, and set aside for seed.

In addition, the amount of meat, meat-based items, and poultry that household heads had consumed over the previous year was also asked. The net available food/grain in a particular year was then calculated using HFBM and converted to calorie intake/day/person following Degefa (2006). Additionally, food items adapted by WFP (2008) Technical Guidance Sheet were used with modifications to the local context to collect data on the frequency of food groups (i.e. grains and tubers; pulses; vegetables; fruit; meat and fish; milk; fats; and sugar) consumed by households over a seven-day recall period. Moreover, a set of questions were developed to capture households' basic consumption-related coping responses to inadequate access to food in a study area.

The spatial data acquired from satellite images from 1999 to 2022 were used to investigate the extent and trends of LULC dynamics. Multispectral LANDSAT satellite images were acquired for three years, namely, 1999, 2009, and 2022, from the United States Geological Survey (USGS) Earth Explorer data hub using path/row 171/53 (Table 4.1).

The qualitative data for this research were mainly generated through focus group discussions (FGDs). Eight FGDs with 7–12 participants in each group was held. The FGD participants were selected with great care to include men and women households who have good knowledge on issues related to VP, foods typically consumed, food security situations, local coping strategy, LULC dynamics and climate change adaptation strategies. Before the commencement of the collection of data, the questionnaire was pilot tested to check for any language barriers, the ambiguity of ideas and similar limitations. The FGDs were conducted by the researcher himself while the survey questionnaire were administered by enumerators who are familiar with the local language and they were also given adequate training on how to approach the respondents and manage the entire collection of the data. The secondary data were collected from annual reports concerning VP, food security, environment and land administration. Besides, reports of empirical studies by researchers and policies and regulations on the issue under study were also taken as an input.

1.8.5. Methods of data analysis

In this study, descriptive and econometric models were employed to analyze the quantitative data under consideration through STATA 15 software package. Descriptive and inferential statistics such as: frequency, percentage, means, t-tests and Chi^2 tests and econometric models including Tobit, Logit and propensity score matching (PSM) were used to analyze the data. Furthermore, following the transcription of the qualitative data obtained through FGDs, content analysis was performed to look for themes or categories of replies.

1.8.5.1. Measuring food security

Food security is a complicated and comprehensive term that stems from numerous interconnected and interdependent elements (Deléglise et al., 2022). Food security is ensured when all people have consistent economic, social, and physical access to sufficient, safe, and nutritious food that meets dietary requirements and food choices for an active and healthy lifestyle (FAO, 1996). Based on this definition, FAO (2008) established four elements of food security. The first element is *availability*, which is the physical presence of sufficient and nutritious food (Lawlis et al., 2018). Food security also requires households to have the *economic and physical resources* to acquire food, which is the second element of food security (FAO, 2008). The third component is *utilization*, which refers to households' ability to use food that they have access to in order to securely prepare and preserve nutritious meals (Ashby et al., 2016; Lawlis et al., 2018). The fourth component is *stability*, which is concerned with the ability of the nation/community/(household) person to endure shocks to the food chain system induced by natural disasters (climate, earthquakes) or man-made disasters (wars, economic crises) (Peng & Berry, 2019).

A suite of measurements are required for the assessment of food security status due to its multidimensional nature and the lack of a "gold standard" to quantify food security (Leroy et al., 2015). Though it is difficult to find a single measure that is comparable across time and space while also capturing all food security dimensions (Sahu et al., 2017; Upton et al., 2016), the WFP suggests using FCS as well as calorie intake to assess food security (WFP, 2022). This study focused on the three food security measurements: the FCS, which is a proxy indicator of household food access (Deléglise et al., 2022; WFP, 2022) and diet quality at household level, the HFBM, which is a proxy indicator physical availability of food (Abi & Tolossa, 2015; Tolossa, 2006), and the CSI, which captures the element of quantity or sufficiency of food (Maxwell & Caldwell, 2008; Vhurumuku, 2014). These indicators provide useful information on food frequency, quantity, and quality, as well as household economic access to food (Deléglise et al., 2022), and are some of the most commonly used in research by international organizations such as WFP and FAO (Maxwell et al., 2014; Vhurumuku, 2014). The FCS is a composite score based on dietary diversity, food frequency, and relative nutritional importance of different food groups and it is measured as the frequency of food groups consumed by households over the previous seven days (WFP, 2015).

The FCS is calculated by inspecting how frequently households consume food items from various food groups over a seven-day period (WFP, 2022). All food consumption frequency in the same group was summed together and multiplied by the value of each food group by its weight following the WFP (2008) Technical Guidance Sheet (Table 1.2). Each food item was assigned a score ranging from 0 to 7 based on the number of days it was consumed. Any total food group frequency value greater than 7 was recorded as 7. Given the total consumption of oil and sugar was high among all study participants in Assosa and Bambasi districts, the participants' food consumption category provides three alternative sets of cut-off points: Households with FCS of ≤ 28, between 28.5 to 42, and ≥ 42.5 are classified as poor, borderline, and acceptable consumption groups respectively.

Table 1.2: Nutrition based weight for food groups

Food group	**Weight**
Grains/Tubers (maize, barely, wheat, sorghum, teff, potatoes, and cassava…)	2
Vegetables and leaves (cabbage, carrot, okra and related)	1
Pulses (bean, pea, haricot bean)	3
Milk (local milk, powder milk)	4
Fruits (mango, avocado, pineapple, orange, apple, Papaya, banana,..)	1
Meat/Fish (meat, egg, fish)	4
Oil/Butter (butter, processed oil)	0.5

Sugar (sugarcane, honey, sugar)	0.5

Source: Adopted from WFP (2008)

HFBM is a modified form of a simple equation used to assess the food security of sample homes in terms of calorie consumption (Abi & Tolossa, 2015; Tolossa, 2006). The model was initially established by Tolossa (2006) modified on FAO Regional Food Balance Model and then employed by several researchers, including Agidew and Singh (2018), Abi and Tolossa (2015), Weldearegay and Tedla (2018), among others. The model involves the measurement of the average daily food availability to each individual in a sample household (Agidew & Singh, 2018). Following data collection, the researcher transformed the households' annual available food supply into kilograms, which were then converted into kilocalories using the FAO and EHNRI food composition tables (Weldearegay & Tedla, 2018). The converted data were then divided by the adult equivalent household size and the number of days in the recall period (365 days). In this regard, households classified as food secure had daily calorie intake greater than or equal to 2100 kcal, whereas households classified as food insecure had daily calorie intake below this level (WFP, 2015).

The CSI is used to examine the frequency and intensity of coping behaviors utilized in response to food insecurity (Coates, 2013; Maxwell & Caldwell, 2008). It is an estimate of the cumulative frequency of the potential food reduction techniques employed in each studied family during a 7-day period (Maxwell & Caldwell, 2008). The procedure for the computation of the CSI is that the frequency of each coping strategies were summed up and multiplied by a severity weight following Maxwell and Caldwell (2008). Because there was no perfect agreement on the severity weight across the area, the focus group discussants were insisted to weigh the severity weight of each individual strategy in to four categories: 4=very severe, 3=severe, 2=moderate and 1=least severe.

1.8.5.2. Methods of analyzing the determinants of households' food security status

In this section, descriptive statistics, the Foster, Greer, and Thorbecke (FGT) food insecurity index, and the Tobit model were employed to analyze the data. The study used the HFBM to assess the *households' food security status*. Foster, Greer, and Thorbecke (FGT) food insecurity index was also used to *estimate the households' food insecurity gap, and its severity'*. Using the Foster, Greer, and Thorbecke (FGT) food insecurity index, the study also determined the prevalence, depth, and severity of food insecurity. The model is essential for understanding the causes of change in food insecurity as a result of changes in the components. Therefore, in this study, the model enables us to estimate the three food insecurity indicators: the number of households below the food security line, the size of the calorie gap between the line and the food insecure, and the accurate distribution of kilocalories among the food insecure households (squared food insecurity gap).

Tobit model was used to '*identify the determinants of households' food security status'.* Because, Tobit is a better model than the standard list square model when a certain dependent variable is considered to be censored (2100 kcal/day in this study) for certain data and a continuous value for the other observations (OLS) (Wooldridge, 2002). The estimating methods of HFBM, Foster, Greer, and Thorbecke (FGT) food insecurity index and Tobit model are thoroughly explained in chapter 2, section 2.2.3.

1.8.5.3. Methods of analyzing the impact of VP on food security and climate change adaptation strategies

Descriptive statistics and econometric models (binary logistic regression and PSM were used to analyze the data. Descriptive statistics such as frequencies, percentages and mean were used to present the summary of socio-demographic characteristics, outcome indicators (FCS and HFBM), and households' perception to climate change. Logistic regression model was applied in order to *'assess the determinants of the decisions to participate in VP'* and estimate PSM. This is because; Logit model is less complex than probit model in estimating the propensity scores (Caliendo & Kopeinig, 2008).

The *'local coping mechanisms opted by households against food insecurity'*, '*the perception of rural households on climate change'*, and '*households' climate change adaptation strategies*, were assessed using descriptive statistics (percentage and mean) and supplemented by the information gathered from FGDs. In order to analyze '*the impact of villagization program on households' food security status'* and '*the impact of VP households' adaptation strategies to climate change risks'*, this study relied on the use of propensity score matching (PSM) technique. The detail steps and procedures of Logit model, PSM technique, FCS and CSI are discussed on chapter 3. The reasons for using PSM to assess the impact of VP on food security and climate change adaptation strategy are described more below.

1.8.5.3.1. Impact evaluation strategy

Impact evaluation is one of many complimentary techniques used to promote evidence-based policy/program (WFP, 2019, 2020). The assessment must be backed up by actual data from survey findings or by quantitative approaches that are related (Khandker et al., 2010). Impact evaluations are one sort of evaluation specifically designed to address cause-and-effect queries. Impact assessments are organized on a single type of topic, as opposed to general evaluations, which can address a variety of questions: *What effect (or cause) does a program have on a desired outcome*? In other words, it will provide an answer to the question, *"Is a certain program beneficial in comparison to its absence*?" (Gertler et al., 2011). Hence, the impact of the VP, or the influence on outcomes (food security and climate change adaptation strategy) that the VP directly creates, is the sole focus of this study. In order to determine the efficacy of the program, this kind of impact evaluation compares a treatment group that has participation in VP to a comparison group that did not.

Random assignment trials (RCTs) are often recognized as the most accurate technique of program evaluation. Because, random assignment of treatment ensures that the treatment group and the control group are similar in all aspects except that only the former group receives the treatment. Therefore, any systematic differences in the outcomes of interest between the treatment group and the control group are solely due to the treatment. For two reasons, participation in a program (i.e. villagization program) may not be completely random. 1) The communities where the programs are offered are not selected at random. 2) The program's participants are not chosen at random in the communities where it is offered. They might have been specifically chosen by program administrators, or they might have chosen to take part in the program on their own (Coble, 2021).Therefore, in these situations, nonrandomization (quasi-experimental) methods like Propensity Score Matching (PSM), Double Difference or Difference-In-Difference (DID), Regression Discontinuity Design (RDD), and Instrumental Variables (IV) estimates are used.

When there is no baseline survey and it is not possible to randomly assign treatment to testers, cross-sectional PSM (which require data from only one period) is one of the most often used approaches to assess the success of a program or policy. PSM is necessary to precisely assess the effects of certain interventions in order to give a strong empirical base (Zhao et al., 2021). It is a potential strategy to limit the influence of confounders and provide methods to evaluate the quality of interventions (Maturo & Rambaud, 2022). Excluding observations that do not fall within the "area of common support" is a useful feature of PSM approaches that allows for the easy exclusion of data for which such matches cannot be made (Coble, 2021).

1.8.5.4. Methods of analyzing LULC dynamics

Although there are many alternative ways to classify picture data, unsupervised and supervised algorithms are the two most popular approaches for mapping LULC (Luo et al., 2017; Madariya et al., 2022). In supervised classification, data is assigned to pre-existing classes after being separated into labels and used to train a system. The process consists of computing a model from a set of labeled training data and then applying the model to predict the class label for incoming unlabeled data (Antonelli & Guarracino, 2023).

Without the aid of labelled training samples, each image in a dataset is identified as belonging to one of the innate categories existing in the image collection in a process known as unsupervised image classification (Olaode et al., 2014). Unsupervised classification is used in this study because it allows for the identification of more classes than supervised classification (Oyekola & Adewuyi, 2018). Additionally, unsupervised classification technique is preferable because there is little pre- existing training data in the study area due to security concerns. Using the K-means image clustering algorithm, pixels are grouped according to their characteristics.

To improve classification accuracy, high-resolution images of Google Earth were linked in ERDAS Imagine 2014 to refine the area assigned from a particular LULC class to another LULC category for the 2022 unsupervised classification image. Then, the same procedure was employed to refine the 2009 and 1999 classifications, using the pixel values of the refined 2022 image as a reference. Visual analysis was also applied in this study using reference data and local knowledge to enhance the accuracy of the unsupervised classification. Considering that the historical maps of Ethiopia are poor (Dibaba et al., 2020; Yesuph & Dagnew, 2019), this study used a high-resolution maps from Google Earth to extract ground truth data and better reconstruct the land-use types. The researcher applied pre-classification and post-classification comparison techniques to detect land use land cover (LULC) changes based on remote sensing data. The post- classification approach is concerned with the classification of multiple date images separately so as to generate thematic maps (Priyatna et al., 2023; Tena et al., 2019).

Afterwards, a pixel-based comparison was made with the corresponding classes so that tables and maps portraying LULC changes were produced (Matlhodi et al., 2019). Besides, we used the Arc GIS 10.8 spatial analyst tool to produce maps depicting change matrix analysis for the reference years of 1999, 2009, and 2022.

1.9. Significance of the Study

This dissertation is thought to be critical in closing empirical, methodological, and knowledge gaps in evaluating the impact of VP. Researchers and policymakers overlooked the impact of VP on households' food security status and climate change adaptation strategy and hence, there are empirical or research gaps in the topic in the study area. Of course, some study has been conducted, but there aren't enough research methods to assess the program's effectiveness. As a result, this study is expected to close the indicated gaps, and the study's findings could serve as policy input as well as subsequent research initiatives.

This study's findings convey to policymakers the impact of VP on households' food security and climate change adaptation strategies, assisting them in adjusting future development measures. In addition, less emphasis has been placed on determining how villagization programs have influenced LULC changes in the study area. Thus, the result of this study provides planners and decision makers with up-to-date information on LULC dynamics for socioeconomic development, resource conservation, and sustainable land management.

1.10. Operational definition of terms

- *Household:* In Ethiopia, a household is defined as a person or group of people who reside in the same housing unit and share cooking facilities (CSA, 2013).
- *Land use land cover change:* Land cover change refers to a change in the continuous characteristics of the land, such as vegetation type, soil conditions, and so on, whereas land-use change refers to a change in how a specific area of land is used or managed by humans (Patel et al., 2019).
- *Non-participant households:* In the context of this study, households that did not participate in government-sponsored VP for a variety of reasons.
- *Non-villagized respondents*: In the context of this study, non-villagized refers to respondents who have not engaged in the BGRS's VP since 2010.

- *Participant households:* In the context of this study, households that freely or coercively participated in government-sponsored VP.
- *Propensity score matching:* is a method of assessing the impact of a certain program intervention by asking, "What would have happened to those receiving the intervention if they had not received the program?"(Caliendo & Kopeinig, 2008).
- *Resettlement*: is defined as the process by which individuals or groups of people leave their original settlement sites spontaneously or un-spontaneously to resettle in new areas where they can begin new life trends by adapting to the biophysical, social, and administrative systems of the new environment (Woube, 2005).
- *Villagization:* is a matter of relocating people from their original settlement into villages, presumably looking to better social and economic facilities as well as administrative services (Hailu et al., 2016; Messay & Bekure, 2011).
- *Villagized respondents*: In the context of this study, villagized respondent refers to respondents who have engaged in the BGRS's VP since 2010.

1.11. Structure of the Dissertation

This dissertation is divided into six chapters. The first chapter which is an introductory part has the following sections: background of the study, statement of the problem, objective of the study, research question, scope and limitation of the study and description of the study area. The first chapter also discussed the historical background of VP, theory of rural development, empirical frameworks and conceptual framework of the study. This chapter also discusses the research methodology, the significance of the study, operational definitions of terminology, and the structure of the dissertation.

The second chapter discusses the factors that influence a household's food security. The primary goal of this chapter was to examine the food security situations, the severity of the food insecurity gap, and the variables that affect households' food security. The third chapter investigated the influence of the villagization program on the food security status of households and attempted to analyze their local coping strategies. The fourth chapter examined the impact of the villagization program on land use and land cover dynamics. Chapter five identified the main climate change adaption techniques used by rural households and investigate how the villagization program affected these strategies in the study area. The final but not least chapter is synthesis, implication, recommendation and suggestions for future research.

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CHAPTER TWO

Determinants of Household Food Security

Abstract

Although several efforts have been made so far to improve the overall challenges of food security, it remains a major problem in the rural areas of Ethiopia particularly in Benishangul-Gumuz region. The objective of this study is to assess the food security conditions, the severity of the food insecurity gap as well as the variables that affect households' food security in the study area. The study is based on a mixed method research approach that combines quantitative and qualitative techniques. Probability and non-probability sampling techniques were used to generate 221 sample households. Primary and secondary data were gathered and utilized in order to achieve the objective. The Tobit model and descriptive statistics were used to analyze the data. The result indicated that 47.96% of the respondents were food secure whereas the 52.04% of the respondents were food insecure. The disparity between food insecurity gap and the severities of food insecurity were 8.9% and 2.53%, respectively. The average daily calorie consumption was 2672.71 kilocalories per day with the highest and lowest intakes of 15592 and 889 kilocalories per day respectively. Moreover, food security was positively and significantly related with the amount of cultivated farmland, irrigation farm size, livestock holding, access to grazing, and participation in off-farm activities. Contrarily, family size, dependence ratio, and distance to market had a negative and significant effect on respondents' food security situation. To reduce food insecurity, the regional and woreda agricultural office, NGOs, and other concerned bodies should promote irrigation, provide sufficient agricultural inputs, and raise knowledge about family planning to reverse the problem of food insecurity in the study area.

Key Words: *Calorie intake, food insecurity index, Benishangul-Gumuz region.*

2.1. Introduction

Food security is defined as having economic, social, and physical access to sufficient, safe, and nutritious food that meets the dietary requirements and food choices for an active and healthy life at all times (FAO, 1996). In contrast, food insecurity occurs when each member of a given household lacks economic, social, and physical access to sufficient, safe, and nutritious food to meet their dietary needs and food choices for a healthy and active life (FAO, 1996; FAO et al., 2013). For everyone to be able to achieve their dietary demands for an active and healthy life, they must always have physical and financial access to enough safe and nourishing food (Lipper et al., 2009). However, the number of individuals experiencing moderate or severe food insecurity increased significantly worldwide, rising from 2.05 billion in 2019 to 2.37 billion in 2020. Nearly 40% of them experienced extreme food insecurity, which means they had either ran out of food or, at worst, had gone an entire day without eating.

Around the world, over one in three people lack access to sufficient food. Levels of moderate to severe food insecurity also reveal ongoing and unsettling geographical disparities. As a result, in 2020, moderate to severe food insecurity affected populations in Latin America and the Caribbean, Asia, Oceania, Northern America, and Europe by 41%, 26%, 12%, and 8.8%, respectively. At both the severest and the least severe categories, food insecurity is still most prevalent in Africa. In 2020, 26% of Africans experienced extreme food insecurity, with about 60% of the continent's population experiencing moderate to severe food insecurity (FAO et al., 2021).

Ethiopia is one of the poorest and most food-insecure countries in Africa and among developing nations (Asrat & Anteneh, 2020). In this regard, there were 8.6 million people who were food insecure in 2020, up from 8 million in 2019. Moreover, acute food insecurity affected 16.8 million people in 2021 (Food Security Information Network, 2022). The presence of armed conflict, ethnic violence, high food costs, climate change, sporadic rainfall, invasion of desert locusts, and COVID-19 epidemic pose the biggest obstacles to achieving food security in Ethiopian (WFP & FAO, 2022). A significant rate of food insecurity also affected the Benishangul-Gumuz region as a result of irregular and unpredictable rainfall, degraded land, low per capita income, inadequate infrastructural development, and inadequate agricultural output

(Sani & Kemaw, 2019). For instance, a study by Daie and Labiso (2021) found that 67% of households in the Assosa zone of the Benishangul-Gumuz region experienced food insecurity.

Few studies have been conducted to comprehend the state of food security and the determinants of it in the Benishangul-Gumuz region, including those by Daie and Labiso (2021), Mohammed and Mohammed (2021), and Tsegaw, Endris, and Assefa (2022). However, studies on food security conditions, gaps in food security and their severity, and factors affecting food security in the particular study area (Assosa and Bambasi districts) are scarce. Additionally, sociocultural, and economic characteristics can vary from area to area, and the factors that determine food security are particular to geographic regions, production methods, and livelihood system (Mohammed and Mohammed 2021). Therefore, the purpose of this paper is to evaluate the severity of the food insecurity gap as well as the food insecurity conditions within the households in Assosa and Bambasi districts. This paper also made an effort to identify the variables that influence households' food security condition in the study area.

