Mekelle University

College of Business and Economics

Department of Economics

Unraveling the Cost of War: Es[illegible] of War Damage on Household's Food and Nutrition Securely in Tigray, Ethiopia.

by :-

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Economics with Specialization in Development policy Analysis

Submitted to;

Advisor: Muuz Hadush (PhD.)

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DECLARATION

I. Mulugeta Kassie Agezew, do here by declare that the thesis entitled "**Unraveling the Cost of War: Estimating the Effect of War Damage on Household's Food and Nutrition Securely in Tigray, Ethiopia**" submitted to the Department of Economics, College of Business and Economics, Mekelle University in partial fulfillment of the requirements for the award of the degree of Master of Science in Economics with Specialiation in Development policy Analysis is my original work and has not been submitted to any other institution anywhere and anytime. All sources of material used for this thesis have been duly acknowledged.

Name: Mulugeta Kassie Agezew

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CERTIFICATION

This is to certify that the thesis entitled "**Unraveling the Cost of War: Estimating the Effect of War Damage on Household's Food and Nutrition Securely in Tigray, Ethiopia**" submitted in partial fulfillment of the requirements for the degree of master of science in Economics with specialization in Development policy Analysis is the original work of Mr. Mulugeta Kassie Agezew, ID No CBE/PSt/0201/16, who carried out the thesis under my guidance.

Advisor: Muuz Hadush(PhD.)

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Abstract

This study investigates the long-term impacts of asset damage resulting from the 2020–2022 Tigray conflict on household food insecurity and dietary diversity in Ethiopia's Tigray region, utilizing a sample of 400 households from the Samre and Bora districts. Employing an instrumental variable (IV) approach with a control function to address endogeneity—using distance to enemy entry gates and neighbor exposure as instruments—the research establishes a causal link between war-induced asset loss and deteriorating nutritional outcomes. Descriptive statistics reveal significant disparities: the "Damage Group" (49.25%, N=197) exhibits younger heads (42.26 years vs. 48.03), higher male headship (76.6% vs. 67.5%), lower education (6.274 vs. 7.517 years), and smaller landholdings (0.563 vs. 0.653 hectares) compared to the "Safe Group" (50.75%, N=203). Critically, only 7.9% of damaged households are food secure (vs. 47.2%), with 73.4% severely insecure (vs. 46.7%), and dietary diversity is markedly lower, with 46.8% in low diversity (vs. 26.4%) and just 6.4% in high diversity (vs. 35.0%).

Empirical analysis, grounded in ordered probit and Poisson regressions, confirms these disparities. For food insecurity, asset damage increases the latent severity by 0.703 units ($p<0.001$), reducing food security probability by 21% and raising severe insecurity by 22.8%, with a 19.3% higher insecurity score (IRR=1.199, $p<0.1$). For dietary diversity, it decreases the latent variable by 0.928 units ($p<0.001$), increasing low diversity by 31.8% and reducing high diversity by 30%, with a 37.7% lower Household Dietary Diversity Score (IRR=0.623, $p<0.01$). Covariates like age, family size, and education modulate these effects, while strong error correlations ($\rho=-0.932$ for insecurity, $\rho=0.958$ for diversity) validate the endogeneity correction. The robust instruments—distance (negative, $p<0.01$) and neighbor exposure (positive, $p<0.001$)—support causal inference, reflecting conflict proximity and spillover dynamics.

These findings underscore a vicious cycle of poverty and malnutrition, with asset destruction eroding productive capacity and resilience, particularly among targeted younger households. The study's implications extend beyond Tigray, offering evidence for targeted asset restoration, human capital enhancement, and inclusive growth strategies in post-conflict settings. Future research should explore longitudinal recovery, gender-specific impacts, and policy interventions like cash transfers to inform sustainable recovery efforts. Conducted as of May 2025, this analysis provides a critical foundation for addressing Ethiopia's fragile agrarian vulnerabilities amid ongoing conflict legacies

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Chapter One: Introduction

1.1. Background of the Study

One of the objectives of the 2030 Agenda for Sustainable Development states, “Sustainable development cannot be realized without peace and security; and peace and security will be at risk without sustainable development” (UN General Assembly, 2021). Food insecurity and conflict are closely interconnected, each exacerbating the other. Food shortages intensify existing tensions by igniting grievances. Globally, 815 million individuals and 155 million children suffer from undernutrition and stunted growth, respectively (FAO et al., 2017). Alarmingly, 60 percent of the undernourished individuals and 79 percent of the stunted children reside in countries affected by violent conflict (FAO et al., 2017). When conflict disrupts both agricultural and non-agricultural activities in a region, it adversely impacts the livelihoods of households.

In addition to climate change and extreme weather shocks, violent conflicts have exacerbated global hunger. In 2020, an estimated 720 to 811 million people experienced hunger, and the prevalence of undernourishment, which had remained stable for the previous five years, rose by 1.5 percent to reach 9.9 percent (FAO et al., 2021). Violent conflicts continue to be a significant contributor to ongoing food crises. In 2020, over 99.1 million people across 23 countries experienced food crises driven by conflict (FSIN and GNAFC, 2021). In Asia and the Middle East, over 39 million people are experiencing food crises driven by conflict, particularly in Yemen, Afghanistan, and Syria. These crises have been ignited by a combination of political, social, and economic grievances, as well as geopolitical tensions that have led to prolonged violence and armed conflicts (FSIN and GNAFC, 2021).

However, 63 percent of the global population experiencing food crises or worse (IPC/CH Phase 3 or higher) resides in Sub-Saharan Africa, up from 54 percent in 2019 (FSIN and GNAFC, 2021). In East Africa, 32 million people are in a state of crisis or worse (IPC/CH Phase 3 or above), particularly in Darfur (Sudan), South Sudan, and Tigray (Northern Ethiopia). Armed conflicts, inter-communal violence, and localized tensions in these areas have exacerbated food crises and hunger.

The Horn of Africa has a long history of conflict, both at local levels and across borders. Food insecurity inevitably worsens when violence forces large numbers of people from their homes, land, and jobs. Additionally, hunger can exacerbate conflict (Abebe, 2021). The total population of the Horn of Africa is approximately 160 million, with 70 million living in areas prone to extreme food shortages. This means that over 40 percent of the population has experienced undernourishment due to food insecurity and insufficient livelihoods (FAO et al., 2017). According to IGAD (2020), the prevalence of acute food insecurity in the region was alarmingly high, with 61 percent in South Sudan, 27 percent in Ethiopia, 22 percent in Kenya, 17 percent in Somalia, and 14 percent in Sudan.

There is a long history of conflict in the Horn of Africa, both within local communities and between communities across different countries. Food insecurity in the Horn of Africa is linked to the ongoing poverty in the region, which limits people's access to food. The World Food Program (WFP) has found that countries experiencing the highest levels of food insecurity, particularly those affected by armed conflict, also see the greatest outward migration of refugees (FAO, 2016). Additionally, when poverty exacerbates these issues, food insecurity can further heighten the likelihood and intensity of armed conflicts (WFP, 2019). Armed conflicts, communal violence, and other localized tensions continued to disrupt peace and security in the region, leaving 8.5 million people facing acute food insecurity.

IGAD (2020) reported that in 2019, conflict, extreme weather, and economic shocks remained the primary causes of acute food insecurity in the region. These factors are interconnected, exacerbating one another and leading to complex situations that are challenging to resolve (Sleet, 2020). Armed conflicts, communal violence, and other localized tensions continued to disrupt peace and security in the region, leading to 8.5 million people—31 percent of the region's total—facing acute food insecurity. The number comes from 7 million people in South Sudan who are primarily experiencing inter-communal tensions and violence, and 1.5 million in Uganda, most of whom are refugees fleeing armed conflict and war in their home countries (IGAD report, 2020). The food security situation in South Sudan deteriorated significantly in 2013 due to the outbreak of conflict, which led to the displacement of both people and livestock, early depletion of food stocks, poor access to markets, and disruptions in agricultural activities (Sleet, 2020).

Since 2000, 48% of civil conflicts have occurred in Africa, where access to rural land is vital for the livelihoods of many. Additionally, in 27 out of 30 interstate conflicts in Africa, land issues have played a significant role. The percentage of undernourished individuals in countries experiencing conflict and prolonged crises is nearly three times greater than in other developing nations. Post-conflict countries that experience high food insecurity are 40% more likely to relapse into conflict within a decade. Eighty percent of South Sudan's population relies on livestock for their livelihoods, a sector that has already lost $2 billion in GDP due to the ongoing conflict (FAO, 2016).