2.2. Materials and Methods

2.2.1. Sampling techniques and sample size determination

In this study, both probability and non-probability sampling techniques were used to collect primary data. In the beginning, two districts were purposely selected, namely, Assosa and Bambasi. This is because; these districts are the largest in population, accessible to the researchers and host a huge number of settlers. Then, eight kebeles were selected at random from the lists that were available in the districts. Finally, a systematic random sampling technique was employed to obtain respondents from the available lists of each sample kebele. To determine the number of sample respondents for this study, a formula developed by Kothari (2004) and practically tested and used by different scholars was used. Therefore, when the population is finite, its mathematical notation is given by:

$$n = \frac{Z^2 \times p \times q \times N}{e^2(N-1) + Z^2 \times p \times q} \tag{2.1}$$

Where: n = sample size, Z = 1.96 (confidence interval of 95%), N = population size, P = the population proportion (assumed to be 0.5), e = 5% error. For the total household size of 519 (Benishangul-Gmumuz Regional State Bureau of Agriulture, 2022), 221 sample sizes were drawn: $\mathrm{n} = \frac{(1.96)^2 \times 0.5 \times 0.5 \times 519}{(0.05)^2(519-1) + (1.96)^2 \times 0.5 \times 0.5} \approx 221$

2.2.2. Data sources and data collection methods

Primary and secondary data sources were used to collect the data. An interviewer-administered questionnaire was used to ask household heads about the total amount of grains they produced, purchased, received through aid, gift, or remittance, as well as the amount of grains they sold, distributed to others, and set aside for seed. In addition, the amount of meat, meat-based items, and poultry that household heads had consumed over the previous year was also asked. This makes easier to determine the net amount of food and grain that was available in a given year and provides information on the household heads' food security situations.

The questionnaire was pre-tested for its validity and reliability and the necessary modifications were made to the tools of data collection after the pre-test. Four enumerators familiar with the culture and local language of the study area were employed to collect the quantitative data. The enumerators were given adequate training in advance on how to approach the study participants and conduct the interviews. Additionally, reports, books, and journals were used to gather the secondary data.

2.2.3. Method of data analysis

The study used descriptive statistics, the Foster, Greer, and Thorbecke (FGT) food insecurity index and the Tobit model to analyze the data gathered. Descriptive statistics like mean, percentage, and frequency were employed to describe the socio-demographic characteristics of households and their level of food security. In particular, to measure the extent of food security, the net available food and grain households were computed using a modified form of a simple equation known as the Household Food Balance Model (HFBM) from the FAO Regional Food Balance Model (Tolossa, 2006). The quantity of food was calculated and converted into dietary calorie equivalents based on the food composition table compiled by the Ethiopian Health and Nutrition Institute (Ethiopia Health and Nutrition Research Institute, 2000). Then, the medically recommended levels of calorie per adult equivalent (2100 kcal/day/person for Ethiopia) were used as a cut-off point for food insecure and food secure households. Thus, respondents with daily calorie consumption greater than or equal to 2100 kcal per day were classified as food secure, while respondents with calorie consumption less than this food security threshold were classified as food insecure. Measuring food security using the calorie intake method is the most widely used technique by researchers such as (Eshetu and Guye 2021; Fikire and Zegeye 2022; Mohammed, Wassie, and Teferi 2021).

According to recent studies, post-harvest losses for main crops in Ethiopia were estimated to be around 15% on average (Befikadu 2018; Godebo 2020; Mohammed and Tadesse 2018) while farmers saved 5% of the total amount of crops they produced for seed (Abi & Tolossa, 2015). A modified household food balance model employed in this analysis is given by:

$$NF = (GP + GB + FA + GG + MP + DP) - (HL + GR + GS + GV) \qquad (2.2)$$

Where, NF= Net food available (kilogram/household/year), GP = Total grain production (kilogram /household/year), GB = Total grain bought (kilogram/household/year), FA = Quantity of food aid obtained (kilogram/household/year), GG = Total grain obtained through gift or remittance (kilogram /household/year), MP=Meat, meat-based products and poultry (kilogram /household/year), DP = Dairy and dairy-based products (kilogram/household/year), HL = Post-harvest losses due to grain pests, disasters, thievery, etc. (kilogram/household/year, GR = Quantity of grain reserved for seed (kilogram/household/year), GS = Amount of grain sold (kilogram/household/year), and GV = grain given to others (kilogram/household/year).

The prevalence, depth, and severity of food insecurity were also calculated using the Foster, Greer, and Thorbecke (FGT) food insecurity index. This methodology provides a definable indicator of both food insecurity and poverty (Foster and Shorrocks 1988). The model is crucial for understanding the causes of change in food insecurity as a result of changes in the components, especially in food security analysis. Thus, in this study, the model allows us to estimate the three food insecurity indicators: the headcount of households below the food security line, the length of the kilocalorie gap between the food insecure and the line, and the precise distribution of kilocalories among the households that are food insecure (squared food insecurity gap). Accordingly, Foster, Greer, and Thorbecke (1984) measure used in the estimation of food insecurity index components is given as:

$$FGT(\alpha) = \frac{1}{n}\sum_{i=1}^{q}[(c - y_i)/c]^{\alpha} \qquad (2.3)$$

Where; FGT (α) is the FGT food insecurity index; $n =$ is the number of sample respondents; $y_{i=}$ is the measure of food kilocalorie intake of the i^{th} household; $c =$ represents the cut-off between respondents with food security and those with food insecurity (expressed here in terms of caloric requirements of 2100 kcal); q =is the number of food-insecure respondents, and is the weight given to the severity of food insecurity. When it comes to model estimation, the indicator is the headcount ratio (incidence) when the weight associated with $\alpha = 0$, the food insecurity gap (depth of food insecurity) when $\alpha = 1$, and the squared food insecurity gap when $\alpha = 2$.

Additionally, the Tobit model was employed to identify the factors that contribute to the degree of food insecurity among respondents in the research area. The Tobit model is a member of a group of economic methods known as censored regression models (Wooldridge, 2002). Tobit is a better model than the standard list square model when a certain dependent variable is considered to be censored (2100 kcal/AE/day in this study) for certain data and a continuous value for the other observations (OLS) (Amore & Murtinu, 2021). The coefficients from the analysis may not necessarily converge to the "actual" population parameters as the sample size increases since OLS offers inconsistent estimates of the parameters (Long, 1997). Thus, in this study, the dependent variable was a censored variable in which it assumed a constant or threshold value of 2100 kcal/AE/day for food-secure households and the actual energy intake in kilocalories for food-insecure households. Suppose thatY_i is observed if the latent variable $Y_i < 2100$ kcal and is not observed if $Y_i > 2100$ kcal. Then the observed $Y_i$will be defined as:

$$Y_i = \begin{cases} Y_i^* = \beta x_i + u_i & if\ Y_i^* < 2100\ kcal \\ 2100\ kcal & if\ Y_i^* \geq 2100\ kcal \end{cases} \qquad (2.4)$$

Where; Y_i the observed variable $Y_i^*$is the latent (unobserved) variable, $x_i$is a vector of explanatory variables, u_i is a vector of error terms and β is a vector of parameters to be estimated.

2.2.4. Definition and measurement of variables

The threshold value is used by the household food balance model (HFBM), which assesses the degree of food security (2100 kcal). The assumption is that the household is food secure if the total food energy consumption is greater than or equal to the threshold value, and that the household is food insecure if the total food energy intake is less than the threshold value (equation 4). Besides, the choice of potential independent variables which can affect the extent of households' food security in the study area was based on the experience of previous studies and economic, social, cultural, or political factors. Therefore, the major variables that are expected to influence household food security and their specific hypotheses are explained in Table 2.1.

Table 2.1: Definition, measurement and expected sign of variables

Variables	Definitions and Measurement	Expected sign
Gender	1= if the household head is male, 0=otherwise	+
Age	Age of the household head in years	+/-
Family size	Family size in Adult equivalent	-
Sex ratio	Ratio of the female members to the male members	-
Dependency ratio	Ratio of inactive labor force to active labor force	-
Literacy rate	1= if the household head is literate, 0= otherwise	+
Cultivated farm size	Cultivated farm size in hectare	+
Irrigation farm size	Cultivated irrigation farm size in hectare	+
Livestock holding	Livestock ownership in TLU	+
Access to grazing	1=if the household head has access to grazing, 0=otherwise	+
Participation in off-farm activities	1=if the household head has participated in off-farm activities, 0=otherwise	+
Access to credit	1=if the household head has access to credit, 0=otherwise	+
Distance to the market	Distance to the nearest market in kilometer	-

Source: Own construction based personal experience and literature review (2022)

2.3. Results and Discussions

2.3.1. Socio-demographic characteristics of respondents

The primary data was collected from a total of 221 sampled respondents. Out of the total respondents, 71.5% are from male-headed households and the remaining 28.5% are from female-headed households (Table 2.2). The age of the respondents ranges from 19 to 78 years, and the mean age is 36 years. The majority (72%) of the respondents was found in the age category of 19–39 years, and the least (3.6%) were in the age group above 60 years. The structure of the marital status of the household head indicates that out of the total sample respondents; the majority (75.1%) are married, while the remaining; 13.6%, 6.8%, and 4.5% of the respondents were single, divorced, and widowed, respectively. Furthermore, the majority (55.2%) of the respondents had a family size falling between 3 and 5 members, with a mean size of 4.58. Concerning the educational status, the majority (56.1%) are illiterate (cannot read and write), while the remaining 43.9 % were literate. Regarding annual income earned from different livelihood activities, 16.3% of the households earned less than 10,000 Ethiopian birr. The majority (57.5%) of households earned between 10,000 and 20,000 Ethiopian birr, with a mean value of 15815.44 Ethiopian birr.

Table 2.2: Socio-demographic characteristics of respondents

Variables	Category	Frequency	(%)	Remark
Gender	Female	63	28.5	
	Male	158	71.5	
Age	19-39	159	72	Min.=19
	40-60	54	24.4	Max= 78
	Above 60	8	3.6	Mean=36
Marital status	Single	30	13.6	
	Married	166	75.1	
	Divorced	15	6.8	
	Widowed	10	4.5	
Family size	< 3	42	19	Min.=1
	3-5	122	55.2	Max. =9
	≥ 6	57	25.8	Mean=4.58
Literacy rate	Illiterate	124	56.1	
	Literate	97	43.9	
Annual income (Ethiopian birr)	< 10000	36	16.3	Min.=6780
	10000-20000	127	57.5	Max. =45600
	>20000	58	26.2	Mean=15815.44

Source: Own computation (2022)

2.3.2. Households' food security situations

The amount of energy utilized in kilocalories by the household was compared with the minimum subsistence daily calorie requirement level (i.e. 2100 kcal/day). The finding revealed that the main food energy source in the study area was production of different food grains, which accounted for 81% of the total available food calories, followed by domestic purchases that covered 16% of a calorie per capita. Food aid and remittances contribute only 3% of the total available food calories. Accordingly, maize, sorghum, millet, and okra (locally called 'Kenkes') are found to be the staples most frequently consumed in the study areas. Additionally, according to the results of the HFBM calculation, 106 sampled households (47.96%) were determined to be food secure, whereas 115 sampled households (52.04%) were found to be food insecure. The study's results also showed that the sampled households' average daily calorie intake was 2672.71 kcal for adult equivalents, which was higher than the minimum 2100 kcal needed for a healthy and productive life (Table 2.3).

Table 2.3: Summary of households' energy intake in the study area

HFBM	Food secure (N = 106)			Food insecure (N = 115)			Total (N = 221)		
Energy intake	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
(kcal/AE/day	2114	15592	3683.29	889	2098	1741.22	889	15592	2672.71

Source: Own computation (2022)

2.3.3. Extent of households' food insecurity

The severity of food insecurity was evaluated using the Foster, Greer, and Thorbecke's (FGT) food insecurity index. As a result, the headcount ratio from the food insecurity index revealed that the incidence of food insecurity was 52.04%, meaning that 52.04% of the households were actually experiencing food insecurity, which is defined as not being able to obtain the minimal amount of calories necessary for subsistence. Besides, the food insecurity gap, which is a measure of the depth of food insecurity, pointed out that each food-insecure household needed 8.9% of the daily caloric requirement to bring them up to the recommended daily caloric requirement level. In order to overcome the issue of food insecurity, households must typically get 8.9% of the daily basic calorie requirement. Therefore, 186.9 Kcal/AE/day of additional food energy would be required on average to move households out of food insecurity. Additionally, the FGT food insecurity index's squared food insecurity gap result showed that the respondents' food insecurity level was 2.53% severe (Table 2.4).

Table 2.4: FGT food insecurity index results on the extent of food insecurity

FGT measures	Percent (%)
Headcount ratio (Incidence of food insecurity)	52.04
Food insecurity gap (Depth of food insecurity)	8.9
Squared food insecurity gap (Severity of food insecurity)	2.53

Source: Own computation (2022)

2.3.4. Determinants of the extent of households' food insecurity

As discussed in the methods section, the Tobit model was used to analyze the determinants of the extent of households' food insecurity situations in the study areas. As a result, the Tobit model regression output for both categorical and continuous variables is presented in Table 2.5. The model as a whole fits much better than an empty model, according to the likelihood ratio chi-square, which is 131.25 and has a p-value of 0.0000. (i.e. a model with no predictors). Besides, the model estimate revealed that out of the 12 explanatory variables, 8 variables were found to have a significant effect on households' extent of food security (Table 2.5). Tobit regression coefficients are interpreted in the same way as OLS regression coefficients, except that the linear effect is on the uncensored latent variable rather than the observed outcome (McDonald & Moffitt, 1980). The results of the Tobit model were discussed in detail as follows;

Family Size: The result indicated that family size has affected households' extent of calorie intake (food security) negatively at a 1% level of significance. The coefficient of family size revealed that with one extra person added to a household, there is a 56.8 decrease in the households' calorie intake while other variables remain constant. This indicates that households with larger family sizes tend to be more food calorie deficient than households with smaller family sizes. This may be households that rely on scarce resources would experience food insecurity as a result of growing family sizes. This result is consistent with the research by Mohammed and Mohammed (2021), who revealed that having an additional family member reduces the likelihood of being food secure by about 17.97%. Similarly, Sani and Kemaw (2019) found that the likelihood of a household experiencing a food energy intake shortage increased by 1211% with one additional member in the household is also in line with the findings of this study.

Dependency ratio: The regression analysis result showed that the dependency ratio has a negative effect on households' calorie intake (food security) at a 5% level of significance. The result implies that a unit increase in dependency ratio leads to a 403.44 decrease in households' calorie intake while keeping other things constant. The possible explanation could be the existence of less active labor force in a household leads to a rise in dependent family members, higher consumer spending, and a decreased capacity to feed the household. This result is consistent with recent findings such as (Mengistu & Kassie, 2022; Owoo, 2021; Samim et al., 2021). For instance, Samim et al. (2021), revealed that for each incremental unit in the dependency ratio size, the likelihood that a household will be food secure decreases.

Cultivated farm size: Cultivated farm size is positively related to households' extent of calorie intake (food security) at a 5% level of significance. Keeping other variables constant, for a one-hectare increase in cultivated farm size, there is a 49.8 increase in households' calorie intake. This indicates that households that had large farm sizes are less likely to be more food insecure than those that had small or no farm sizes. This result is consistent with the findings of Diramo et al. (2018), who revealed that each additional hectare of arable land will increase a household's food security status by a factor of 0.68. In addition, in line with this study, the research of Habtewold (2018) in the Oromia region found that increasing farm size by one hectare increased the likelihood of being food secure by 1.39 times. In contrast, the findings of Awoke et al. (2022) indicated that as the land size holding increased by one more hector, the probability of being food secure decreased by 0.48 in the central and north Gondar. This result was justified by the fact that farmers spent resources by concentrating on increasing their farmland rather than employing more advanced agricultural technologies.

Irrigation farm size: Irrigation farm size influenced extent of food energy intake positively at a 10% level of significance. For a one hectare increase in irrigation farm size, there is a 400.3 increase in households' calorie intake, while other things remain constant. This is because households that have access to irrigation farms can produce twice to three times per year, which can increase the yields of crops. This result is in line with those of Jambo et al.(2021), who revealed that households that participated in small-scale irrigation increased the daily calorie intake by 643.76 than those that did not have the option to do so.

Livestock size: The model result indicated that livestock size is positively related to households' extent of calorie intake (food security) at a 5% level of significance as postulated. The finding implies that for a unit increase in the tropical livestock unit (TLU), there is a 17.4 increase in households' calorie intake at citreous perilous. This implies that households having a larger number of tropical livestock units (TLU) can have a better food security status in the study areas. This result is supported by Melese and Alemu (2021), who have shown that the probability of being severely food secure increases by 26.6% as the number of oxen increases by one. Similar findings were made by Tsegaw et al. (2022), who revealed that a unit increase in livestock in tropical livestock unit can raise households' dietary diversity food scores by 4.36%.

Access to grazing: Access to grazing is positively related to households' extent of calorie intake at a 1% level of significance as postulated. The extent of calorie intake was 193 points higher for households that had better access to grazing land than for those that had not.

Participation in off-farm activities: Participation in off-farm activities influenced households' extent of calorie intake positively and significantly at a 1% significance level. This implies that the predicted value of households' extent of calorie intake is 189.4 points higher for households that have participated in off-farm activities such as petty trade, traditional gold mining, collecting and selling of firewood, and charcoal, and others. This result is consistent with the research of Endiris et al. (2021), which showed that rural farmers who participated in off-farm activities had higher household food security status compared to those do not participated.

Distance to market: Distance to market influenced households' extent of calorie intake negatively at a 1% level of significance. The result showed that an increase in distance to the market may lead to a decrease in households' calorie intake while keeping other variables constant. The implication is that households that are closer to the market are more likely to be food secures than those far from it. This result agrees with the findings of Akukwe (2020) who found that households who live near a market on a regular basis are more likely to be food secure than those who live far away. Similarly, Fikire and Zegeye (2022) revealed that a household that is located one kilometer away from the market has decreased the probability of food security by 4.6% as compared to households that were nearby the market.

Explanatory variables		**Coefficients**	**Std. Err**	**t-statistics**
Gender	Male	54.69523	63.43859	0.86
Age		-2.017357	2.75864	-0.73
Family size		-56.81816	17.78654	-3.19***
Sex ratio		28.25628	77.80481	0.36
Dependency ratio		-403.4446	161.6928	-2.5**
Literacy rate	Literate	40.05506	59.41146	0.67

Table 2.5: Tobit model result on determinants of extent of food insecurity

Cultivated farm size		49.8261	20.31163	2.45**
Irrigation farm size		400.2874	206.5396	1.94*
Livestock holding (TLU)		17.44559	8.347625	2.09**
Access to grazing	Yes	193.0736	61.0884	3.16***
off-farm activities	Yes	189.4157	70.54177	2.69***
Access to credit	Yes	57.53145	61.3808	0.94
Distance to market		-6085.15	1380.412	-4.41***
Constant		2208.165	185.3766	11.91
Sigma		346.7788	24.23777	
		No. of Obs.=	221	
		LR chi2(16) =	131.25	
		Prob> chi2 =	0.0000	
Log likelihood =-876.54452		Pseudo R2 =	0.0697	
Observation summary		115 uncensored observations 106 right-censored observations at calorie intake >= 2100		

*, **and *** denotes statistically significant level at 10%, 5% and 1% respectively.
Source: Own computation (2022)

2.4. Conclusions and Policy Implications

2.4.1. Conclusions

In this research, the severity of household food insecurity, the incidence of food insecurity, and the food insecurity gap have been analyzed in the selected districts of the Benishangul-Gumuz regional state. The main food energy source in the study areas was the production of different crops: maize, sorghum, millet, and fruits and vegetables such as mango, papaya, avocado, and okra (locally called "Kenkes"). But, eliminating or reducing food insecurity continues to be a challenge for rural communities in the study areas. As a result, the study indicated that more than half of the surveyed rural households (52.04%) were unable to get the minimum daily energy (2100 kcal) requirement. Besides, the food insecurity gap (8.9%) and the severity of food insecurity (2.53%) were also high in the study areas. Moreover, the food insecurity status of the household was determined by different socio-demographic, economic, and institutional factors. Hence, the estimated Tobit model results revealed that family size, dependency ratio, and distance to market had affected households' extent of calorie intake (food security) negatively whereas cultivated farm size, irrigation farm size, livestock holding, access to grazing land, and participation in off-farm activities had positive correlation with households' extent of calorie intake (food security).

2.4.2. Policy implications

As the study indicated, irrigation and cultivated farm size were positively related to households' extent of calorie intake in the study areas. Thus, construction of additional small-scale irrigation schemes, the provision of sufficient inputs, and improving households' technical skills to enhance agricultural production and productivity are essential. In addition, participation in off-farm activities influenced households 'calorie intake positively in the study area. Thus, the relevant organization should develop interventions to improve farmers' involvement in off-farm activities (petty trade, traditional gold mining, collecting and selling of firewood, and charcoal) intended to improve household food security situation. Several studies, including this one, have found that having a larger family increases the likelihood of food insecurity. As a result, raising awareness about effective family planning is important for ensuring food security.

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CHAPTER THREE

Impacts of Villagization Program on Households' Food Security status and Local Coping Strategies

Abstract

Villagization program was amid to amalgamate the scattered settlement patterns of pastoral and semi-pastoral communities into a contiguous form of villages. The program was meant to enable the government to supply socio-economic infrastructure and improve agricultural technologies in a more convenient manner. Villagization is therefore designed to help the communities alleviate rural poverty and improve food security. The main goal of this study is to analyze the impact of the villagization program on households' food security situation in the Benishangul-Gumuz Regional State and assess their local coping strategies. The study used a cross-sectional survey research design in which both probability and non-probability sampling techniques were used to select sample households targeted for data collection. Accordingly, 109 and 112 household samples were randomly selected from village and non-village households, respectively. Descriptive statistics, a logistic model, and Propensity Score Matching techniques were used to analyze the data. The results revealed that compared to households incorporated into villagization program, non-villagized households were found to be better in terms of food consumption and calorie intake. The propensity score matching results indicated that non-villagized households' food consumption scores were 3.56 times higher than villagized households. In addition, non-villagized households showed 573.9 times higher kcal/day as compared to the villagized households. Moreover, villagized households took more severe food coping responses compared with non-villagized households due to food shortages. To tackle the food insecurity issue of villagized households, the regional government and other concerned bodies should fulfill basic infrastructure and provide agricultural inputs. In addition, in the future, villagization program should be carried out through the active participation of beneficiaries.