In conflict-affected countries in sub-Saharan Africa, the number of undernourished people rose by 23.4million between 2015 and 2018, increasing at a faster rate than in countries not experiencing conflict (World Health Organization, 2019). When violent conflicts target specific social segments—such as ethnic, religious, or political groups—food insecurity can transform into a “weapon of war” (Messer and Cohen, 2015). This can occur either as a deliberate strategy or as an unintended consequence. The aim may be to strip a warring party of the support of the local population or to eradicate entire groups through starvation, as seen in cases of ethnic cleansing or genocide. Direct strategies may involve cutting off food supplies to undermine both hostile armed groups and the populations that support them (De Waal, 2018).

The armed conflict in the Tigray region since 2020 has had a significant negative impact on food security. Three-fourths of households have expressed anxiety about their food supply and are resorting to a monotonous diet due to a lack of resources. Many households are forced to eat a limited variety of foods, consume smaller meals, eat foods they do not prefer, or even go an entire day without eating. Key indicators of food insecurity—household food insecurity access, food insecurity experience, and hunger scales—have increased significantly by 43.3, 41.9, and 32.5 percentage points, respectively, compared to the prewar period (Weldegiargis et al., 2023).

1.2. Problem of the Statement

Armed conflict is a major driver of food insecurity (FAO et al. 2017). Nearly 80% of the world’s 155 million stunted children and about 60% of undernourished individuals reside in conflict-affected countries (FAO et al. 2017). Numerous regions across the globe experience an unequal burden of conflict and food insecurity. In 2017, the United Nations raised alarms regarding the fact that over 20 million individuals in Nigeria, Somalia, South Sudan, and Yemen faced the threat of famine triggered by conflict (Akande & Gillard 2019, Security Council Report, 2018). Numerous localized conflicts exist in different regions across the globe, impacting only specific areas of the respective countries, and their consequences appear to be initially confined to those regions (Brück et al. 2016).

In the Horn of Africa, there is a strong connection between a country's exposure to external or internal conflicts and the decline or prolonged stagnation of its food security. Internal conflicts have primarily emerged as the predominant form of mass violence, significantly impacting rural areas and their populations (Abebe, 2021). Food security has long been a pressing issue in the Horn of Africa. This region is home to some of the world's most food-insecure populations, primarily due to ongoing conflicts, economic instability, pervasive poverty, and vulnerability to climate shocks (Sleet, 2020).

Conflict has several consequences, as it heightens food insecurity for both migrants and host communities by restricting access to food. Additionally, conflict causes a substantial decline in economic growth, which further exacerbates poverty and food insecurity situation. This resulted in Africa, particularly the Horn region, remaining stagnant in poverty reduction, while the rest of the world has made significant progress in this area (FAO, 2016). Armed conflicts directly lead to food insecurity and starvation by disrupting and destroying food systems. They reduce the availability of farming labor, damage farm tools, heighten vulnerabilities, disrupt access to markets, and increase food prices, making goods and services unavailable altogether (Bora et al.,2011)

Conflict significantly affects food security by leading to forced displacement and loss of resources. It disrupts food production, interrupts farming and non-farming activities, and damages essential infrastructure (FAO, 2016). As a result, conflict decreases food availability, obstructs access to food, and undermines all production systems. Its negative consequences extend to hunger, nutrition, and overall development, particularly in rural areas, where agricultural production and livelihoods are adversely impacted. Consequently, the livelihoods of rural communities are disrupted, leading to increased food insecurity and hindering sustainable development (FAO, 2016).

The decline is primarily attributed to the loss of the workforce, depletion of assets, displacement of people, environmental destruction, and the devastation of infrastructure, including schools, healthcare facilities, and other social services. Studies suggest that reduced agricultural production and income contribute to conflict by limiting employment opportunities and raising prices and grievances (FAO, 2016). Conflict is a significant push factor that leads to migration and forced displacement, with detrimental effects on food security. It heightens the vulnerability of impoverished populations by disrupting food supply chains, affecting harvests, interrupting economic activities, displacing individuals from their homes, and depleting resources. Additionally, conflict escalates vulnerabilities and risks while diminishing coping mechanisms for both migrants and host communities. These factors collectively undermine food security.