Keywords: *Villagization, propensity score matching, food security, local coping strategies*

3.1. Introduction

Villagization is one aspect of a resettlement program usually implemented to provide the rural population with a more applicable and manageable modern means of improving their current livelihoods (De Wet, 2012). It is also the term used to describe the process of transferring rural residents who live in dispersed settlements to large, government-designed villages, either voluntarily or forcibly (Messay & Bekure, 2011; Stevenson & Buffavand, 2018). Villagization programs were regarded as popular strategies by national and local governments in developing countries for promoting local and national development (Gebresenbet, 2021; Rogers & Wilmsen, 2020). The majority of nations use villagization program to encourage: 1) infrastructure development, such as building roads or dams (Asiama et al., 2017; Tilt & Gerkey, 2016), 2) extensive natural resource extraction (Owen et al., 2018; Yang et al., 2017) and 3) preservation of the environment and ecological restoration (Karanth et al., 2018). Additionally, dangers brought on by climate change (i.e., droughts, floods, storms, famine) might lead to widespread villagization (Messay & Bekure, 2011).

Many African countries, including Tanzania, Mozambique, Rwanda, Zimbabwe and Cameroon, have developed and put into practice villagization schemes. None of them, however, were able to modernize their respective populations as intended (Havugimana, 2009; Leeuwen, 2001). In Ethiopian history, villagization program was envisioned as a remedy—almost a panacea—for rural populations' poverty and suffering (Dessalegn, 2003). The program as a method of transforming the rural community started mainly in the 1980s, during the Derg regime, however, the anticipated outcome was not realized (Dessalegn, 2003; Yantiso, 2009). Similar to the previous regimes (i.e. Haile Selassie and the Derg), the EPRDF has also implemented a huge villagization program in several regions of the nation since 2003 primarily to address issues with food insecurity and poverty in rural areas (Daie, 2012; Messay & Bekure, 2011).

The EPRDF has also developed a villagization program specifically for pastoral and semi-pastoral communities in order to gather 1.5 million people in preset areas. As a result, it was planned for some 500,000 people in the Somali, 500,000 in the Afar, 225,000 in the Benishangul-Gumuz, and 225,000 in the Gambella regions to be gathered in planned villages (New Coalition for Food Security in Ethiopia (NCFSE), 2003). The program's objectives were to provide fundamental socioeconomic infrastructure and guarantee food security (Hailu et al., 2016). The program was formally launched since 2010 in almost all districts of Benishangul-Gumuz region. Accordingly, the regional government has gathered 45,817 households (almost 229,085 people) into 239 nucleated villages between 2010 and 2018 (Benishangul-Gumuz Regional State (Benishangul-Gumuz Regional State (BGRS), 2018).

Despite the government's claims that the villagization program will enhance socioeconomic growth, modernization, and food security, the empirical studies have demonstrated that the results are in doubt. For instance, Amare (2016) and Tesfaye (2020) revealed that the relocated communities to new villages as a result of villagization program have improved their food security situation. To the contrary, villagization schemes resulted in multifaceted impacts on the socioeconomic condition of the resettled communities as well as on environmental resources of the host population. These include violations of human rights; land grabbing (Human Rights Watch, 2012; Mittal, 2015); rampant food insecurity (Vanclay, 2017; Wilmsen et al., 2019); and rapid forest depletion (Abera et al., 2020; Gebre & Andualem, 2018; Getahun et al., 2017).

Whatever the situation may be, there hasn't been much study on how the villagization program has affected the level of food security in rural households in the Benishangul-Gumuz region. For instance, Daie and Labiso (2021) have made an effort to evaluate the effect of villagization program on rural household food security. However, this investigation did not employ enriched methodology, making it challenging to pinpoint the program's impact on food security. In order to close this gap and give strong empirical bases, propensity score matching (PSM) technique was used to analyze the impact of the program. Another limitation of previous research was its inability to explore the local coping mechanisms employed by households in the study area to mitigate food insecurity, a topic this study has addressed. This study also attempts to provide information for policy and decision-makers in order to improve food security situations in the areas under study. Therefore, the goal of this study is to analyze the impact of villagization program on households' levels of food security and identify their local coping strategies in the selected districts of Benishangul-Gumuz region.

3.2. Materials and Methods

3.2.1. Research design and sampling techniques

A mixed method research design was employed in this study. Both probability and non-probability sampling techniques were used to collect primary data from different sources. Accordingly, the Assosa and Bambasi districts were purposely selected due to the existence of a relatively high number of villagized households as well as a large population and vast area coverage. This was followed by the selection of eight villages (four villagized and four non-villagized) using simple random sampling. Finally, a systematic random sampling technique was employed to obtain villagization program participant and non-participant households from the available lists of each sample kebele. To determine the number of sample respondents for this study, a formula developed by Kothari (2004) and practically tested and used by different scholars was used. Therefore, when the population is finite, its mathematical notation is given by: $n = \frac{Z^2 \times p \times q \times N}{e^2 (N-1) + Z^2 \times p \times q}$ (3.1)

Where: n= sample size, Z=1.96 (confidence interval of 95%), N=population size, P=the population proportion (assumed to be 0.5), $q = 1 - p = 0.5$, e= 5% error. Overall, there are 263 non-villagized and 256 villagized households, with a sample size of 112 and 109 households, respectively.

The sample size of non-villagized households; $n = \frac{(1.96)^2 \times 0.5 \times 0.5 \times 263}{(0.05)^2 (263-1) + (1.96)^2 \times 0.5 \times 0.5} = 112$ and the sample size of villagized households; $n = \frac{(1.96)^2 \times 0.5 \times 0.5 \times 256}{(0.05)^2 (256-1) + (1.96)^2 \times 0.5 \times 0.5} = 109$. Totally, 221 samples were drawn.

3.2.2. Data sources and collection methods

The necessary quantitative and qualitative data were gathered from a variety of sources. Quantitative data was collected using a survey questionnaire. The questionnaire was pre-tested and the necessary adjustments were made based on the feedback obtained from pre-test participants. A total of 12 enumerators who are familiar with the culture and the local language were trained and participated in collecting data from sample households. The qualitative data was generated through focus group discussions (FGDs) and an observation checklist. Eight FGDs with 7–12 participants in each group was held. The FGD participants were selected with great care to include men and women households who have good knowledge on issues related to villagization schemes, food security situations and coping mechanisms of the area. Besides, the secondary data was collected from relevant regional and local authority reports, books, and journals.

3.2.3. Methods of data analysis

The quantitative data were analyzed using descriptive statistics and econometric models (binary logistic regression and Propensity Score Matching (PSM)). Descriptive statistics such as frequencies, percentages and mean were used to present the summary socio-demographic characteristics and food security indicators of respondents. In order to describe the variables that affected households' participation in the villagization program and to estimate propensity scores, the Logit model is utilized. Finally, the impact of the villagization program on the food security status of rural households in the study area is examined using the Propensity Score Matching (PSM) technique.

Food Consumption Score (FCS): The FCS of the sample respondents were calculated using the Technical Annex from (WFP, 2015) and grain and tuber, pulses, vegetables, fruit, meat and fish, milk, lipids, and sugar are among the food component categories. The frequency of consumption and weights attached to each food group is used for computing food consumption score (Carletto et al., 2013). For observed consumption pattern where oil and sugar are part of frequently consumed food groups, the food consumption score yields categorical information regarding the level of food consumption achieved and provide three alternative set of cut-off points: In this regard, households with FCS of ≤ 28, between 28.5 to 42, and ≥ 42.5 are classified as poor, borderline, and acceptable consumption groups respectively.

$$\text{FCS} = (\text{grain \& tubers} * 2) + (\text{Pulses} * 3) + \text{vegetables} + \text{fruits} + (\text{meat} * 4) + (\text{milk} * 4) + (\text{fats} * 0.5) + (\text{sugar} * 0.5) \qquad (3.2)$$

The Household Food Balance Sheet Model (HFBM): The model was initially formulated by (Tolossa, 2006) adapted from FAO Regional Food Balance Model and then used by various researchers. A modified household food balance model employed in this analysis is therefore given by:

$$NGA = (GP + GB + FA + GG + MP + DP) - (HL + GR + GS) \qquad (3.3)$$

Where; NGA=Net grain available, GP=Total grain produced, GB= Total grain bought, FA= Quantity of food aid obtained, GG= Total grain obtained (gift or remittance), MP =Meat, meat based products and poultry, DP= Dairy and dairy based products, HL= Post harvest losses due to grain pests, disasters, thievery, GR= Quantity of grain reserved for seed, GS= Grain sold.

Households who are found to fall above or equal to the national minimum daily calorie requirement level (≥ 2100 kcal/day/adult equivalent) were categorized as food secure and households who fall below the national daily calorie requirement are categorized as food insecure (Abi & Tolossa, 2015).

The coping strategies index (CSI): The CSI measures the experience of food insecurity as opposed to tools that base their assessments on consumption or caloric intake (REACH, 2021). It consists of coping strategies used by households when there is a food or financial deficit (Maxwell & Caldwell, 2008). Following Maxwell and Caldwell (2008), a set of questions were developed to capture households' basic consumption-related coping responses to inadequate access to food in a study area. The measurement of the coping strategies index of the respondents can be summarized by the following relationships:

$$CSI = \sum_{i=0}^{k} F_i \, S_i \qquad (3.4)$$

Where; F_i = Frequency of the ith coping mechanism taken by a household in the past 7 days; S_i = is the severity weight attached to ith coping mechanism and k = maximum number of coping strategy.

3.2.4. Model specification

At the practical level, experiments are often costly and require close monitoring before and after program intervention. There may also be the possibility of being denied treatment, which can pose ethical issues that are politically sensitive. Thus, another alternative to the experimental approach is the use of quasi-experimental approaches that seek to create, using empirical methods, a comparable comparison group that can serve as a reasonable counterfactual (Winters et al., 2011).One of the quasi-experimental approaches mostly applied to a wide variety of subjects to identify the causal effects of policies, development programs, and projects in developing countries is Propensity Score Matching (PSM) technique. This study uses the Propensity Score Matching (PSM) procedure because it is a useful strategy to prevent bias and misleading issues (Bekele et al., 2021) and because it is a strong quasi-experimental technique that measures an intervention's impact in a straightforward manner (Caliendo & Kopeinig, 2008; Dillon, 2011). In order to estimate the PSM primarily the best matching estimator should be chosen among the available options, such as Nearest Neighbor (NN) matching, Caliper or Radius matching, Stratification or Interval matching, and Kernel and Local Linear matching (Khandker et al., 2010). Checking for overlap (common support) is another step for the implementation of PSM, which ensures that individuals/groups with the same values for characteristics X have a positive probability of being both participants and non-participants of a program, and it enables us to compare comparable units (Legesse et al., 2018).

A number of techniques are available for matching quality/effect analysis including; mean comparisons between treatment and comparison groups (before and after matching), standardized bias, and overall measures of covariate imbalance. In addition, comparison of pseudo-R^2 before and after matching is also an important method in testing the matching quality (Sianesi, 2004). It indicates how well the covariates X explain the probability of participating in the treatment. The Pseudo-R^2 has to be very low after matching to indicate success of the matching (Caliendo & Kopeinig, 2008).Before analyzing the impact of the program on the household food security status, the participation equation should be described using the Logit model, where the dependent variable, i.e., program participation, takes 1 when a household head participates in the villagization program and 0 otherwise. Hence, the cumulative logistic probability function was specified as:

$$P_i = F(Z_i) = F[\alpha + \sum_{i=1}^{m} \beta_i X_i] = \left[\frac{1}{1+e^{-[\alpha+\sum \beta_i X_i]}}\right] \quad (3.5)$$

Where: P_i = the probability that an individual participates in villagization program X_i = represents the i^{th} explanatory variable α and β_i= are parameters to be estimated. e = represents the base of natural logarithms.The probability that a given household who did not participated in villagization program can be defined as:

$$[1 - P_i] = \left[\frac{1}{1 + e^{Z_i}}\right] \quad (3.6)$$

The ratio of the probability that a household who has participated in the program (eq.4) to the probability of that it who did not participated in the program (eq.5) (the odds ratio) is given by;

$$\left[\frac{P_i}{1-P_i}\right] = \left[\frac{1+e^{Z_i}}{1+e^{-Z_i}}\right] = e^{Z_i} \quad (3.7)$$

The above natural logarithm including to disturbance term can be expressed as:

$$Z_i = \ln\left[\frac{P_i}{1-P_i}\right] = Z_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_m X_m + U_i \quad (3.8)$$

Where; Z_i is natural logarithm of the odds ratio, α is an intercept β_1, β_2 and β_m are partial slopes of the equation. $X_1, X_2 ... X_m$ are vectors of explanatory variables. U_i is the error term.

Finally, the Average Treatment Effect on the Treated (ATT) can be estimated using the following

steps: $Ti = Yi(1) - Yi(0)$ (3.9)

Where; $Yi1$ and $Yi0$ is the outcome with and without treatment respectively for household i. Consider $D = \{0,1\}$ to be a binary indicator where 1 equals being assigned into treatment and 0 means not being assigned treatment. The Average Treatment Effects (ATE) can be estimated through:

$$ATE = E[Yi/Di = 1] - E[Yi/Di = 0] \quad (3.10)$$

ATE is hence the average difference between the treated households (villagized households) and the non-villagized households. However, such comparison might not capture the true impact of the treatment if we have selection into treatment and there are other factors that are correlated with both treatment and some omitted variable that is affecting the outcome variable. A fundamental problem is that we can observe the outcome variable under either treatment or control for each household, but never both at the same time. In this case, a preferred parameter to use instead of ATE is the Average Treatment Effect on the Treated (ATT), defined by:

$$ATT = E\left[\frac{Y^1}{D} = 1\right] - \left[\frac{Y^0}{D} = 1\right] \quad (3.11)$$

Where; $E({Y^1}/_{D} = 1)$ is never observed, replacing it by the expected value of $({Y^0}/_{D} = 0)$, which

is observable in ATE, will not give an accurate estimate as long as Y^0 for the treated and comparison group systematically differs. The true parameter is only identified if:

$$E[Y^0|D = 1] - E[Y^0|D = 0] = 0 \quad (3.12)$$

But, this is not very likely to hold in non-experimental studies. Instead we rely on a matching approach in order to derive a counterfactual that enables us to match treated households with non-treated households with as similar characteristics as possible in order to reduce the bias from self-selection. The matching is made based on an index, the propensity score, summarizing the pre-treatment characteristics of each household. The propensity score is the probability of assignment into treatment, $P(x)$, conditional on a set of pre-treatment characteristics, X, so that

$$P(x) = Pr[D = 1|X] = E[D|X] \quad (3.13)$$.

3.3. Results and Discussions

3.3.1. Socio-demographic characteristics of respondents

Table 3.1, show that 71.5% and 28.5% of the respondents were from male- and female-headed households, respectively. About 39.7% of female-headed households were from villagized sites and 60.3% were from non-villagized sites, whereas 53.2% and 46.8% of male-headed households were from villagized and non-villagized sites, respectively. The majority (72%) of the respondents were between the ages of 19-35 years of age. Table 3.1 also illustrates that the majority (75.1%) of the respondents were married, while the remaining; 13.6%, 6.8%, and 4.5% of the respondents were single, divorced, and widowed, respectively. Furthermore, 55.2% of the respondents' family sizes fell between 3 and 5. 56.1% of the respondents were illiterate (cannot read and write), while the remaining 43.9% were literate. Of the illiterate household heads, 42.7% were from villagized sites, whereas 57.3% were from non-villagized sites. It seems clear that the illiteracy rate is higher in villagized sites.

Table 3.1: Socio-demographic characteristics of respondents

Variables	Category	Villagized(N=109)		Non-villagized (N=112)		Total	
		Frequency	(%)	Frequency	(%)	Frequency	(%)
Sex	Female	25	22.9	38	33.9	63	28.5
	Male	84	77.1	74	66.1	158	71.5
Age	19-39	76	69.7	83	74.1	159	72
	40-60	30	27.5	24	21.4	54	24.4
	Above 60	3	2.8	5	4.5	8	3.6
Marital status	Single	6	5.5	24	21.4	30	13.6
	Married	93	85.3	73	65.2	166	75.1
	Divorced	8	7.3	7	6.3	15	6.8
	Widowed	2	1.8	8	7.1	10	4.5
Family size	< 3	8	7.3	34	30.3	42	19
	3-5	52	47.7	70	62.5	122	55.2
	≥ 6	49	44.9	8	7.1	57	25.8
Education level	Illiterate	53	48.6	71	63.4	124	56.1
	Literate	56	51.4	41	36.6	97	43.9

Source: Own computation (2022)

3.3.2. Descriptive results of food security indicators

Table 3.2 illustrates the proportion of households falling under the two food groups developed based on the chosen thresholds. Accordingly, 56.3% and 37.6% of non-villagized and villagized respondents had acceptable food consumption practices, respectively. Likewise, 51.4% of villagized respondents had a borderline FCS as compared to 30.3% of non-villagized respondents at the same FCS level. About 11% and 13.4% of the surveyed villagized and non-villagized respondents fall within the poor food consumption category, respectively. Moreover, the household food balance model (HFBM) result confirms that 58.7% and 47.3% of villagized and non-villagized respondents were food insecure (<2100 kcal) respectively. In general, when calorie intake per day is taken into account, 52.9% of respondents were food insecure. The results of all food security assessment methods show that respondents who were villagized were found to be more food insecure than respondents who were not villagized.

Table 3.2: Descriptive results of outcome variables

Outcome variable	**Consumption category**	**Villagized HHs**		**Non-villagized HHs**		**Total**	
		Frequency	percent	Frequenc	percent	Frequency	percent
FCS	Poor	12	11	15	13.4	27	12.2
	Borderline	56	51.4	34	30.3	90	40.7
	Acceptable	41	37.6	63	56.3	104	47.1
	Total	109	100	112	100	221	100
HFB	Food secure (≥ 2100 kcal)	45	41.3	59	52.7	104	47.1
	Food insecure (< 2100 kcal)	64	58.7	53	47.3	117	52.9
	Total	109	100	112	100	221	100

Source: Own computation (2022)

3.3.3. Factors influencing participation in villagization program

The conditional probability of households' participation in villagization program is estimated using a Logistic Regression Model. The model considered all observable covariates that affect participation for which observational data is available. In this respect, family size and access to credit had positively influenced participation in villagization program at 1% level of significance

In addition, participation in off-farm activities and irrigation farm size had positively influenced participation in villagization program at 5% and 10% level of significance respectively. Whereas, cultivated farm size and distance to market had negatively influenced participation in villagization at 1% level of significance respectively. Similarly, access to grazing land and annual income had also negatively related with participation in the program at 5% level of significance. Besides, marital status and livestock holding had negatively influenced participation in villagization at 10% level of significance (see Table 3.3). Meanwhile, the main purpose of this stage is to compute the propensity scores, which are used in the matching process in the next stages, we were not discussed the details of the magnitude and why each of the covariates affected households' participation in the intervention.

Table 3.3: Propensity score estimation of the determinants of participation in the program

Variables	Coefficients	Std. Err.	z
Gender	0.4266486	0.5394458	0.79
Age	-0.0283711	0.0238305	-1.19
Marital status	-0.9657683	0.5387274	-1.79 *
Family size	0.9563993	0.1981747	4.83***
Sex ratio	0.2033603	0.6370044	0.32
Dependency ratio	-0.1207543	0.4869163	-0.25
Educational status	0.5661036	0.4920301	1.15
Perception	0.7491893	0.5489252	1.36
Cultivated farm size	-0.5654441	0.1718466	-3.29***
Irrigation farm size	3.439745	1.810753	1.9*
Livestock holding (TLU)	-0.1300703	0.0734143	-1.77*
Access to grazing land	-1.490615	0.5868865	-2.54**
Off-farm activities	1.056201	0.5139112	2.06**
Access to credit	1.342465	0.4982312	2.69***
Distance to market	-44.14706	12.2555	-3.6***
Annual income	-0.0000916	0.0000447	-2.05**
Constants	2.809247	1.85527	1.51
		Obs.	221
		LR chi2(16)	181.39
		Prob > chi2	0.0000
Log likelihood	-62.46918	Pseudo R2	0.5921

*,** & *** denote statistical significance at 10%, 5% and 1% level respectively.
Source: Own computation (2022)

3.3.4. Estimation of propensity score

In this investigation, the radius caliper (D = 0.25) was found to be the best and most appropriate matching algorithm for the data, which yields lower Pseudo-R^2 and a large matched sample size. The common support ensures that treatment observations have comparison observations "nearby" in the propensity score distribution. As shown in Figure 1, the distribution of propensity scores of the treatment groups is found in the upper hand (the red color) of the distribution, whereas that of the control groups is found on the lower hand (blue color) of the distribution. This ensures that any combination of characteristics observed in the treatment group can also be observed in the control group (Granger et al., 2020). As a result of this restriction, 47 observations from the control were discarded (Figure 3.1).

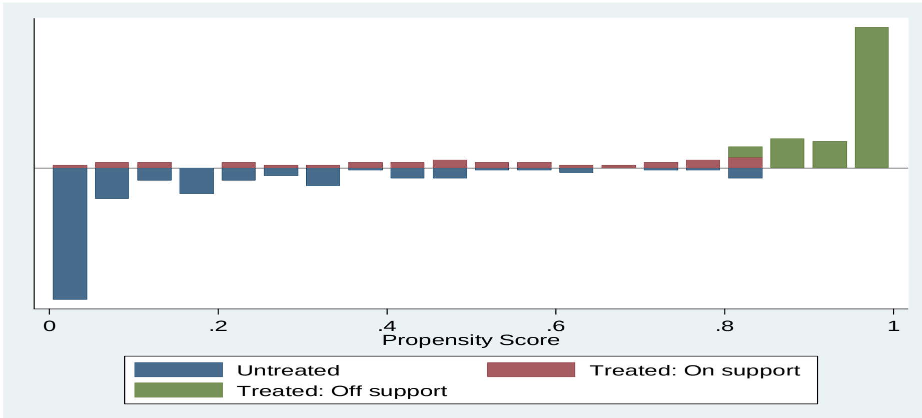


Figure 3. 1: Distribution of Propensity Score across Treatment and Comparison Groups

Besides, the matching quality analyses indicated that before matching, 10 out of the chosen variables exhibited statistically significant differences, but after matching, all covariates had statistically insignificant differences. This implies that the matching process was effective in balancing the distributions of the covariates in the matched sample. In addition, the standardized percentage before matching among the covariates was between 6.5% and 109.9%, but, after matching, the standardized bias percentage for almost all covariates lay between 1.3% and 23.5%. Moreover, the result also indicated that before matching, pseudo R^2 was 0.593 but after matching it had reduced to 0.027, implying that both the treated and control groups have an identical distribution in the covariates after matching and the impact of the program could be easily evaluated since the participants and the non-participants are similar in their pre-intervention observable characteristics.

3.3.5. The impacts of villagization program on food security

The propensity score matching results presented in Table 3.4 indicate that villagization program has negatively and significantly affected the food security situations of households in the study areas at a 10% significance level. Specifically, the estimates of the average treatment effect showed that non-villagized households had on average 3.56 higher food consumption scores than those who had engaged in the program. Similarly, the finding also indicated that non-villagized households obtained an average of 573.49 kcal higher compared to those households that participated in the villagization program. The overall results indicated that households that have participated in government-sponsored villagization programs had lower food consumption scores and lower calorie intake per day as compared to households that have not participated in the program. The FGD discussants confirmed that the food security situation in new villages is dire. Because the areas where they have been moved are often dry with poor-quality soil, some of the farmers have become landless because of the absence of a feasibility study of the new sites. Besides, the promises of the regional government to provide infrastructure (schools, health facilities, water,…) and agricultural extension services or input have not been maintained. The new villages seem to provide even fewer resources than the existing ones, and some farmers are returning to their old villages. This result is in conformity with the findings of (Stevenson & Buffavand, 2018; Zikargie & Cochrane, 2022) but contradicts with the findings of (Amare, 2016; Labiso, 2020) who have examined that participation in villagization programs has resulted in producing more than in their area of origin. Hence, the majority of villagized households' food security situation has improved in the new areas.

Table 3.4: Results of the ATT of food security indicators

Outcome variables	Sample	Villagized	Not-villagized	Difference	t-statistics
FCS	Unmatched	36.82	44.29	-7.48	
	ATT	38.29	41.85	-3.56	-1.97*
HFBM	Unmatched	2296.06	3039.27	-743.20	
	ATT	2164.39	2737.88	-573.49	-1.93*

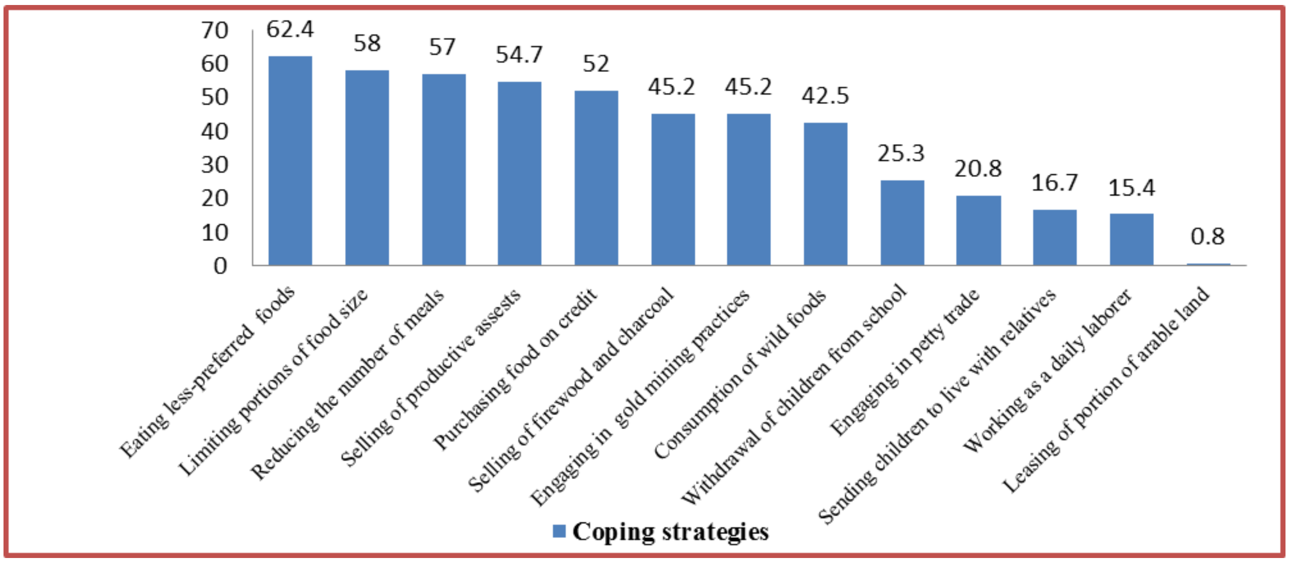
* denote statistical significance at 10% level.
ATT =Average Treatment Effect on the Treated.

Source: Own computation (2022)

3.3.6. Households coping strategies to food insecurity

The information gathered from FGDs and previous studies indicated that households in the study areas adopted multiple forms of coping strategies at times of food shortage and/or food insecurity. Accordingly, the coping strategies index developed by Maxwell and Caldwell (2008) was modified and adapted to the local situation, and 13 commonly used coping strategies were established.

This study confirmed that the main coping mechanisms households adopted during food shortages were: eating less-preferred and less expensive foods (62.4%); limiting portions of food size at mealtime (58%); reducing the number of meals per day (57%); selling productive assets (livestock and small animals) (54.7%); purchasing food on credit (52.2%); selling of firewood and charcoal (45.2%); engaging in traditional gold mining practices (45.2%); consumption of wild foods (42.5%); withdrawing children from school (25.3%); engaging in petty trade (20.8%), sending children to live with relatives (16.7%); working as a daily laborer (15.4%) and leasing of a portion of arable land (0.8%) (Figure 3.2). Information obtained from FGDs indicated that most rural households consume low-quality foods that are affordable to them. Besides, they reduce the amount of food prepared and consume less of it to cope with the risks of food shortages. In the study area, sometimes household heads consume only coffee during breakfast time and decrease their meal times from three to two a day to feed their family. They also depend on the consumption of wild foods such as mushrooms, roots, vegetables, fruits, and bamboo shoots during the rainy season.



Note: a single respondent has listed all of the coping strategies he/she used in times of food insecurity.

Figure 3.2: Coping strategies against food insecurity

Source: Own computation (2022)

Furthermore, the mean values of the coping strategies index of food villagized and non-villagized households were also compared using the independent-samples T-test. As presented in table 3.5, the mean values of the coping strategies index of villagized and non-villagized households were found to be 27.28 and 15.51 respectively. The mean difference (-11.76) of coping strategies index of the two groups is significantly different from zero at 1% significant level. This implies that coping mechanisms of villagized households were significantly different from non-villagized households and on average, villagized households took many and/ or more severe coping mechanisms than non-villagized households so as to cope-up food shortage. As indicated in the CSI field methods manual, the higher the value of coping strategies indexes the more food insecure the households are (Maxwell & Caldwell, 2008).

Table 3.5: Summary Statistics of Mean values of Coping Strategy Index

	Respondents	N	Mean (SD)	Mean Difference	t-value
Coping Strategies Index	Villagized	109	27.28 (21.84)	-11.76	4.778***
	Non-villagized	112	15.51 (14.03)		

*** Significant at 1% significance level
Source: Own computation (2022)

3.4. Conclusion and Recommendations

This study has analyzed the impact of villagization programs on households' food security status and assessed their coping mechanisms in the selected districts of the Benishangul-Gumuz region. The outcomes of descriptive and propensity scoring Matching analysis of the sample data indicates that, compared to villagized households, non-villagized households are better off in terms of the mean total food consumption score and calorie intake per day. Besides, non-villagized households used less severe coping mechanisms than villagized households to cope with food shortages. The top five coping strategies employed by households against food shortages and food insecurity were: eating less-preferred foods; limiting portions of food size at mealtime; reducing the number of meals per day; selling productive assets, and purchasing food on. This finding is evident that relocating scattered dwellings and settling in predetermined geographic areas through villagization alone would not provide a sustainable and lasting solution to the chronic food insecurity problems in the study areas. As a result, the required and promised infrastructure facilities and necessary technology for farm products such as improved farm tools, improved seed varieties, organic fertilizers, and extension services should be provided in the study areas. Furthermore, future villagization efforts in the region should prioritize feasibility studies in new locations and include communities in all aspects of program planning and implementation.

Reference

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CHAPTER FOUR

Assessing the Impact of Villagization Program on Land Use Land Cover Dynamics

Abstract

Planning for continuing natural resource management requires current information on the dynamics of land use and land cover. The aim of this paper was to analyze the impacts of the villagization program on land use land cover dynamics in Benishangul-Gumuz region, western Ethiopia. The study has employed mixed method research design using both primary and secondary sources. Multispectral LANDSAT satellite images with a 30 m resolution were acquired for land use land cover change detection between the years 1999, 2009, and 2022. Arc GIS 10.8, QGIS 3.28, ERDAS Imagine 2014, and Microsoft Excel software were used for image classification, accuracy assessment, and change detection. Six different land use land cover types: forest land, shrub and grassland, cultivated land, residential, bare land, and water bodies were identified between 1999 and 2022. The trends indicated a dramatic decrease at the rate of 27.2 ha of forestland, 17.1 ha of shrub and grassland, and 4.6 ha of water bodies per year, while the share of cultivated land, residential, and bare land have expanded at an average rate of 34.3 ha, 11.7 ha, and 2.9 ha per year respectively between 1999 and 2022. The phenomenon was caused by added population pressure due to villagization program, which in turn triggered farmland expansion and deforestation. It is recommended that raising local community awareness, reforestation, practicing land use plans, and promoting successful livelihood diversification could help to alleviate the issue and reroute the course of events in order to achieve sustainable natural resource management.

Keywords: Benishangul-Gumuz, forest depletion, land use land cover change, population pressure.

4.1. Introduction

One component of a resettlement program that is typically used to give the rural population a more comprehensible and manageable way to improve their existing standard of living is villagization (Hailu et al., 2016). Villagization is also referred to as the practice of transferring individuals from large, governmental-designed villages who previously resided in scattered settlements, either forcibly or voluntarily (Gomersall, 2018; Stevenson & Buffavand, 2018). Villagization programs were viewed as popular strategies by national and local governments in developing countries to promote local and national development (Gebresenbet, 2021; See & Wilmsen, 2020). For Ethiopia, villagization was envisaged as a solution, almost a panacea, to the further impoverishment of rural communities (Ferede & Wolde-Tsadik, 2018). As a result, the Benishangul-Gumuz regional state launched the villagization schemes to offer essential socioeconomic amenities and achieve food security (Daie & Labiso, 2021). Accordingly, 45,817 households (nearly 229,085 people) were villagized into 239 nucleated sites between the years (2010- 2018) (Vaughan, 2020).

Despite this, several empirical studies revealed that the implementation of villagization schemes resulted in mutually reinforcing impacts on the socio-economic condition of the resettler communities while endangering the ecological richest of host communities (Yadeta et al., 2022). Most villagization schemes implemented in Ethiopia during the country's previous and current regimes exerted severe pressure on the country’s natural resources due to the absence of feasibility studies, limited local consultation and engagement with settlers and host communities, and suspicion of sinister motives (Gebre & Andualem, 2018; Getahun et al., 2017; Yonas et al., 2016). As a result, rapid forest depletion was common in different villagization sites of the country, which resulted from the expansion of cropland, residential areas, and high demand for natural resources (Abera et al., 2020).

Continuously updated information on LULC dynamics is essential for many socioeconomic and environmental uses, including community development, resource conservation, and sustainable land management (Maina et al., 2020; Nasare et al., 2023). However, less attention has been given to evaluating how villagization programs have impacted LULC changes, particularly in Benishangul-Gumuz regional state. Therefore, the objective of this study was to examine the effect of the villagization program on LULC dynamics over a 20-

year period.

4.2. Materials and Methods

4.2.1. Description of the research location

The study was undertaken in the Benishangul-Gumuz Regional State particularly in Bambasi woreda (Womba and Dabus kebeles) and Assosa woreda (Abramo kebele). Bambasi woreda is located in the region's south, between 09^{o}47’ North and 34^{o}47’ East, while Assosa woreda is located between 10°04′ N and 34°31′ E (Figure 1) and is bordered by Oromia Regional State and Mao-Komo special woreda in the south and southwest, Assosa woreda in the west, and Oda-Buldigilu woreda in the northeast (Wikipedia contributors, 2023). Assosa woreda is bordered by Menge in the northeast, Kurmuk and Homoesha in the north, Oda-Buldigilu in the east, Mao-Komo special woreda in the south, Bambasi in the southeast, and Sudan in the west (Wikipedia contributors, 2021). Bambasi woreda covers a total area of 472,817 hectares of land (2,032.3 and 1,292.3 hectares in Womba and Dabus kebeles, respectively), of which 223,016 hectares are used for cultivation and 174,820 hectares of the land area is covered by forests, whereas. Assosa woreda covers a total area of 199,941 hectares (1,036.4 hectares in Abramo kebele) (BGRSBoA, 2022; Mosissa et al., 2020). The prevalent base of livelihood involves a mixed farming system where people derive their income both from crop production and livestock rearing activities (BGRSBoA, 2022).

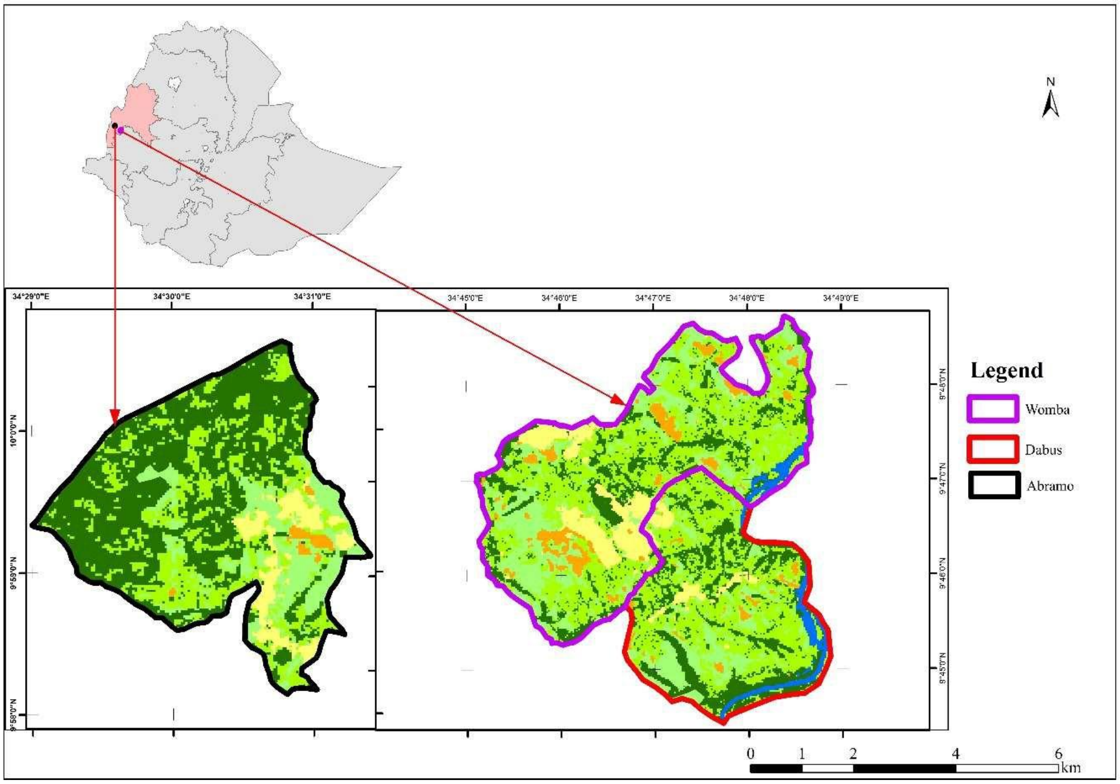

Figure 4.1: Map of the study site

4.2.2. Research design and sampling techniques

Mixed method research approach was employed in this study. To gather primary data from various sources, both probability and non-probability sampling strategies were applied. In this regard, two woredas (Assosa and Bambasi) were purposely selected because they are the largest in population and land size and host a huge number of settlers in the zone. Moreover, three villagized kebeles: Abramo, Womba, and Dabus were purposely selected. Accordingly, the technique of systematic random sampling was applied to obtain the size sample respondents for each sample kebele. The number of sample respondents for this study was determined using the following formula, which was created by Kothari (2004) and utilized and tested by numerous academics:

$$n = \frac{Z^2 \times p \times q \times N}{e^2 (N-1) + Z^2 \times p \times q} \qquad (4.1)$$

Where: n= sample size, *Z*=1.96 (confidence interval of 95%), *N*=population size, *P*=the population proportion (assumed to be 0.5), $q = 1 - p = 0.5$, *e*= 5% error. Thus; for the total population 152, the sample size of 109 were selected; $n = \frac{(1.96)^2 \times 0.5 \times 0.5 \times 152}{(0.05)^2 \times (152-1) + (1.96)^2 0.5 \times 0.5} = 109$

4.2.3. Data sources and acquisition methods

In this section, both primary and secondary sources were consulted to obtain quantitative and qualitative data. Structured questionnaires and focus group discussions with elders, village steering and technical committees, kebele authorities, and development agents were used. To obtain suitable sensor data, it was deemed necessary to consider factors such as the scale and characteristics of a study area, the user's needs, the availability of various image data and their characteristics, cost and time constraints (Tewabe & Fentahun, 2020). For this, LULC change detection, multispectral LANDSAT satellite images of Abramo, Womba, and Dabus kebeles were acquired for three years, namely, 1999, 2009, and 2022, from the United States Geological Survey (USGS) Earth Explorer data hub using path/row 171/53. Because Landsat satellite imagery is an effective instrument to assess changes in land use over vast areas and over extended periods of time (Putri et al., 2023). The 2022 image is OLI/TIRS combined (Operational Land Imager and Thermal Infrared Sensor) with a 30-meter resolution, while the 1999 and 2009 images are thematic mappers (TM) with a resolution of 30 meters and a spatial reference of WGS84 UTM 36N (Table 4.1).

In order to lessen the impact of cloud cover and seasonal variation on the classification result, which degrades the image quality, the acquisition dates of the photographs were taken at the start of the dry season and during months with clear sky. To provide a good understanding of the previous LULC situations prior to the villagization program in the study area, the year 1999 was used as a reference in this study. The 2009 images were taken to examine the LULC conditions one year before the execution of the program. Last but not least, the researchers chose to use images of 2022 to examine the post-villagization conditions of LULC in the research areas.

Table 4.1: Detailed information about the Landsat images used in the research

Year	Satellite	Sensor	Path/ Row	Resolution (m)	Acquisition date	Source
1999	Landsat 5	TM	171/53	30 m	11 Nov 1999	https://earthexplorer.usgs.gov
2009	Landsat 5	TM	171/53	30 m	09 Nov 2009	https://earthexplorer.usgs.gov
2022	Landsat 8	OLI/TIRS	171/53	30 m	23 Nov 2022	https://earthexplorer.usgs.gov

4.2.4. Data analysis

Although there are many alternative ways to classify picture data, unsupervised and supervised algorithms are the two most popular approaches for mapping LULC (Luo et al., 2017; Madariya et al., 2022). Unsupervised classification is used in this study because it allows for the identification of more classes than supervised classification (Oyekola & Adewuyi, 2018). Additionally, unsupervised classification technique is preferable because there is little pre- existing training data in the study area due to security concerns. Using the K-means image clustering algorithm, pixels are grouped according to their characteristics. To improve classification accuracy, high-resolution images of Google Earth were linked in ERDAS Imagine 2014 to refine the area assigned from a particular LULC class to another LULC category for the 2022 unsupervised classification image. Then, the same procedure was employed to refine the 2009 and 1999 classifications, using the pixel values of the refined 2022 image as a reference.

Visual analysis was also applied in this study using reference data and local knowledge to enhance the accuracy of the unsupervised classification. Considering that the historical maps of Ethiopia are poor (Dibaba et al., 2020; Yesuph & Dagnew, 2019), this study used a high-resolution maps from Google Earth to extract ground truth data and better reconstruct the land-use types. We applied pre- classification and post-classification comparison techniques to detect land use land cover (LULC) changes based on remote sensing data. The post-classification approach is concerned with the classification of multiple date images separately so as to generate thematic maps (Priyatna et al., 2023; Tena et al., 2019). Afterwards, a pixel-based comparison was made with the corresponding classes so that tables and maps portraying LULC changes were produced (Matlhodi et al., 2019). Besides, we used the Arc GIS 10.8 spatial analyst tool to produce maps depicting change matrix analysis for the reference years of 1999, 2009, and 2022. The percentage of change (PC), magnitude of change (MC), and annual rate of change (ARC) for each LULC classification were assessed for each period in order to compare the magnitude of net changes for each of the corresponding time periods:

$$MC(ha) = A_i - A_f \tag{4.2}$$

$$PC(\%) = \left(\frac{A_i - A_f}{A_i}\right) \times 100 \tag{4.3}$$

$$ARC\ (ha.year^{-1}) = \left(\frac{A_i - A_f}{n}\right) \quad (4.4)$$

Where; where A_i is the class area (ha) at the initial time, A_f is the class area (ha) at the final time, and n is the number of years of the period.

4.3. Results and Discussions

4.3.1. Socio-demographic characteristics of the respondents

As depicted in Table 4.2, 77.1% of the respondents were male and 22.9% of the respondents were female participants. Their average age is 37 years old; however their ages range from 19 to 78. The majority of responders (69.7%) fall between the age ranges of 21 to 39 years. About 47.7% of the respondents have a family size of 3-5 members where the mean family size is 4.78. Concerning the educational status, the majority (56.9%) were illiterate (cannot read and write), while the remaining 43.1% were literate.