Various studies indicate that conflict negatively impacts the food security of children in the Horn of Africa (Arcand et al., 2015; Duque, 2016; Nasir, 2016).This results in the birth of children with low weight and poor health, which in turn transmits the negative effects of conflict across generations According to the FAO (2016), a study that analyzed conflict data alongside advancements in farm technologies investigated the impact of violent conflict on agricultural production, including livestock and various crop types. The findings revealed that production declines significantly in regions affected by conflict.

Evidence indicates that exposure to armed conflicts leads to significant, often irreversible short- and long-term effects, which can be passed down across generations (Akresh et al., 2012). Empirical studies conducted in various regional contexts indicate that children from conflict-affected areas are shorter than those born in regions unaffected by conflict (Akresh et al., 2011). Additionally, if a mother is exposed to conflict during pregnancy, it can negatively affect the child's birth weight (Camacho, 2008). Adults who experienced conflict in their early years have also shown physical and cognitive impacts (Akresh et al., 2012). In a rigorous study from Burundi, Verwimp (2012) estimates that one year of exposure to conflict increases the mortality risk for boys due to nutritional deficiencies by 25 percentage points. Guerrero-Serdan (2009) considers the impact of violence in Iraq on chronic, general, and acute malnutrition. The results indicate that conflict-affected children are shorter.

Food insecurity can simultaneously worsen societal conditions and undermine political stability (Abebe, 2021). In post-conflict situations, it has contributed to violence in the Central African Republic and Yemen. For instance, in South Sudan, inter-communal violence surged by 300 percent in 2019, further exacerbating an already fragile food security situation and obstructing humanitarian access to the most affected areas (Sleet, 2020). The most noticeable effect of violent conflicts on food security is the destruction of agricultural land, irrigation systems, and infrastructure. This chronic food insecurity can, in turn, significantly contribute to the prolongation or escalation of violent conflicts, creating a vicious cycle of violence and hunger (Martin-Shields and Stojetz, 2019).

Although numerous single-case studies examine the reciprocal relationship between specific aspects of food insecurity and various contexts of violent conflict (see Brück et al., 2016), it is surprising that these two themes are rarely explored together. While existing frameworks describe the relationships between conflict and food security attributes, it is crucial to employ econometric methods to identify patterns in how food security and conflict influence one another. This review of empirical research focuses on the endogeneity that characterizes the connection between food insecurity and violent conflict (Brück et al., 2016). Additionally, exposure to conflict may directly impact food security while also interacting with other variables, such as price fluctuations and climatic conditions.

Both conflict and food security are measured in highly idiosyncratic ways. Food is essential for the survival of armed groups (e.g., Justino and Stojetz, 2018), which can lead to decreased local consumption levels, particularly in scenarios where food and hunger are employed as "weapons of war" (Messer and Cohen, 2015). This has been evident in the study region, which experienced a complete siege (Gebrihet et al., 2025). Collecting microdata on this issue is challenging, and to the best of our knowledge, these effects have not yet been systematically studied or quantified. Therefore, an emprical study necessitates robust findings from rigorous quantitative analyses, as well as strong evidence on the impact of conflict on food and nutrition security, which is of paramount importance (Brück et al., 2016; Baumann and Kuemmerle, 2016).

The existing literature provides strong evidence of the negative effects of conflict on food security and dietary diversity. However, most studies neglect the severity of medium-term asset loss and its role in perpetuating food insecurity. There is a systematic gap in examining how war exposure disproportionately affects female-headed households regarding dietary diversity, aid access, and coping mechanisms. Additionally, there is a lack of heterogenous analysis—such as by livelihood, displacement status, or agroecology—to identify vulnerability thresholds and resilience factors. While studies often utilize household fixed effects (Marchesi & Rockmore, 2023) or spatial conflict measures (Kafando & Sakurai, 2024), they rarely address endogeneity comprehensively.The impact of conflict on food security varies, with gender identified as a moderating factor. This suggests that women may experience different levels of food insecurity than men (Rudolfsen et al., 2024).