Table 4.2: Socio-demographic characteristics of responders

Variables	Category	Frequency	Percent	Remark
Sex	Female	25	22.9	
	Male	84	77.1	
Age	21-39	76	69.7	Min=21
	40-60	30	27.5	Mean=36.99
	Above 60	3	2.8	Max=76
Family size	< 3	8	7.3	Min=1
	3-5	52	47.7	Mean=4.78
	≥ 6	49	44.9	Max=8
Education status	Illiterate	62	56.9	
	Literate	47	43.1	

Source: Computed based on field survey (2023)

4.3.2. Land use land cover dynamics

In this study, 122 random points were generated in QGIS in proportion to the area of each class to check the accuracy of the classified images. Then, we overlaid the random points on Google Earth high-resolution imagery which is taken as the ground truth. Accordingly, the classification accuracy was determined using measures obtained from the error matrices. These include overall accuracy, user's accuracy, producer's accuracy, and Kappa statistics. The three-year image analysis showed that the overall accuracy of land use land cover (LULC) classification changes varies from 90% to 94% and that the Kappa coefficients vary from 0.86 to 0.92 for the study areas (Table 4.3). The result strongly tallies with the pre-determined standard per individual land use class viewed from the vantage points of user accuracy (UA) and producer accuracy (PA). The overall accuracy assessment demonstrated strong match between the ground reference values and the classification map which is greater than 80% as suggested by (Congalton, 1991).

Table 4.3: Accuracy assessment results of LULC classes (1999-2022)

LULC Classes	**1999**		**2009**		**2022**	
	PA (%)	**UA (%)**	**PA (%)**	**UA (%)**	**PA (%)**	**UA (%)**
Forest land	90	93.8	100	90.7	100	94.1
Shrubs and grass land	91.2	91.2	77.8	87.5	91.3	91.3
Cultivated land	88.9	85.7	90.2	9	91.7	95.7
Residential	100	100	100	83.3	88.9	88.9
Bareland	100	100	66.7	100	100	100
Waterbody	100	83.3	100	100	100	100
Overall Accuracy	**91%**		**90%**		**94%**	
Kappa coefficient	**0.87**		**0.86**		**0.92**	

Source: Computed using satellite images from 1999, 2009 and 2022 (2023)

Based on the results of satellite image analysis, six land use land cover types were identified in the study areas (Abramo, Womba and Dabus kebeles) in the three reference periods; 1999, 2009, and 2022. These include forest land, shrub/grassland, cultivated land, settlements, bare land, and water bodies (see the details in Figures 4.2-4.4 and Table 4).

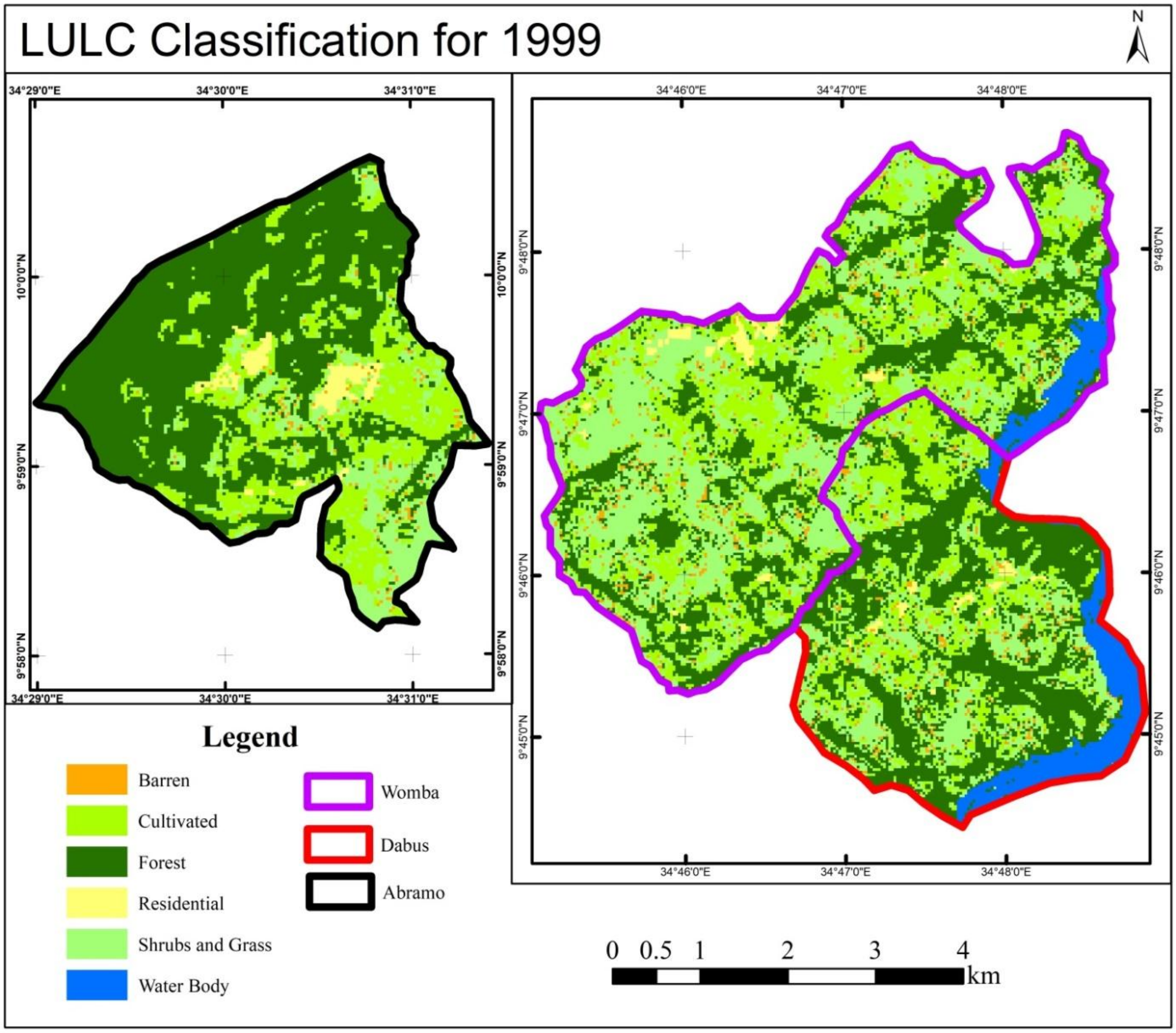

Figure 4.2: LULC change map of the study areas 1999

Source: Computed using satellite images of 1999 (2023)

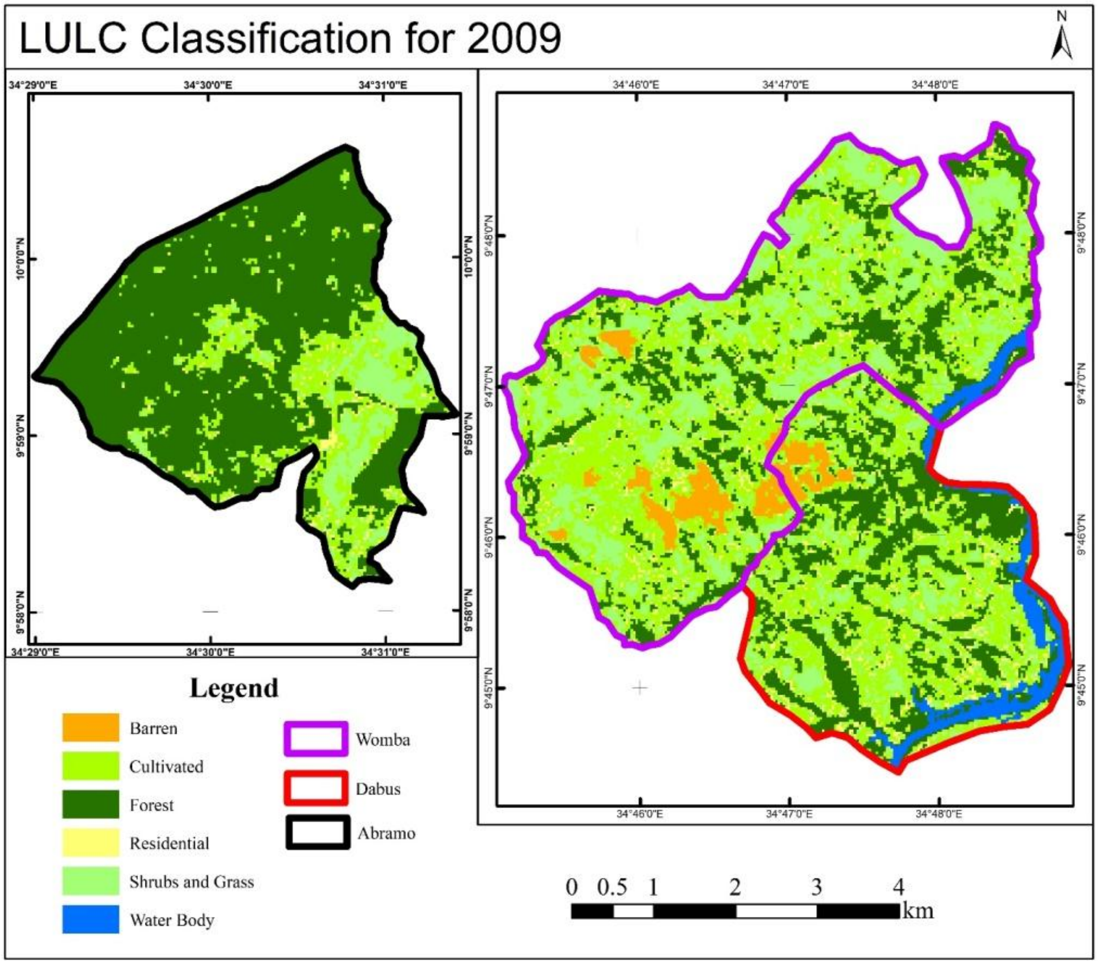

Figure 4.3: LULC change map of the study areas 2009

Source: Computed using satellite images of 2009 (2023)

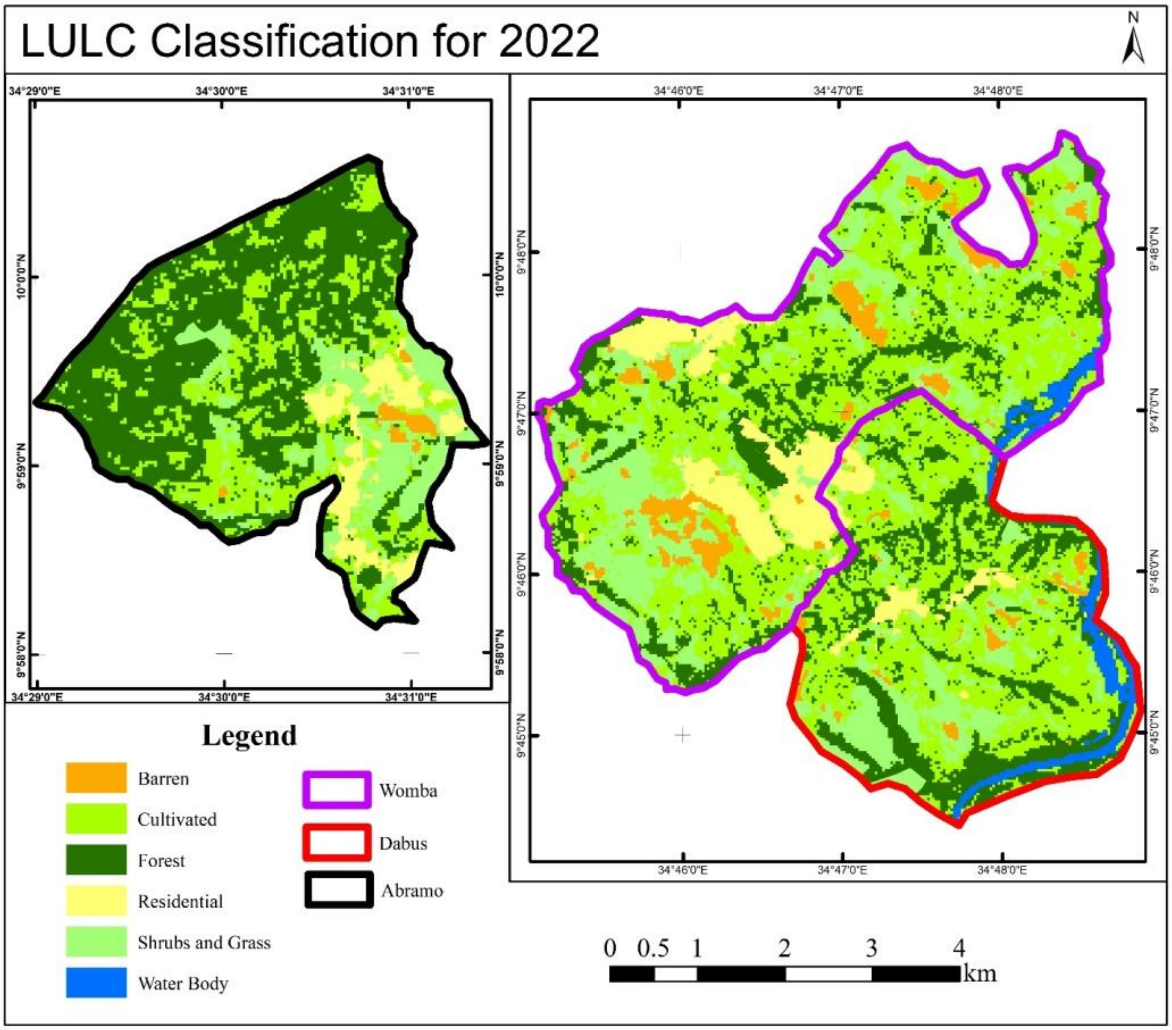

Figure 4.4: LULC change map of the study areas 2022

Source: Computed using satellite images of 2022 (2023)

After properly coding the classification findings for the three years, we created change maps to provide a full matrix of change, which is shown in Table 4.4.

Table 4.4: Summary of LULC change matrix of the study areas

Classification types	Years					
	1999		2009		2022	
	Area (ha)	**(%)**	**Area (ha)**	**(%)**	**Area (ha)**	**(%)**
Forest land	1,742.5	40	1,553.6	35.6	1116.3	25.6
Shrubs & grassland	1,208.5	27.7	873	20	815.4	18.7
Cultivated land	1,012	23.2	1,465.9	33.6	1800.2	41.3
Residential	71.4	1.6	208.5	4.9	340.1	7.8
Bareland	120.2	2.8	124.3	2.8	187.5	4.3
Water Body	206.1	4.7	135.4	3.1	101.2	2.2
Total	**4,360.7**	**100**	**4,360.7**	**100**	**4,360.7**	**100**

Source: Computed using satellite images from 1999, 2009 and 2022 (2023)

Forest land: Forest land covered the largest portion of all land use and cover types. However, during the course of the study, a continual loss in forest cover was noted. In this regard, out of the total areas, it has constituted about 1,742.5 ha (40%), 1,553.6 ha (35.6%), and 1,116.3 ha (25.6%) of land in 1999, 2009, and 2022, respectively (see Figure 4.2-4.4 & Table 4.4). The Benishangul-Gumuz regional government has villagized 727 households (nearly 3,635 people) from far-to-reach villages to the study sites since 2010 (BGDRMC, 2019). As a result, there was the highest loss of forest coverage by 437.3 ha (28.1%) at an average rate of 33.6 ha per year between 2009 and 2022. The overall trend of change detection indicates a reduction in forest cover by 626.2 ha (35.9%) at an average pace of 27.2 ha per year between 1999 and 2022 (Table 4.5). The information obtained from the FGDs also revealed that population pressure brought on by the villagization program, which led to the clearing of natural forests for the production of crops, charcoal, and firewood as well as tree cutting for building homes and expanding settlements, was the main factor in the depletion of forest cover in the study site. This study appears to concur with other studies carried out in other areas. For instance, a study by Yadeta et al. (2022) during 2000-2018 showed that due to changes in demographics brought about by a villagization program, the amount of forest cover in the Hawa-Galan district of Oromia region substantially decreased with average annual deforestation rates of 4.14%. In addition, a study by Roba et al. (2021) in the Nensebo district of Ethiopia, which spans from 1986 to 2019, found that the rate of forest cover loss was 0.95% per year due to population pressure, which was frequently brought by the introduction of villagization schemes.

Shrub and grassland: Shrub and grassland is also another important classification in the study area. It covered 1,208.5 ha (27.7%) of land in 1999. However, its cover declined from 873 ha (20%) to 815.4 ha (18.7%) in 2009 and 2022 respectively (see Figure 4.2-4.4 & Table 4.4). Between 1999-2009 and 2009-2022, this land cover decreased by 335.5 ha (28%) at an average pace of 33.5 ha per year and by 57.6 ha (6.6%) at an average pace of 4.4 ha per year. According to the overall trend of change detection, shrub and grassland has reduced by 393.1 ha (32.5%) at an average pace of 17.1 ha per year, between 1999 and 2022 (Table 4.5).

Cultivated land: Only 1,012 ha (23.2%) of the total landmass were cultivated in the reference year 1999 (see Figure 4.2 & Table 4.4). Due to a rise in the need for the production of food crops, cultivated land in the study sites has dramatically expanded in comparison to other LULC types since the introduction of the villagization program. Hence, it has increased from 1,465.9 ha (33.6%) in 2009 to 1,800.2 ha (41.3%) in 2022 (see Figure 4.3-4.4 & Table 4.4). The analysis of the rate of change of cultivated land indicated that it has increased by 453.9 ha (45%) at an average pace of 45.4 ha per year and 334.3 ha (22.8%) at an average pace of 25.7 ha per year between 1999-2009 and 2009-2022 respectively. Moreover, throughout the study period (1999 to 2022) cultivated land has increased by 788.2 ha (77.9%) at an average pace of 34.3 ha per year (Table 4.5) implying that the primary force behind LULC dynamics in the study area was the growth of cultivated land. A study by Abera et al. (2020) in the Chewaka district of Ethiopia between 2000 and 2018 also found that cultivated land increased at an average rate of 1515.7 ha per year, whereas there had been no cultivated land in the area prior to the implementation of the villagization program. This is consistent with the current study.

Residential: In 1999, the total area covered by residential was only 71.4 ha (1.6%) of land (see Figure 4.2 & Table 4.4). However, the share of the residential drastically shifted once the villagization operation got underway. Between 1999 and 2022, it rose by 137.1 ha (192%) at an average rate of 13.7 ha per year and by 131.6 ha (63.1%) at an average rate of 10.1 ha per year. It has also radically increased by 268.7 ha (376.3%) at an average rate of 11.7 ha per year between 1999 and 2022 (Table 4.5). The FGD discussants remarked that settlement areas were expanded at the expense of forests and shrub/grasslands. For instance, the construction materials for 3,635 new settlers were derived from the forest of the study areas.

Bare land: Bareland has slightly increased during the study period. In 1999, 2.8% of the entire area was made up of bare land, totaling 120.2 ha of land. The coverage of bare land increased from 124.3 ha (2.8%) in 2009 to 187.5 ha (4.3%) in 2022 (see Figures 4.2-4.4 and Table 4.4). Between the years 1999 and 2009, bare land covering increased somewhat during the study period, by 3%. However, from 1999 and 2022, it alarmingly grew by 67.3 ha (56%) at an average pace of 2.9 ha each year (Table 5).This result is consistent with the study conducted by Tesfaye et al. (2021), who noted an increase in bare land from 17,940 ha (10.9%) in 2015 to 18,219.8 ha (11%) in 2020 in South Wello. But, studies conducted by Dega et al. (2022) and Hailu et al. (2020) revealed that there was a continuous decline in bare land mainly due to the expansion of cultivated land and settlement areas.

Water body: In the study area, the expanse of water bodies had shown declining trends over years. The size of the water body decreased from 206.1 ha (4.7%) in 1999 to 135.4 ha (3.1%) in 2009 and further decreased to 101.2 ha (2.2%) in 2022 (see Figures 4.2-4.4 and Table 4.4). The analysis of the rate of change of water bodies indicated that it has decreased by 70.7 ha (34%) at an average rate of 7.1 ha per year between 1999 and 2009. Between 2009 and 2022, it also showed a significant loss of 34.2 ha (25.2%) at an average rate of 2.6 ha each year. Over the course of the study (1999-2022), the waterbody shrank by 104.9 ha (50.9%), on average, at a pace of 4.6 ha each year (Table 4.5). This finding is consistent with a study carried out by Gebre and Andualem (2018) at the Abobo villagization site in western Ethiopia.

Table 4.5: Land use/land cover change between periods

	1999-2009			**2009-2022**			**1999-2022**		
LULC types	**Area (ha)**	**(%)**	**Rate of change (ha^{-1} year)**	**Area (ha)**	**(%)**	**Rate of Change (ha^{-1} year)**	**Area (ha)**	**(%)**	**Rate of change (ha^{-1} year)**
Forest land	-188.9	-11	-18.9	-437.3	-28.1	-33.6	-626.2	-35.9	-27.2
Shrub & grassland	-335.5	-28	-33.5	-57.6	-6.6	-4.4	-393.1	-32.5	-17.1
Cultivated land	+453.9	+45	+45.4	+334.3	+22.8	+25.7	+788.2	+77.9	34.3
Residential	+137.1	+192	+13.7	+131.6	+63.1	+10.1	+268.7	+376.3	11.7
Bareland	+4.1	+3	+0.4	+63.2	+50.8	+4.9	+67.3	+56	2.9
Water body	-70.7	-34	-7.1	-34.2	-25.2	-2.6	-104.9	-50.9	-4.6

Source: Computed using satellite images from 1999, 2009 and 2022 (2023)

4.4. Conclusions and Recommendation

In order to address the issues of poverty and food insecurity in the study area, the regional government of the Benishangul-Gumuz developed a villagization program and relocated the rural farmers to comparatively underutilized land. However, the program has fallen short of the intended goals due to a dearth of feasibility studies, insufficient consultation with host communities and resettled communities during the planning and implementation stages, and—most importantly—the issue of environmental impacts being overlooked. As a result, since population relocation, forest land has dramatically decreased by 626.2 ha (35.9%), on average, every year between 1999 and 2022, at a pace of 27.2 ha. Similarly, from 1999 and 2022, the shrub/grassland cover decreased by 393.1 ha (32.5%) at an average rate of 17.1 ha per year. Additionally, over the course of the study period, the water body shrank by 104.9 ha (50.9%), on average, at a pace of 4.6 ha per year. However, cultivated land has grown by 788.2 ha (77.9%) at an average pace of 34.3 ha per year between 1999 and 2022. Moreover, between 1999 and 2022, the settlement significantly expanded by 268.7 ha (376.3%) at an average pace of 11.7 ha each year. Over the study period of 1999–2022, bare land rose drastically by 67.3 ha (56%) at an average rate of 2.9 ha each year. The primary cause of the reduction in forest and shrub and grassland cover in the study area was population pressure brought on by villagization programs, which resulted in the clearing of natural forests for the production of crops, charcoal, and firewood as well as cutting trees for house construction and settlement growth. Awareness creation about natural resource conservation, the introduction of community-based integrated natural resource management, and local land use plans are vital to sustainably utilizing natural resources. Furthermore, the agricultural sector cannot be viewed as a sole means of alleviating poverty; achieving food security in rural areas and enhancing successful livelihood diversification are deemed essential.

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CHAPTER FIVE

The Impact of Villagization Program on Households' Climate Change Adaptation Strategy in Benishangul-Gumuz Region, Western Ethiopia

Abstract

Ethiopia is one of the nation's most susceptible to climate-related disasters, particularly recurrent drought and flooding, which for decades caused chronic food shortage. This study aims to identify the main climate change adaption techniques used by rural households and investigate how the villagization program affected these strategies in the study area. Descriptive statistics, the logit model, and Propensity Score Matching (PSM) methods were used to examine the data. Most of the respondents (85% in Assosa and 80% in Bambasi districts) believed that rise in temperatures have been observed had risen over the previous several years. In addition, in Assosa and Bambasi districts, respectively, 70% and 85% of the respondents thought that the amount of rainfall had decreased over the previous years. Crop diversification, soil and water conservation, altering planting dates, and harnessing social capital were the top four adaptation strategies employed to lessen the adverse consequences of climate change in the areas covered by this study. The analysis of the sample data revealed that non-villagized households had an average adaptation strategy to climate change that was 0.2 (20%) points higher than that of program participants. Thus, villagization program needed to be reviewed to encourage the dissemination of the right technology that will support households in improving their adaptive strategies to climate change shocks.

Keywords: *Households' perception; propensity score matching; adaptation strategies index*

5.1. Introduction

Villagization is one aspect of a resettlement program usually implemented in order to provide the rural population with more legible and controllable modern means of improving their current livelihoods (De Wet, 2012). Villagization is the act of transferring residents of scattered communities into sizable, artificial villages, either voluntarily or forcibly (Messay & Bekure, 2011; Stevenson & Buffavand, 2018). Local and national governments in underdeveloped nations viewed villagization program as effective means of fostering development (Gebresenbet, 2021; Rogers & Wilmsen, 2020). In Ethiopia, villagization schemes were perceived as a remedy or a panacea—for alleviating poverty among the rural population (Dessalegn, 2003). Consequently, VP has been incorporated into the national poverty reduction and food security programs in Ethiopia. The program seeks to build household resilience to food insecurity by relocating people and communities from resource-poor areas to places with greater livelihood options (Kevin *et al*., 2016; Luo, 2019).

The introduction of VP in Ethiopia dates back to the Imperial regime, the current government had specifically designed the scheme for four pastoral and semi-pastoral regions (Afar, Somali, Gambella, and Benishangul-Gumuz) involving 1.5 million people to ensure sustainable food security (Grunditz, 2015). For instance, the Benishangul-Gumuz region has relocated 45,817 households (nearly 229,085 people) into 239 nucleated villages between 2011 and 2018 (BGRS, 2018). The government started VP as a strategy to increase climate change adaptation and mitigation in order to achieve the eradication of poverty and improve people's livelihoods (BGDRMC,2019).

Climate change, triggered by various causes including global warming, refers to variations in the mean or variability of the climate that lasts for a long period of time, usually at least ten years (IPCC, 2018, 2022). Understanding how people perceive climate change and how to adapt to it could have a bigger impact on the ability to persuade policymakers (Abdela, 2022; Fadina & Barjolle, 2018; Marie *et al*., 2020) because climate change has rapidly expanded across the world since the turn of the century and threatens the livelihood of people on the planet (He *et al*., 2020). Greater effects will be felt in places where subsistence farming is the main source of food (IPCC, 2022). A third of the world's population is directly or indirectly affected by the heat waves brought on by climate change (Schattman *et al*., 2020). Learning how to cope with these effects is becoming a priority for human growth and development because the developing countries are suffering more (Hailegiorgis *et al*., 2018). Risks are anticipated to present significant barriers to agricultural growth in developing nations and have a large impact on agricultural productivity, which results in significant changes in farming outcomes (Huong et al., 2019; IPCC, 2014).

Over 80% of Ethiopians depend on rain-fed agriculture , which is highly vulnerable to climate change and fluctuations and frequently prone to climate-related disasters, most notably drought and flooding (Gebru *et al*., 2020). The 1984 drought, which caused widespread starvation, especially in northern Ethiopia, was the result of the unfavorable climatic impact that dates back to the 1970s in Ethiopia (Dessalegn, 2003; Woube, 2005). Disasters caused by climate change, like droughts, floods, and unpredictable rainfall have increased the country's dependence on food aid (Likinaw *et al*., 2022). Similarly the western region of Ethiopia has been vulnerable to the devastating effects of climate change induced natural disasters. Moreover, communities across the country are more vulnerable to the resultant effects of recurring global climate change (Gedefaw *et al*., 2018; Morka & Mesfin, 2018).

Empirical literatures have identified a number of adaptation options that can be used to help manage the effects of anticipated climate change (IPCC, 2022; Megabia *et al*., 2022). The majority of adaptation strategies employed for climate change, however, are location-specific (Mwinkom *et al*., 2021). Moreover, to date, the effect of villagization program on households' climate change adaptation strategies in the areas under this study have received very little academic attention. Therefore,, the objectives of this study were to: i) assess the perception of rural households on climate change; ii) identify the major adaptation strategies rural households frequently adopt to cope with the effects of climate change and iii) examine how the villagization program in the districts selected for this study have influenced households' adaptation strategies to climate change risks.

5.2. Materials and methods

5.2.1. Research approach and sampling techniques

A MMR approach was employed in this study. Both probability and non-probability sampling techniques were used to collect primary data from different sources. Accordingly, the Assosa and Bambasi districts of the Assosa zone were purposely selected due to the existence of a relatively high number of villagized households as well as a large population and vast area coverage. This was followed by the selection of four villagized and four non-villagized sites (eight villages) using simple random sampling. Finally, a systematic random sampling technique was employed to obtain program participant and non-participant households from the available lists of each sample kebele.

To determine the number of sample respondents for this study, a formula developed by Kothari (2004) and practically tested and used by different scholars was used. Therefore, when the population is finite, its mathematical notation is given by:

$$n = \frac{Z^2 \times p \times q \times N}{e^2(N-1) + Z^2 \times p \times q} \qquad (5.1)$$

Where: n= sample size, Z=1.96 (confidence interval of 95%), N=population size, P=the population proportion (assumed to be 0.5), $q = 1 - p = 0.5$, e= 5% error. For the total population of 519, 221 (109 villagized and 112 non-villagized) sample sizes were drawn:

$$\mathrm{n} = \frac{(1.96)^2 \times 0.5 \times 0.5 \times 519}{(0.05)^2(519-1) + (1.96)^2 \times 0.5 \times 0.5} \approx 221$$

5.2.2. Data Sources and Collection Methods

We primarily rely on quantitative data that was collected through structured-questionnaires from both participant and non-participant households. The questionnaire was pre-tested and the necessary adjustments were made based on the feedback obtained from pre-test participants. A total of 12 enumerators who are familiar with the culture and the local language (Ruttan) were trained and participated in collecting data from sample households. For a thorough investigation of adaptation strategies to climate change, mixed-methods approaches are essential; quantitative methods alone are insufficient to comprehend resilience dynamics (Sagara & Smith, 2018). As a result, the qualitative data generated through focus group discussions (FGDs) and observation checklists were utilized. In addition, the secondary data was collected from NMA, Assosa branch, relevant regional and local authority reports.

5.2.3. Methods of Data Analysis

The socio-demographic features, perceived climatic change and variability, and climate change adaptation techniques of households' in the study site were all described using descriptive statistics such as mean, percentage, and frequency. More crucially, PSM was employed to examine how the villagization program affected techniques for adjusting to climate change risks. Software called STATA 15 was used to examine the data. The utilization of the selected climate change adaptation strategies by the sample respondents in the study site is indicated by the climate change adaptation strategy index.

This study developed a household adaptation strategy index in accordance with (Megabia et al., 2022) based on sample respondents' responses to inquiries about predetermined adaptation techniques. The information gathered from FGDs and previous studies indicated that households in the study areas adopted ten main adaptation strategies to climate change risks.

$$CCASI = \frac{1}{TCCASI} \sum [CD + SC + SW + \cdots + PF] \tag{5.2}$$

Where; $CCASI$= Climate change adaptation strategy index, $TCCASI$= Total number of climate change adaptation strategies, CD= Crop diversification, SC= social capital, SW= soil and water conservation, PF= Planting fodder tress.

5.2.3.1. Propensity Score Matching (PSM)

Although random assignments are frequently regarded as the most reliable method of program evaluation, they are often not practical. For two reasons, participation in a program may not be completely random. 1) The communities where the programs are offered are not selected at random. 2) The program's participants are not chosen at random in the communities where it is offered. They might have been specifically chosen by program administrators, or they might have chosen to take part in the program on their own (Coble, 2021). Similar to this, the regional government of Benishangul-Gumuz has purposely commenced VP in selected kebeles and districts of the region (BGDRMC, 2019). Besides, participation in villagization program lacks baseline survey (the baseline survey was not conducted prior to the intervention of the program in the study area).

When there is no baseline survey and it is not possible to randomly assign treatment to testers, cross-sectional PSM (which require data from only one period) is one of the most often used approaches to assess the success of a program or policy. PSM is necessary to precisely assess the effects of certain interventions in order to give a strong empirical base (Zhao et al., 2021). It is a potential strategy to limit the influence of confounders and provide methods to evaluate the quality of interventions (Maturo & Rambaud, 2022). Excluding observations that do not fall within the "area of common support" is a useful feature of PSM approaches that allows for the easy exclusion of data for which such matches cannot be made (Coble, 2021). However, PSM has also some limitations. It may lead to inefficiency, model dependency, and imbalance even though it has many benefits (King & Nielsen, 2019). Hence, researchers should have methodological and substantive understanding of the intervention program being evaluated in order to avoid these issues (Guo et al., 2020; Prasad et al., 2021; Reiffel & Jupiter, 2019).

For the implementation of PSM, there are five commonly used steps (Staffa & Zurakowski, 2018). The first step is estimating the propensity score which involves the decision to choose the model to be used for the estimation and the variables that should be included in the model. In this study, to estimate the PSM, the logit model is used because it is less complex than probit model (Caliendo & Kopeinig, 2008; Kim et al., 2016). Care must be taken not to include any variable which does not affect either participation or outcome of interest (Cuong, 2013). Therefore, the, choice of covariates in this study was based on the theoretical and empirical sources and the experience of the authors. The next step in PSM is choosing among different matching estimators like Nearest Neighbor (NN) matching, Caliper or Radius matching, Stratification or Interval matching, and Kernel and Local Linear matching (Austin, 2014; Khandker et al., 2010).

Checking for overlap (common support) is another step for the implementation of PSM, which ensures that individuals/groups with the same values for characteristics X have a positive probability of being both participants and non-participants of a program, and it enables us to compare comparable units (Legesse et al., 2018). A number of techniques are available for matching quality/effect analysis including; mean comparisons between treatment and comparison groups (before and after matching), standardized bias, and overall measures of covariate imbalance. In addition, comparison of pseudo-R^2 before and after matching is also an important method in testing the matching quality (Sianesi, 2004). It indicates how well the covariates X explain the probability of participating in the treatment. The Pseudo-R^2 has to be very low after matching to indicate success of the matching (Caliendo & Kopeinig, 2008). According to the (Gujarati, 2012), the logistic probability function was specified as:

$$P_i = F(Z_i) = F[\alpha + \sum_{i=1}^{m} \beta_i X_i] = \left[\frac{1}{1+e^{-[\alpha + \sum \beta_i X_i]}}\right] \qquad (5.3)$$

Where: P_i = the probability that an individual participates in villagization program X_i = represents the i[th] explanatory variable α and β_i= are parameters to be estimated. e = represents the base of natural logarithms. The probability that a given household who did not participated in villagization program can be defined as:

$$[1 - P_i] = \left[\frac{1}{1+e^{Z_i}}\right] \quad (5.4)$$

The ratio of the probability that a household who has participated in the program (eq.3) to the probability of that it who did not participated in the program (eq.4) (the odds ratio) is given by;

$$\left[\frac{P_i}{1-P_i}\right] = \left[\frac{1+e^{Z_i}}{1+e^{-Z_i}}\right] = e^{Z_i} \quad (5.5)$$

The above natural logarithm including to disturbance term can be expressed as:

$$Z_i = \ln\left[\frac{P_i}{1-P_i}\right] = Z_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_m X_m + U_i \quad (5.6)$$

Where; Z_i is natural logarithm of the odds ratio, α is an intercept β_1, β_2 and β_m are partial slopes of the equation. $X_{1,}X_{2\ldots}X_m$ are vectors of explanatory variables. U_i is the disturbance/error term. Let's use the notation D for the program intervention, where $D = 1$ when a respondent has participated in villagization program and $D = 0$ otherwise. Y_1 represent adaptation strategies to climate change when the respondent i has participated in villagization program $(D = 1)$ and Y_0 represent the same variable when a respondent is not-participated in the program $(D = 0)$. The observed result is then;

$$Y = DY_1 + (1 - D)Y_0 \quad (5.7)$$

When $(D = 1)$ we observe Y_1; when $(D = 0)$ we observe Y_0.Here, determining the average treatment effect (ATT) on households' participating in the program and those who are not is our main objective. This can indicated as:

$$ATT = E(Y_1 - Y_0|D = 1 = E(Y_1|D = 1 - E(Y_0|D = 1) \quad (5.8)$$

A program impact evaluation obviously has a problem in that we can only witness $E(Y_1|D = 1)$, but since $E(Y_0|D = 1)$ is not observed, it is not there in the data. By matching treatment and control families, a counterfactual outcome must be produced (i.e., an outcome that participants would have typically experienced had they not participated in the program) in order to overcome this challenge. The Conditional Independence Assumption (CIA) is defined as;

$$(Y_1, Y_0) \perp D|X \quad (5.9)$$

This assumption basically states that the observed outcomes for the control group and the counterfactual outcome in the treated group are identical: $E(Y_0|X, D = 1 = E(Y_0|X, D = 0)$ (5.10)

So, using the CIA, the ATT can be determined as: $ATT = E(Y_1|X, D = 1) - E(Y_0|X, D = 0)$ (5.11)

5.3. Results and Discussions

5.3.1. Socio-demographic characteristics of respondents

Table 5.1 shows that 71.5% and 28.5% of the respondents were from male-headed and female-headed households, respectively. About 39.7% of female-headed households were from villagized sites and 60.3% were from non-villagized sites, whereas 53.2% and 46.8% of male-headed households were from villagized and non-villagized sites, respectively. The majority (72%) of the respondents were between the ages of 19-35 years of age. Table 3 also illustrates that the majority (75.1%) of the respondents were married, while the remaining; 13.6%, 6.8%, and 4.5% of the respondents were single, divorced, and widowed, respectively. Furthermore, 55.2% of the respondents' family sizes fell between 3 and 5. 56.1% of the respondents were illiterate (cannot read and write), while the remaining 43.9% were literate. Of the illiterate household heads, 42.7% were from villagized sites, whereas 57.3% were from non-villagized sites. It seems clear that the illiteracy rate is higher in villagized sites.

Variables	Category	Villagized(N=109)		Non-villagized (N=112)		Total	
		Number	(%)	Number	(%)	Number	(%)
Sex	Female	25	22.9	38	33.9	63	28.5
	Male	84	77.1	74	66.1	158	71.5
Age	19-39	76	69.7	83	74.1	159	72
	40-60	30	27.5	24	21.4	54	24.4
	Above 60	3	2.8	5	4.5	8	3.6
Marital status	Single	6	5.5	24	21.4	30	13.6
	Married	93	85.3	73	65.2	166	75.1
	Divorced	8	7.3	7	6.3	15	6.8
	Widowed	2	1.8	8	7.1	10	4.5

	< 3	8	7.3	34	30.3	42	19
Household size	3-5	52	47.7	70	62.5	122	55.2
	≥ 6	49	44.9	8	7.1	57	25.8
Literacy status	Illiterate	53	48.6	71	63.4	124	56.1
	Literate	56	51.4	41	36.6	97	43.9

Table 5.1: Socio-demographic characteristics of respondents

5.3.2. Households' perception about climate change

The researcher asked residents if they thought the temperature and rainfall in the area over the previous years had gone up, down, or stayed the same in order to gauge how households perceive climate change. According to the results, the majority of respondents in the research area thought that the temperature and rainfall had risen and fallen, respectively, in the previous years. As a result, 85% of the respondents in Assosa and 80% of the respondents in the Bambasi district reported a rise in temperature. On the other hand, in the Assosa and Bambasi districts, respectively, 70% and 85% of respondents thought that the amount of rainfall had decreased over the previous years (Figure 5.1). The findings of this study are in line with those of Regasa et al. (2018), who observed that farmers in the Bambasi district perceive that the main effects of climate change are excessive body heat (55.61%), erratic rainfall (49.27%), deforestation and wildfire (33.17%), heavy rainfall during flowering and seed setting (31.22%), and excessive heating (30.73%). Similarly, the result is also consistent with the findings of Mesfin and Bekele (2018) who have revealed that the climate change perception of farmers in the Assosa district as a result of body heat (55.61%), erratic rainfall (49.27%), changing the environment (deforestation and wildfires (33.17%)), and excessive heating (30.73%).

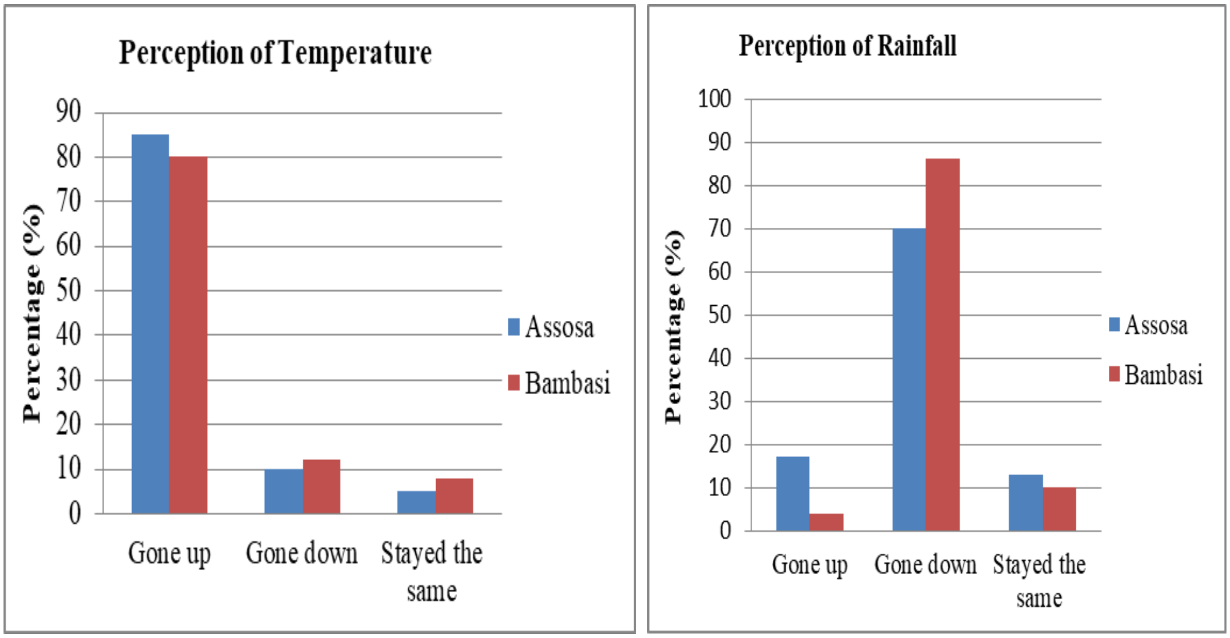

Figure 5.1: Households' perceptions of temperature and rainfall in the study area

Source: survey data (2022

As shown in Table 5.2, the highest mean annual rainfall in Assosa and Bambasi district was 63 mm and 60 mm, respectively with a coefficient of variation 13.4% and 11.9% respectively. This indicates that there is variability for rainfall in the two districts and along the timeline of each district. In the Assosa district, the average minimum and maximum temperatures were 15.9°C and 28.9°C, respectively, with coefficients of variation of 4.2 and 1.4 respectively. While in the Bambasi district, the average minimum and maximum temperatures were 14.2°C and 31.9°C, respectively, with coefficients of variation of 14.2 and 4.1 respectively. This finding also indicated the availability of temporal temperature variability from 2007 to 2021.