The research question of this thesis focuses on the impact of war exposure on household food and nutrition security, using the Tigray region of Ethiopia as a case study. The armed conflict in Tigray, which lasted from November 2020 to November 2022, along with the accompanying siege, resulted in the near-total collapse of the region's economy. The conflict caused widespread infrastructure damage, disrupted agricultural activities, and led to significant displacement, contributing to acute food insecurity (Clark, 2021; Weldegiargis et al., 2023; Geremedhn & Gebrihet, 2024). Its long-lasting effects continue to influence food security, impacting access, stability, and distribution (Clark, 2021; Gebregziabher et al., 2023; Araya & Lee, 2024; Geremedhn & Gebrihet, 2024). Findings from the study indicate that female-headed households face a higher level of food insecurity compared to male-headed households. According to the Food Insecurity Experience Scale (FIES) scores, 17% of households were food-secure, 20% were mildly food-insecure, 35% were moderately food-insecure, and 29% were severely food-insecure. Additionally, the Food Consumption Score (FCS) analysis showed that 52% of households had poor food consumption, 33% fell into the borderline category, and 16% had acceptable food consumption (Gebrihet et al., 2025).

This thesis makes two significant contributions to the literature on war exposure and food security in Sub-Saharan Africa (SSA). First, it utilizes advanced instrumental variables estimation to address potential endogeneity between conflict and food insecurity, which may arise from either systematic destruction or the reverse causality between these two factors. Second, it provides a regional overview of micro-data analysis on conflict and food insecurity in SSA, drawing on nationally representative household survey data from the war-torn Tigray region. This approach enhances the understanding of the war's impact and improves recovery programs through precise and reliable estimates, supporting a stronger claim regarding the causal effect of war exposure on agricultural yields. Finally, unlike previous studies that focus on national-level data, this thesis analyzes the impact of war exposure at the household level across different groups. By 2030, it is estimated that up to two-thirds of the world's extreme poor was be living in conditions of fragility and conflict (Corral et al., 2020). To address the food insecurity challenges of the future, it is essential to understand the relationship between food insecurity and conflict.

1.3. Research Question

The thesis is centered around the following five research questions:

1. What is the intensity and severity of asset damage among the sampled households?
2. What is the profile of post-war household food insecurity and the dietary diversity score?
3. What is the impact of war exposure on food and nutrition security in Tigray?
4. What is the gender differential impact of war exposure on food and nutrition security?
5. Is the effect of war exposure on food and nutrition security heterogeneous in Tigray?

1.4. Objective of the Study

The main objective of this study is to estimate the effect of war damage on households' food and nutrition security in the Tigray region. The specific objectives are to:

1. Assess the magnitude of war-induced asset loss in Tigray region
2. Characterize household food insecurity and dietary diversity using standardized metrics (e.g., HFIAS, HDDS).
3. Estimate the causal impact of war exposure on food and nutrition security
4. Evaluate gender-differentiated impacts of conflict
5. Examine heterogeneous effects across subgroups

1.5. Significance of the study

This study holds substantial academic, humanitarian, and policy relevance, particularly in the context of post-war recovery in Tigray, Ethiopia. By rigorously analyzing the socioeconomic and nutritional consequences of conflict using robust econometric methods, this research contributes to

1. **Academic Contributions**

- **Advances Conflict Economics Literature**: Unlike most studies on war and food security that rely on aggregate data or qualitative assessments, this research offers micro-level, causal evidence demonstrating how war damages assets and disrupts nutrition, thereby filling a gap in the existing empirical literature.

- **Methodological Rigor**: The application of instrumental variable (IV) estimation effectively addresses endogeneity concerns (such as reverse causality between war exposure and food insecurity), enhancing the validity of the findings.
- **Gender and Intersectional Analysis**: This study examines gender-differentiated impacts, contributing to feminist economics and humanitarian research by revealing how conflict exacerbates or alters pre-existing inequalities.
- **Heterogeneity Analysis**: By investigating variations across different livelihoods (e.g., farmers vs. pastoralists), displacement status, and agroecological zones, the study provides nuanced insights into who is most vulnerable and the reasons behind their vulnerability.

2. Policy and Humanitarian Relevance

- **Targeted Aid Programming**: Findings on asset loss severity can guide NGOs and governments in prioritizing compensation (e.g., livestock restocking, farm tool distribution) for the worst-affected households.
- **Nutrition-Sensitive Interventions**: By quantifying dietary diversity gaps, the study informs emergency food aid and long-term programs (e.g., fortified food distribution, maternal-child nutrition support).
- **Gender-Responsive Policies**: Evidence on female-headed households' disproportionate burdens can advocate for policies like cash transfers, women's access to credit, or protection programs.
- **Resilience Building**: Identifying subgroups with heterogeneous effects (e.g., displaced vs. non-displaced) helps tailor recovery programs to enhance community resilience.

3. Societal Impact

- **Amplifying Marginalized Voices**: The survey captures firsthand experiences of Tigrayan households, ensuring their needs are empirically documented in post-war recovery dialogues.
- **Conflict Prevention**: By demonstrating how war devastates food systems, the study underscores the long-term costs of conflict, supporting advocacy for peacebuilding.

4. Timeliness and Global Relevance

- **Post-2020 Tigray Crisis**: As one of the first large-scale econometric studies using **2025 survey data**, it offers updated insights into a region still grappling with war aftermath.
- **Broader Applicability**: While focused on Tigray, the findings may inform responses to conflicts in similar agrarian economies (e.g., Sudan, Yemen).

1.6. **Scoop the study**

This study examines the socioeconomic and nutritional consequences of war exposure on households in the Tigray region of Ethiopia, focusing on asset destruction, food insecurity, and dietary diversity. The research is based on survey data collected from war-affected households in 2025 and employs instrumental variable (IV) estimation methods to address endogeneity and establish causal relationships.

Tigray, Ethiopia, is a region severely affected by the war from 2020 to 2022. This thesis was rely on cross-sectional survey data collected in 2025, capturing the post-war conditions. It was include households in conflict-affected zones, with stratification to ensure representation across urban and rural areas, as well as different livelihood types. The study was quantify losses in productive assets such as livestock, tools, and infrastructure, assessing their economic severity. Additionally, it was measure post-war household food insecurity using the Household Food Insecurity Access Scale (HFIAS) and dietary diversity through the Household Dietary Diversity Score (HDDS). The study was also estimate the differential impacts on male-headed versus female-headed households, including access to aid and nutritional outcomes, as well as variations by agroecology (highland versus lowland) or location (rural versus urban). To mitigate endogeneity, the study was use instrumental variables, such as distance to conflict epicenters or pre-war infrastructure and the frequency of neighbor damage. Furthermore, the study aims to (1) provide empirical evidence on the medium-term impacts of war on food systems, (2) identify high-risk groups for targeted humanitarian interventions, and (3) advance methods for causal inference in conflict research.

1.7. Structure of the Thesis

The thesis is systematically organized to promote clarity and coherence in addressing the research topic. Chapter One serves as the Introduction, where the research problem, objectives, and significance of the study are outlined, establishing the foundational context and rationale. Chapter Two offers a comprehensive review of theoretical frameworks and empirical studies, providing a critical analysis of existing literature to situate the research within the broader academic discourse. Chapter Three details the research methodology, including the study area, sample size, data collection techniques, and methods of data analysis, ensuring transparency and reproducibility. Chapter Four presents the study's results and engages in an in-depth discussion that interprets the findings in relation to the research objectives and the reviewed literature. Finally, Chapter Five concludes the thesis with a concise summary of key findings, modest conclusions, and practical recommendations for future research and applications.

Chapter Two:
Literature Review

2.1. Definition of Concepts

Armed conflict is defined as "a contested incompatibility concerning government and/or territory, where the use of armed force between two parties, at least one of which is a state government, results in at least 25 battle-related deaths within a calendar year" (Gleditsch et al. 2002). Researchers often categorize conflict types by their intensity, using either the country-year or dyad-year as the fundamental unit of analysis (Gleditsch et al. 2002). A war, or major conflict year, is defined as a state-based conflict or dyad that results in at least 1,000 battle-related deaths within a specific calendar year. Conversely, a minor conflict year is characterized by having at least 25 but fewer than 1,000 battle-related deaths in a single calendar year.

Civil wars result in significant loss of life, extending beyond the immediate casualties incurred during the conflict. Even after hostilities cease, civil wars continue to cause indirect fatalities and disabilities. These subsequent impacts predominantly affect the civilian population (Ghobarah et al., 2003). Armed conflicts compel entire communities to move, disrupt their means of livelihood, damage infrastructure and hinder economic development, weaken social cohesion and political structures, and restrict access to essential resources such as water, food, and healthcare. War represents a regression in development (Collier et al., 2003). Armed conflict and economic growth are intrinsically linked; armed conflict significantly hinders economic growth, whereas economic growth is closely associated with a decrease in the likelihood of armed conflict (Petrova et al., 2023).