Table 5.2: Temporal variability of temperature and rainfall in Assosa and Bambasi districts

	Assosa District			Bambasi District		
Years	**Rainfall (mm)**	**Tmaximum (°C)**	**Tminimum (°C)**	**Rainfall (mm)**	**Tmaximum (°C)**	**Tminimum (°C)**
2007	37.2	28.0	14.7	39.33	29.0	15.1
2008	45.3	27.5	14.8	56.17	29.5	14.7
2009	46.1	27.7	15.0	50.31	30.8	15.5
2010	40.8	28.4	15.5	52.86	34.2	13.2
2011	50.3	27.8	14.1	46.14	30.9	10.0
2012	43.0	27.9	14.5	49.73	30.2	9.6
2013	41.6	27.9	14.4	59.91	29.8	9.5
2014	53.3	27.8	15.0	59.12	29.8	9.1
2015	43.7	28.5	15.3	45.90	30.9	12.8
2016	63.0	27.8	15.0	52.29	30.3	23.8

2017	50.8	27.8	15.5	51.33	29.8	14.3
2018	48.0	28.1	15.9	50.96	29.6	17.3
2019	46.8	28.4	15.9	49.49	31.0	19.0
2020	44.4	28.5	15.9	48.10	31.1	13.3
2021	42.0	28.9	16.3	39.50	31.9	15.8
Average	46.4	28.1	15.9	50.1	30.59	14.2
CV (%)	13.4	1.4	4.2	11.9	4.1	27.9

Source: National Meteorological Agency, Assosa branch (2023)

The average annual rainfall of Bambasi district ranges between 39.25 mm in 2021 to 59.9 mm in 2013; while the average annual temperature of this district ranges between 9.6 to 31.9°C (Fig. 5.2).

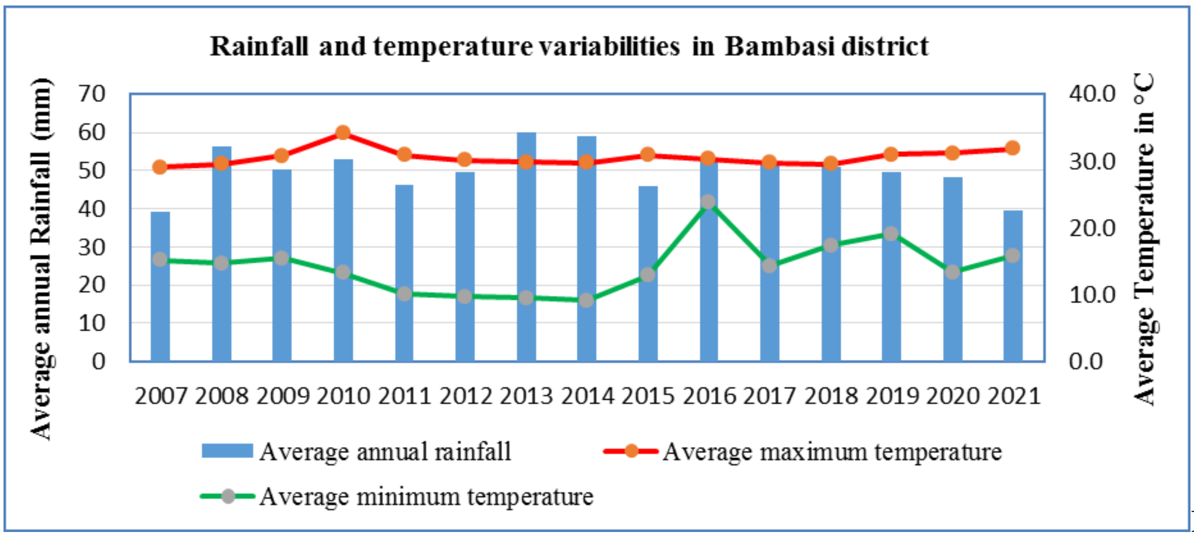

Figure 5.2: Average annual rainfall (mm) and average monthly minimum and maximum temperature (℃) of Bambasi district (2007-2021)

Source: National Meteorological Agency, Assosa branch (2023)

The average annual rainfall of Assosa district ranges between 37.2mm in 2007 to 63mm in 2016; while the average annual temperature of this district ranges between 14.1°C to 28.9°C (Fig. 5.3).

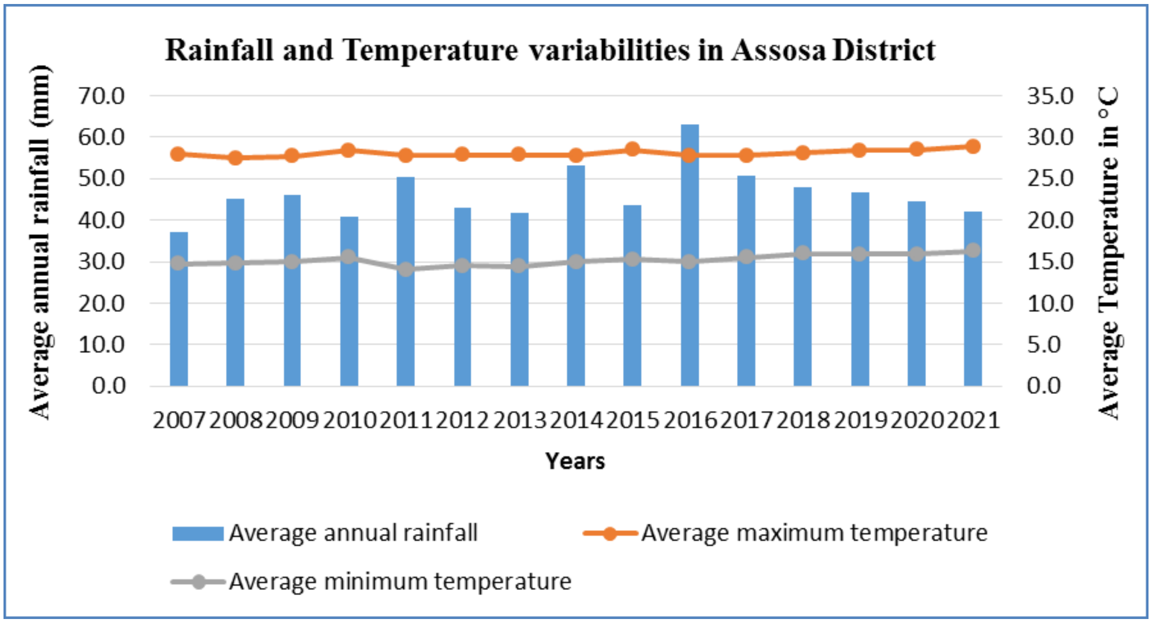

Figure 5.3: Average annual rainfall (mm) and average monthly minimum and maximum temperature (℃) of Assosa district (2007-2021)

Source: National Meteorological Agency, Assosa branch (2023)

5.3.3. Households' adaptation strategies

According to the information gathered from FGDs and earlier studies, households in the study areas adopted multiple-forms of adaptation strategies to lessen the adverse effects of climate change (Table 5.3). Based on their long-term farm experience, and advice from the extension workers about climate change, rural households can apply multiple adaptation strategies. Crop diversification (80.1%), soil and water conservation (77%), adjusting planting date (74.7%), harness of social capital (71.5%), livestock diversification (62.4%), income source diversification (56.1%), planting fodder trees (53.4%), applying chemical fertilizer (52%), applying organic fertilizer (47.1%) and small-scale irrigation (36.2%) were the main climate change adaptation strategies used by rural households in the study area. According to findings from FGDs in both Assosa and Bambasi districts households received advice from extension agents to diversify their crops during climate shocks. For instance, it has been claimed that they were urged to cultivate improved varieties of maize (Shone, BH-540 and BH-660), teff (Kuncho), soybean (Belesa-95), groundnut (Maniputer), potato (Gudene), sorghum (Girana-1) and finger millet. Because these improved varieties are less susceptible to climatic change than other types and are generally less susceptible to diseases and pests (Kozicka *et al*., 2020; Mesfin & Bekele, 2018; Nelimor *et al*., 2019).

Soil and water conservation is the second most frequent adaptation strategy used by households to mitigate the negative effects of climate change and variability. Such as creating check dams, soil bunds, and bench terraces. Both villagized and not-villagized participants in focus groups indicated that soil and water conservation activities such as creating check dams, soil bunds, and bench terraces recently become common practices among farmers. Every household member who is of working age is required to take part in at least 15 days of annual public soil and water conservation practices between January and March. Participants in the research area can also get materials and incentives from development response to displacement impacts project (DRDIP) (BGRSBoA, 2022).

Changing the planting date is also the third most common adaptation strategy used by farm households to mitigate the negative consequences of climate change and unpredictability. During

Adaptation strategies	**Respondents (%) in respective groups**

climate unpredictability, most rural households, according to participants in focus groups, change the planting date based on their local expertise and suggestions from extension agents. They verified that the major issue that caused significant damage was the rain's delayed onset and its lack during the grain-filling stage of crops. This outcome is in line with research by Destaw and Fenta (2021), Kipkemboi *et al.* (2022), Mekonnen *et al*. (2021) and Mersha *et al*. (2022), who found that adjusting planting dates was one of the most important agro-adaptation strategies for reducing the consequences of climate change on crop production.

In this study, social capital is used to describe a web of social networks that fosters reciprocal trust and benefit (Nyahunda & Tirivangasi, 2021; Sánchez-Arrieta *et al.*, 2021). The information obtained through FGDs revealed that established that different forms of social capital are being embraced by the rural households to withstand the consequences of climate change. Livestock diversification, income source diversification, planting fodder trees and applying chemical fertilizer were medium techniques employed by rural households combat climate change. While applying organic fertilizer and small-scale irrigation were indicated as the least used Adaptation methods in the research domain (Table 5. 3).

Table 5.3: Adaptation strategies used by households in the study area

	Total	Villagized	Not-villagized	χ^2
Crop diversification	80.1	70.6	89.3	12.041***
Harness of social capital	71.5	56	86.6	25.452***
Soil & water conservation	77	70.6	83	4.78**
Applying chemical fertilizer	52	66.1	38.4	16.936***
Livestock diversification	62.4	42.2	82.1	37.577***
Applying organic fertilizer	47.1	36.7	57.1	9.269***
Income source diversification	56.1	40.4	71.4	21.642***
Adjusting planting date	74.7	61.5	87.5	19.787***
Small scale irrigation	36.2	42.2	30.3	3.35*
Planting fodder tress	53.4	30.3	76	46.194***

*, ** & *** denote statistical significance at 10%, 5% and 1% level respectively.
Source: Own computation (2023)

The result also showed that there were significant differences in the level of adaption strategy between households that were villagized and not villagized (Table 5.3 & Figure 5.4).

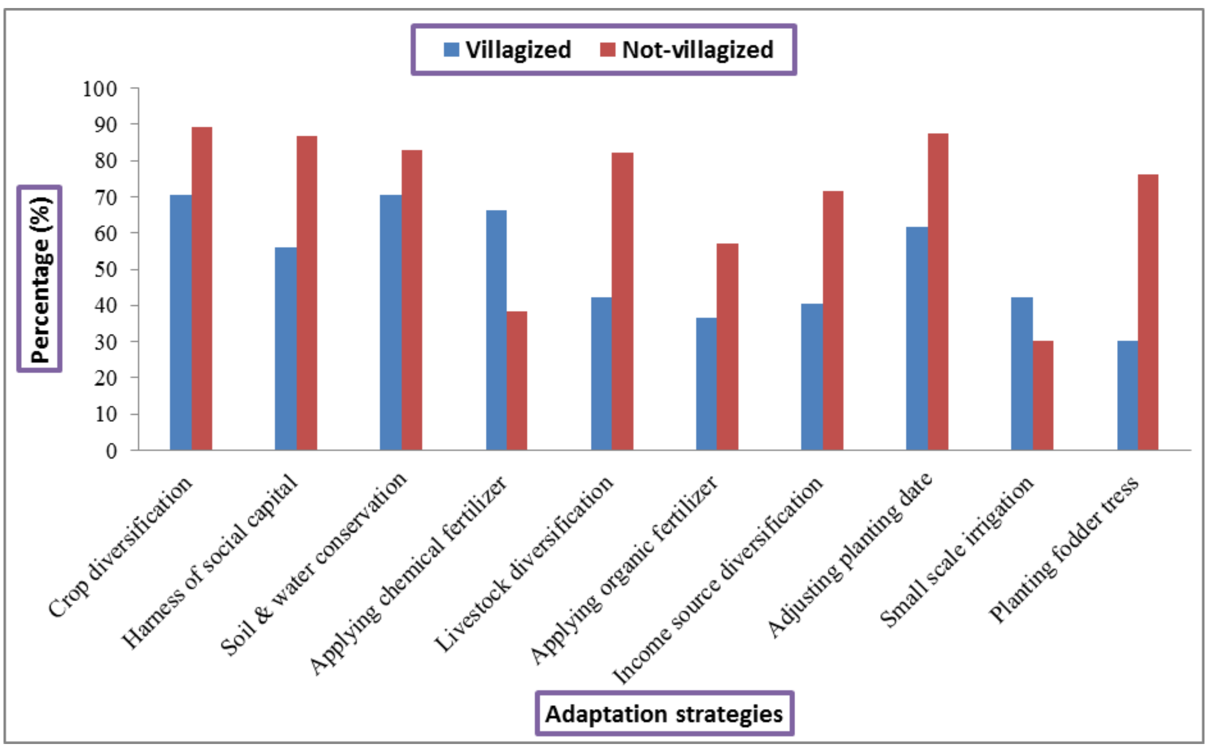

Figure 5.4: Level of adaptation strategies between villagized and not-villagized households

5.3.4. Adaptation Strategies Index

Following Megabia *et al*. (2022), household adaptation strategy index was calculated and respondents who were villagized and those who were not were compared using an independent t-test on a sample of 221 respondents (Table 5.4). As a result, the results show that the average adaptation strategy index for the entire sample is 0.61, whereas it is 0.51 and 0.71 for villagized households and that were not villagized, respectively. This finding indicates that compared to respondents who had been villagized, non-villagized respondents exhibited significantly higher adaptation techniques to climate change. At the 1% level of statistical significance, the mean difference is predicted to be 0.19, which is statistically distinct from zero. The results from this section, which only compare the means of the outcome variables between villagized and non-villagized families, indicate that non-villagized households are often in a better adaptation strategy to climate change shocks than villagized ones.

Table 5. 4: Comparison of mean adaptation strategies among the groups

Groups	Obs.	Mean	Std. Dev.	Difference	t-value
Not-villagized	112	0.71	0.133		
Villagized	109	0.51	0.278	0.19	6.456***
Combined	221	0.61	0.237		

*** denote statistical significance at 1% level. Source: Own computation (2023)

However, analyses of mean differences using an independent t-test alone do not take into consideration the impact of other rural household variables, and therefore may conflate the consequence of the villagization program on the adaptation strategy with the influence of other household characteristics. Therefore, reliable estimates of the influence of the villagization program on adaption strategy are provided by the propensity score matching (PSM) approaches that take into account selection bias resulting from the treated and control groups.

5.3.5. Estimation of Propensity Score

The conditional probability of households' participation in villagization program is estimated using a Logistic Regression Model. The model tried to consider all observable covariates that affect participation for which observational data is available. In this respect, family size, access to market and perception towards the program had positively influenced participation in villagization program at 1% level of significance. In addition, age of the household head, literacy rate and access to saving institution had positively influenced participation in villagization program at 5% level of significance (see Table 5.5). Meanwhile, the main purpose of this stage is to compute the propensity scores, which are used in the matching process in the next stages. Thus, the researcher did not discuss the minutiae of the magnitude and why each of the covariates affected households' participation in the intervention.

Table 5.5: Pscore estimation of covariates

Variables	**Coefficients**	**Std. Err.**	**z**
Gender	1.514	0.624	1.01
Age	1.0396	0.0205	1.97**
Marital status	0.8392	0.2678	-0.55
Family size	2.31	0.335	5.77***
Dependency ratio	0.755	0.745	. -0.29
Literacy rate	2.088	0.773	1.99**
Access to saving	2.228	0.833	2.14**
Access to market	3.426	1.431	2.95***
Perception	11.1	4.87	5.45***
Constants	0.0002	0.0003	-5.7***
		Obs.	221
		LR chi2(9)	109.56
		Prob > chi2	0.0000
Log likelihood	--98.385803	Pseudo R2	0.3576

** & *** denote statistical significance at 5% and 1% level respectively.
Source: Own computation (2023)

In this investigation, Nearest Neighbour Matching (NNM) with replacement (Neighbour (2)) was found to be the best and appropriate matching algorithm for the data which yields lower Psedo-R^2. When using Nearest Neighbor Matching "with replacement," an untreated individual may be used more than once as a match, improving overall matching quality and lowering bias (Szekér & Vathy-Fogarassy, 2021). Additionally, the NNM with replacement (Neighbour (2)) method produced statistically negligible changes between all variables after matching (see Table 5.6), indicating that the matching procedure was successful in balancing the distributions of the covariates in the matched sample (see Table 5.6).

Table 5.6: Matching algorithm result

Matching Estimator	**Performance Criteria**		
Radius Caliper	Balancing test*	Pseudo-R^2	Matched sample size
0.1	7	0.047	210
0.25	8	0.043	210
0.5	8	0.120	210
Kernel Matching			
Band width=0.1	7	0.044	210
Band width=0.25	7	0.039	210
Band width=0.5	8	0.076	210
Nearest Neighbour matching with replacement			
Neighbour (1)	8	0.052	208
Neighbour (2)	9	0.016	208
Neighbour (3)	9	0.022	208
Neighbour (4)	9	0.021	208
Neighbour (5)	9	0.020	208

** Number of insignificance covariates regarding mean differences between villagized and non-villagized households after matching.*

Additionally, Figure 5.5 showed that there is good overlap between the density distributions of the propensity scores for the treated and control variables, indicating that the common support criterion is met. The propensity score distribution for the control (not-villagized) households is shown in the graph's lower half (blue color), while the top half (red color) pertains to the treatment (villagized) households. Because their estimated propensity scores are outside the bounds of the common support, 13 observations (all from the treatment group, the green color on the graph), were discarded.

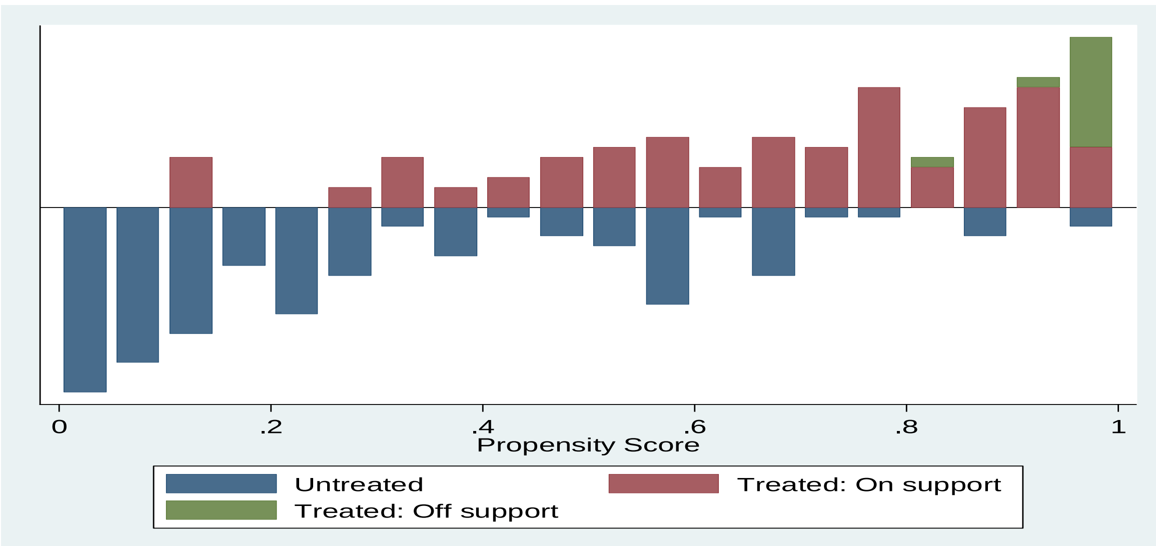

Figure 5.5: Common support region graph

Regarding the matching quality, before matching, there was an average bias of more than 39% between the treatment and control groups in terms of the propensity score. After matching, this bias was dramatically decreased to a level of 9.1% (see Table 5.7). The insignificant likelihood ratio and low pseudo R^2 also support the idea that after matching, both groups have the same distribution of covariates. Hence, before matching pseudo R^2 is 0.357 but after matching it has reduced to 0.016 implying that both treated and control groups have an identical distribution in the covariates after matching and the impact of the program could be easily evaluated since the participants and the non-participants are similar in their pre-intervention observable characteristics.

Table 5.7: Matching quality indicators

Sample	Ps R2	LR chi2	p>chi2	Mean Bias (%)
Unmatched	0.357	109.43	0.000	39.7
Matched	0.016	4.36	0.886	9.1

Source: Own computation (2023)

5.3.6. The impact of VP on adaptation strategy index (ASI)

The propensity score matching results presented in Table 5.8 indicates that villagization program has negatively and significantly affected the household adaptation strategy index at 1% significance level. The estimates of the average treatment effect (ATT) showed that villagized households had on average 0.2 (20%) points lower adaptation strategy to climate change than those who were not engaged in the program. This is because non-villagized households have large farm size and livestock than villagized households with mean difference 2.21 ha and 1.94 TLU respectively.

The empirical investigations showed that larger farm land parcels and a high number of livestock, respectively, improves farmers' capacity to diversify crops and livestock (Danso-Abbeam *et al*., 2021; Derso *et al.*, 2022; Maru *et al*., 2022; Mekuria & Mekonnen, 2018). According to the information obtained from the FGD, following the start of the villagization program, the farm size of households was restricted to a maximum of 3 ha per household. However, due to the lack of a feasibility study on the new sites, even a significant number of the households that took part in the villagization program have lost access to their farm and grazing land.

Additionally, non-villagized households, as opposed to villagized ones, have better social capital (trust, reciprocity, and collaboration) with their kin and neighbors, which directly increase adaptation strategy to climate change. Social capital can be a means of achieving the accumulation of many types of capital and help to strengthen the adaption strategy to climate change (Hegazi & Seyuba, 2021; Nyahunda & Tirivangasi, 2021). Adado (peer-to-peer support), attabaru (a type of contribution for someone to overcome his/her current problem), and collective agricultural effort (Amaha and Amoyo), for example, were some of the harnessing of social capital conducted by non-villagized communities in the research area. According to the data acquired through FGDs, the majority of non-villagized households in the Assosa area diversify their income sources by engaging in border trade with North Sudan and gold mining activities.

Table 5.8: Differences in ATT for villagized and non-villagized households

Variable	Sample	Villagized	Not-villagized	Difference	t-statistics
Adaptive strategy index (ASI)	Unmatched	0.52	0.70	-0.18	-4.6***
	ATT	0.51	0.71	-0.20	

*** denote statistical significance at 1% level.
Source: Own computation (2022)

5.4. Conclusion

Climate change is one of the most significant environmental issues impacting humanity today. It has an impact on economic systems like agricultural output and could lead to widespread unrest (Abdela, 2022). Rural households also notice climate changes based on their indigenous knowledge and experience. Hence, the majority of respondents in the research area were clearly aware of the fluctuation in temperature in the previous years. The outcomes of the meteorological data also demonstrated the presence of seasonal temperature and rainfall variability in the districts of Assosa and Bambasi from 2007 to 2021. A notable strategy for addressing the influence of climate change is regarded to be climate change adaptation in the rural areas (Saddique *et al.*, 2022). Hence, the main adaptation techniques used to mitigate the negative consequence of climate change in the research area included crop diversification, soil and water conservation, adjusting planting dates, harnessing social capital, livestock diversification, income source diversification, planting fodder trees, applying chemical and organic fertilizer, and small-scale irrigation.

The results of both descriptive and propensity sore matching (PSM) analysis of the sample data indicates that compared to villagized households, non-villagized households are better off in terms of mean total of adaptation strategy to climate change risks. The estimates of the average treatment effect (ATT) showed that non-villagized households had on average 0.2 (20%) points higher adaptation strategy to climate change than those who were engaged in the program. Hence, government initiatives like the villagization program need to be reviewed in order to encourage the creation and dissemination of the right technology that will aid households in improving their adaptive strategies to climate change shocks.

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CHAPTER SIX

Synthesis, Implication, Recommendation and Suggestions for Future Research

6.1. Synthesis of the chapters

The researcher has exhaustedly discussed the study's background, the problem statement and objectives in Chapter 1. The objectives of this study assisted the researcher in developing the research questions. In this chapter, the researcher has also determined the scope and description of the study area to make the research manageable, handy, researchable, and optimal and SMART (simple, measurable, achievable, researchable and time bound). In this chapter the researcher has also discussed previous studies and publications that were important to the researcher's investigation. Accordingly, the implementation of VP in various countries, particularly Ethiopia, had a negative impact on the livelihood, food security, and natural resources of rural households (i.e. rapid loss of forest cover, fertile soil, and wildlife resources). The reviewed literature also indicated that the application of VP inhibited some pastoralist communities from adequately considering their way of life, customs, and knowledge, which has resulted in the destruction of their socioeconomic rights. The empirical findings of this study in Chapters 2, 3 and 4 are congruent with above literature reviews. The researcher has also determined the philosophical foundation of the research, research approach, and design, which has a significant impact on every decision made during the research process, including the choice of approach and methods (i.e., research questions, participant selection, data collection tools, and collection procedures, as well as data analysis).

In Chapter 2, the researcher has tried evaluating the food security status of households including the food insecurity gap and the severities of food insecurity. The researcher found that more over half of the surveyed rural households (52.04%) were unable to meet the minimal daily calorie requirement of 2100 kcal. In addition, the food insecurity gap (8.9%) and the severity of food insecurity (2.53%) were also high in the study areas. In this chapter, the researcher has also made an effort to identify the variables that influence households' food security condition in the study area. The researcher identified that household size, dependency ratio, and distance to market had influenced households' food security situation negatively whereas cultivated farm size, irrigation farm size, livestock holding, access to grazing land, and participation in off-farm activities are positive related with households' food security status. The main source of food energy in the research areas was agricultural production, which included maize, sorghum, millet, and fruits and vegetables such as mango, papaya, avocado, and okra (known locally as "Kenkes").

The researcher attempted to examine the influence of VP households' food security status and discover their local coping methods in Chapter 3. The results of descriptive and econometric analysis of the sample data indicates that compared to households incorporated into VP, non-villagized households were found to be better in terms of food consumption score and calorie intake. In this regard, non-villagized households' food consumption scores were 3.56 times higher than villagized households. In addition, non-villagized households showed 573.9 times higher kcal/day as compared to the villagized households. Moreover, villagized households took more severe food coping responses compared with non-villagized households due to food shortages. As a result, the mean values of the coping strategies index of villagized and non-villagized households were found to be 27.28 and 15.51 respectively. This implies that coping mechanisms of villagized households were significantly different from non-villagized households and on average, villagized households took many and/ or more severe coping mechanisms than non-villagized households so as to cope-up food shortage. The main coping mechanisms households adopted during food shortages were: eating less-preferred and less expensive foods, limiting portions of food size at mealtime, reducing the number of meals per day, selling productive assets, purchasing food on credit, selling of firewood and charcoal, engaging in traditional gold mining practices and consumption of wild foods (e.g. wild mushroom, roots, wild vegetables, wild fruits and bamboo shoot).

In Chapter 4, the researcher attempted examines the effect of the VP on LULC dynamics and its deriving factors over a 20-year period. Six land use land cover types were identified in the study areas based on satellite image analysis, including forest land, shrub and grassland, cultivated land, residential, barren land, and water bodies. The LULC change detection also revealed that, since population relocation to new villagization sites, forest land, shrub and grassland, and water body have dramatically decreased at a rate of 27.2 ha, 17.1 ha, and 4.6 ha, respectively, on average, every year between 1999 and 2022. However, between 1999 and 2022, cultivated land, residential land, and bare land grew at an annual rate of 34.3 ha, 11.7 ha, and 2.9 ha, respectively. The primary cause of the reduction in forest, shrub, and grassland cover in the study area was VP-induced population pressure, which resulted in the clearing of natural forests for crop, charcoal, and firewood production, as well as cutting trees for house construction and settlement growth.

In Chapter 5, the researcher attempted to assess rural households' perceptions of climate change, identify the major adaptation strategies rural households frequently employ to cope with the effects of climate change, and investigate how the villagization program has influenced households' adaptation strategies to climate change risks. In this regard, the majority of respondents in the research area thought that the temperature and rainfall had risen and fallen, respectively, in the previous years. Based on their indigenous knowledge and experience, 85% of people in Assosa and 80% of people in the Bambasi district reported a rise in temperature. On the other hand, in the Assosa and Bambasi districts, respectively, 70% and 85% of respondents thought that the amount of rainfall had decreased over the previous years. Similarly, the meteorological data indicated that the Assosa district's average annual temperature has been increasing while the district's average annual rainfall has been declining. In addition, the meteorological data revealed that while the district's average annual rainfall has decreased, the average annual temperature in the Bambasi area has been rising. The main adaptation techniques used to mitigate the negative consequence of climate change in the research area included crop diversification, soil and water conservation, adjusting planting dates, harnessing social capital, livestock diversification, income source diversification, planting fodder trees, applying chemical and organic fertilizer, and small-scale irrigation. Similar to the food security findings mentioned above, compared to villagized households, non-villagized households are better off in terms of mean total of adaptation strategy to climate change risks. Hence, non-villagized households had on average 0.2 (20%) points higher adaptation strategy to climate change than those who were engaged in the program.

In conclusion, households that participated in the VP did not significantly improve their food security position, as expected at the outset of its operation. Furthermore, the state of natural resources has deteriorated. As a result, the VP implementation in the study districts did not achieve its aims, which included lowering poverty and improving food security while taking natural resource protection into account. Due to a lack of feasibility studies, poor consultation with host and villagized communities during the planning and implementation stages, and, most crucially, the issue of environmental repercussions being disregarded, the program has fallen short of its stated goals.

6.2. Implications

6.2.1. Theoretical implications

Taking the basic resource theory of rural development as an example in further buttressing the limitation of the theories and models, there are areas where the availability of abundant natural resources failed to stimulate development. There are also areas where limited resources have led to rapid development. The argument is that, what really counts is the availability of a technically labour force rather than a mere natural resource in a given area. In addition, non-availability of appropriate technology to facilitate the exploitation and utilization of the natural resources would make them to be of little or no use in the community.

6.2.2. Methodological implication

The researcher determined that pragmatic paradigm, mixed methods approach and exploratory sequential design were acceptable for the research to fulfill the goal of the study. This was based on recommendations acquired from a thorough assessment of research methodologies in social science, which encourage such methodology due to the subject's complexity. Despite the fact that the study was predominantly quantitative, the study's synergistic advantage from combining the two methodologies was significant. The researcher was able to incorporate households' perceptions in the analysis of food security status, LULC dynamics, and climate change adaptation strategies by using a qualitative methodology in addition to a quantitative one. For example, holding FGDs to learn "why the food security situation in new villages is dire"? Because the major goal of the dissertation is impact evaluation (the impact of VP on food security and climate change adaptation strategy), the best appropriate program evaluation technique should be used. As a result, the researcher decided to apply the PSM technique to evaluate the VP's success because PSM aids in limiting the influence of confounders. Because of the abundance of cofounders, using solely descriptive statistics may result in weak inference.

6.3. Recommendations

The following recommendations are made for the concerned bodies based on the results and conclusions:

6.3.1. Regional and Woreda Agricultural sectors and other sectors

As mentioned in Chapter 2 & 3, the study found that more than half of the surveyed rural households were food insecure. As a result, the regional and woreda agricultural sectors should provide socio-economic facilities, improved technology such as enhanced farm tools, improved seed varieties, organic fertilizers, and extension services. In addition, participation in off-farm activities influenced households' food security status positively in the study area. Thus, the local authorities should develop interventions to improve farmers' involvement in off-farm activities intended to improve household food security situation. Furthermore, several studies, including this one, have found that having a larger family increases the likelihood of food insecurity. As a result, raising awareness about effective family planning is important for ensuring food security. Although a few kebeles (such as Dabus, Womba, and Abrhamo) have launched soil and water conservation activities, local authorities should expand them to other rural villages in order to reduce the negative consequences of climate change and increase food security. As discussed in chapter 4, due to the neglect of environmental issues throughout the planning and implementation phases of VP, considerable strain on the study area's natural resources, such as rapid forest, shrub land and grass land depletion, has been seen in villagization sites during the last two decades. As a result, the regional and woreda agricultural sectors should work on raising local community awareness, organize afforestation and reforestation campaigns. They should also implement community-based integrated natural resource management, and local land use plans in order to use the natural resources sustainably.

6.3.2. Policy makers

Resettling a specific number of rural people residing in the drought-prone regions through R&V in locations where there are sufficient resources (land, water, etc...) was a strategy to achieve food security situations in Ethiopian including BGRS, which is alongside this theory. However, many empirical findings including this revealed that the program did not achieve its stated goal. As a result, policymakers need to reconsider VP and prioritize feasibility studies in new areas in future development interventions in the region, as well as incorporate communities in every aspect of program planning and implementation phases. In addition, policymakers should prepare to build additional small-scale irrigation schemes and provide sufficient inputs particularly in newly formed villagization sites, to boost agricultural production.

6.4. Suggestions for future research

The focus of this study is confined to examining food security situation and coping mechanisms at the household level. Future research is also required in the case of groups of people who are at a higher risk of poverty, such as people with disabilities, the elderly, and children. Despite the fact that household food security is the cumulative effect of long-term socioeconomic and environmental conditions, this study relied on cross-sectional data (data collected at a single point in time). In fact, information on household food security requires longitudinal data. As a result, the problem will be studied in the future using panel data.

This study is also restricted to VP participants in the region's Assosa and Bambasi districts. As a result, using this as a benchmark, more study may be conducted in other districts of the region to obtain a complete picture of the influence of VP on food security and natural resources in the region. In addition, the food security situation of over 5,391 households who have been displaced and relocated to other new village sites as a result of the commencement of the GERD project in the BGRS's Guba district has not yet been investigated.

Appendix 1: Household Survey Questionnaire

I. General Information, demographic and socioeconomic questions

	A. General information				
1	Region				
2	Zone				
3	District				
4	Kebele/village site				
5	Enumerator's name		Signature:		
	B. Demographic and socioeconomic information				
1	Age of the household head				
2	Sex of the household head	Male	Female	Total	
3	Family size	Male	Female	Total	
4	Sex ratio				
5	Family size by age group	Below 15	65 and above	Total	
6	Dependency ratio				
7	Marital status of household head	Single	Married	Divorced	Widow/r
8	The perception of the respondent towards the program	Optimistic	Pessimistic	Total	
9	Educational status of the household head	Literate	Illiterate	Total	
10	Main occupation of the household head	Farmer	Livestock rearing	Merchant	Handicraft / Mining
	If others (specify)				
11	Do you have rain-fed farm land)	Yes	No		
	If you answer is yes, how many hectares?				
12	Do you have access to irrigable land?	Yes	No		
	If you answer is yes, how many hectares?				
13	Do you have access to irrigable land?	Yes	No		
14	Do you have any source of off-farm income?	Yes	No		
	If yes, specify the source of activity				
15	How many of the following livestock assets do you own? (Write 0 if none)				

Livestock types	Total	unit price/Birr	Total price	Livestock types	Total	unit price/Birr	Total price
Cows				Donkey (adult)			
Oxen				Donkey (young)			
Calf				Mule (adult)			
Heifer				Mule (young)			
Goat (adult)				Horse (adult)			
Goat (young)				Horse (young)			
Poultry							

II. Questions for participants and non-participants of VP

A. Questions for only participants of VP				
1	What was your original Kebele/village?			
2	When did you come to this new villagization			
3	What is your perception towards villagization program?	Optimistic	Pessimistic	
4	What were your reasons to participate in VP? (you can choose multiple answers by marking √)			
	Our household is poor		The household head is married	
	We can't get enough food to eat		We have higher non-active labor force	
	We are landless		The ratio of the female members are higher	
	The household head is female		We own no, or only few livestock	
	The household head is older		We don't have access for grazing land	
	The size of the family is large		We don't have any source of off-farm income	
	The household head is literate		Others (specify)	
B. Questions for the non-participants of VP				
1	Have you heard any information about the implementation of VP in the region?	Yes	No	
2	If yes, What is your perception towards VP?	Optimistic	Pessimistic	
3	What were your reasons not to participate in VP (you can choose multiple answers by marking √)			
	Our household is not poor		The household head is single	
	We have enough food		We have higher active labor force	
	We have enough and quality land		The ratio of the female members are smaller	
	The household head is male		We own large number of livestock	
	The household head is young		We have access to grazing land	
	The size of the family is small		We have off-farm source of income	
	The household head is illiterate		Others (specify)	

Appendix 2: Tools Used for Food Security Measurement

I. HFBM Questions

a) Household crop production and consumption pattern from July 2020 to June 2021 G.C? by Kg.

S/N	Crop types	Total grain produced	Total grain bought	Received from food aid organization	Received through gift/remittance	Post-harvest losses	Grain used as a seed	Total Grain sold	Given to others	Used to social events	Net grain available for HHs
1	Wheat										
2	Teff										
3	Maize										
4	Barley										
5	Sorghum										
6	Bean										
7	Peas										
8	Potato										
9	Tomato										
10	Onion										
11	Cabbage										
12	Avocado										
13	Mango										
14	Banana										
15	Papaya										
16	If other specify										

b) Household Livestock production and consumption pattern from February, 2020 to January 2021 G.C? by Kg.

S/N	product Types	Unit	Total produced	Total purchased	Post harvest losses	products used as a seed	Livestock sold	Used to Social events	Given out to Relatives	Net Livestock product available to households
1	Meat									
2	Cheese									
3	Butter									
4	Milk									
5	Egg									

II. FCS Questions

Could you please tell me how many days in the past week (7 days) your household has eaten the following foods?		
	Food item	**No. of days eaten over the past 7 days**
Grains	Made of Maize	
	Made of Barely	
	Made of Wheat	
	Made of Teff	
	Made of Sorghum	
	Made of Dagusa	
Tubers	Enset (Kocho)	
	Potatoes	
	Cassava	
Vegetables and leaves	Cabbage	
	Carrot and related	
Pulses	Bean	
	Pea	
	Haricot bean	
Fruits	Avocado	
	Pineapple	
	Orange	
	Apple	
	Papaya	
	Banana	
	Gishita	
Meat and fish	Meat	
	Egg	
	Fish	
Milk related	Local Milk	
	Powder milk	
Sugar related	Sugarcane	
	Sugar	
	Honey	
Oil and fat	Butter	
	Processed oil	

III. Coping Mechanism Related Questions

a) Consumption based coping strategies				
	In the past 7 days, was there a time your households use the following coping method as a response to food shortage. *1, if Least severe 2, if Moderately severe 3, if Severe & 4, if Very sever* (you can marking you answer by √)	Yes	No	If yes, how often (number of days each is used)
A	Rely on less preferred and less expensive foods?			
B	Borrow grain from a friend or relative?			
C	Borrow cash from lending individuals or institutions to buy food?			
D	Depend on food aid from government or NGOs?			
E	Purchase grain on credit?			
F	Depend on wild edible foods (Gathering & hunting)?			
G	Harvest immature crops (maize, haricot bean, etc)?			
H	Consume seed stock held for next season?			
I	Send household members to eat elsewhere?			
J	Send household members to beg food or money to buy food?			
K	Limit portion size at mealtimes?			
L	Restrict consumption by adults in order for small children to eat?			
M	Feed working members & abandoning non-working			
N	Reduce number of meals eaten in a day?			
O	Skip entire day (s) without eating?			
	Others (specify if any)			

b) **Other Coping Strategies**				
Were there times your household used the following coping strategies over the past 7 days period as a response to problems/shocks/ facing your household such as food shortage? (you can marking you answer by √)		Yes	No	If yes, number of times you employed it
Coping Strategies Based on Asset Disposal				
A	Sell domestic assets for buying grain			
B	Sell farmland to buy food grain			
C	Lease land in exchange of grain or cash to buy food grain			
E	Sell farm ox or milk cow to buy grain			
F	Sell other a livestock-bull, heifer, calf, donkey, etc to buy grain			
G	Sell small animals (goat, sheep, chicken, etc) to buy grain			
Coping Strategies Based on Labor Disposal				
A	Grow early maturing crops to feed households during food			
B	Sell labor for buying food or in exchange of food grain			
C	Sell charcoal to buy food grain			
D	Sell firewood to buy food grain			
E	Sell construction wood to buy grain			
F	Migration to nearby towns for wage labor to remit to family			

VI. Climate Change Adaptation Strategy Related Questions

No		**Go up**	**Go down**	**Stay the same**	**I don't know**
1	What is your perceptions about change in temperature over the years (2007-2021)				
2	What is your perceptions about change in rainfall over the years(2007-2021)				
3	What are climate change adaptation strategies in you locality?				
	Crop diversification				
	Soil and water conservation				
	Adjusting planting date				
	Harness of social capital				
	Livestock diversification				
	Income source diversification				
	Planting fodder trees				
	Applying chemical fertilizer				
	Applying organic fertilizer				
	Small-scale irrigation				

Appendix 3: FGDs Checklists

I. FGDs Checklists for Food Security

1. What are the main foods that are preferred by households in this village?
2. Is the food produced by the farmers adequate to cover their annual consumption requirement?
3. If they are unable to produce sufficient amount at home, can they purchase from local markets?
4. Are there households who supplement their source of livelihoods by receiving remittances from relatives or by receiving relief support freely from any organization?
5. What does the temporal aspects in food insecurity looks like: is the food insecurity experienced by households chronic or seasonal? If seasonal, what are the common seasons of food insecurity challenges?
6. Can you tell me about characteristics of the households of your community to whom food shortage is not an issue?
7. What are the household's main coping mechanisms? Which of these mechanisms seem sustainable and/or viable?
8. Are the coping mechanisms the same for all households? If not, how do they differ?

II. FGDs Checklists for LULC

1. What are currently existing LULC types in your village?
2. What does the LULC type of your village looks like before 2009 and after 2009 years?
3. Which LULC type is increasing and which is decreasing starting from 2009 to this time in your village? Why?
4. On which period do you observed a rapid land use/land cover change, 2009 or 2021? Why?
5. What are the drivers of LULC change over the last 13 years, between 2009 & 2021? Rank it. (Options: villagization and population growth, farmland expansion, deforestation, wildfire, unsustainable harvest of forest products like: firewood, charcoal, infrastructure development and unwise utilization and low land management practice…etc.)
6. Which land cover is highly affected by drivers of LU/LC change? Forest land, grass land, shrub/bush land, wet land or bare land…?
7. Are there any natural vegetation conservation practices in your village? (Options: controlling over harvest, wildfire control, illegal farm expansion control)
8. What is the solution for the drivers of LULC changes?

IV. FGDs Check list related Climate Change

1. Perceptions about change in climate (temperature and rainfall) over the years (2007-2021)
2. Climate change adaptation strategies
   - Crop diversification
   - Soil and water conservation
   - Adjusting planting date
   - Harness of social capital
   - Livestock diversification
   - Income source diversification
   - Planting fodder trees
   - Applying chemical fertilizer
   - Applying organic fertilizer
   - Small-scale irrigation

Appendix 4: Observation Checklists

1. Settlement/village patterns
2. Housing conditions of villagers
3. Cultural value, traditions
4. Stability of villagers in new site
5. Social relations, neighborhood, network, reciprocity
6. Current forest situation of the districts mainly to compare with its history
7. Land-use pattern
8. Large-scale agricultural land investments if any
9. Forest cover situations
10. Land use management systems
11. Main source of living (farming system): mixed farming, agro-pastoralism, non-farm activities, etc
12. Non-farm/off-farm activities: availability
13. Socioeconomic infrastructure facilities: education, health, transport, water supply…
14. Whether they practice coping strategies
15. Whether households get transfers, remittances, aid, or gather wild food from communal sources.