The foundation of food security is built upon three key components: food availability, food access, and food utilization (Barrett, 2010). This framework was later expanded to include a fourth component, stability, which integrates aspects of access and availability (FAO 2006). To summarize, these components can be defined as follows: food availability guarantees a sufficient supply; access indicates that individuals can easily obtain the food they require; utilization ensures that people receive an adequate intake of nutrients; and stability pertains to the consistent ability of individuals to access food (FAO, 2006).

2.2. Theoretical Review of the Study

Armed conflicts have a direct and indirect influence on human development, with repercussions experienced at the individual, household, and societal levels (e.g., Gates et al., 2012; Moyer, 2023). The framework, which draws upon foundational studies by Ghobarah et al. (2003) and Collier (1999), establishes a shared terminology and examines the interconnections between conflict and different aspects of development. This framework identifies six distinct types of impacts: destruction, deterioration, disruption, diversion, devaluation, and dissaving. Destruction refers to all harm inflicted on individuals and assets, whereas deterioration denotes the reduction in the availability and quality of resources due to conflict. Both of these processes impact various aspects of individual well-being and development, including health, education, and economic stability. The ongoing violence results in the deaths and injuries of both soldiers and civilians, while personal property, agricultural resources, and livestock are either stolen or destroyed. This turmoil compels individuals to abandon their homes. Furthermore, such violence hampers access to clean water and food, disrupts educational and healthcare services, and negatively impacts labor and productivity (Collier, 1999; Vesco et al., 2025).

Disruption refers to the interruption of operations and the diminished effectiveness of resources caused by conflict. The threats associated with violence and the enforcement of curfews hinder the availability of resources and services (Collier, 1999). This results in the inability to transport or store goods, restricts individuals from attending work, and limits access to infrastructure. Conflict escalates expenses while diminishing the effectiveness of everyday activities by lowering resource efficiency (Ghobarah et al., 2003). Violence hinders economic productivity and growth, reduces food production, restricts access to educational institutions, and undermines social capital and collaboration. Similarly, diversion refers to the redistribution of resources resulting from conflicts (Collier, 1999), where government budgets intended for growth-enhancing initiatives and public goods are redirected towards military spending (Ghobarah et al., 2003).

The four main dimensions of food security—availability, access, utilization, and stability—serve as the mechanisms through which armed conflict can influence household dietary diversity and overall food security. This study primarily focuses on the dimensions of food availability and access. Armed conflict may diminish food availability for farming households by reducing agricultural output.

Additionally, restricted access to land and essential production inputs, such as labor, fertilizer, and support services in conflict-affected areas, can adversely affect household farm productivity (George et al., 2021; Martin-Shields & Stojetz, 2018). Risks and uncertainties related to conflict can negatively impact long-term food availability for households, as demonstrated by Martin-Shields and Stojetz (2018).

Conflict results in devastation and a decline in the quality of certain production elements, including land, labor, and entrepreneurship. It also affects overall factor productivity and efficiency within an economy (Collier et al. 2003). These changes can, in turn, affect the availability of different agricultural inputs, such as food, as well as the efficiency of markets concerning price determination and distribution, ultimately obstructing economic growth.

Households in conflict-affected areas often face various forms of violence and crime. Beyond the threat of attacks from key conflict actors, such as militants or insurgents, these households become increasingly vulnerable to criminal activities (Kaila and Azad, 2023). Conflict can significantly affect both the economic situation of households and their physical access to food. The destruction of markets and road infrastructure can impede access to markets and disrupt the supply of food and agricultural inputs. When combined with lower individual farm harvests, this can result in higher food prices and decreased purchasing power for households. Additionally, conflict can cause the loss of business activities that generate off-farm income for families (Arias et al., 2018; Kah, 2017). This loss of income further diminishes households' ability to purchase food, leading to reduced food consumption and less dietary diversity.

2.3. Empirical Review of the Study

The recent surge in active organized conflict worldwide can be attributed primarily to conflicts in Africa, which saw a 58% increase, escalating from 19 to 30 conflicts between 2017 and 2020. This rise was largely fueled by the reactivation of conflicts that had been inactive for several years (Pettersson et al., 2021). Numerous research studies have shown that conflict adversely affects food security, which is defined as the consistent physical and economic access to an adequate supply of food necessary to fulfill dietary requirements for a healthy and productive life (USAID, 2021). The impact of conflict in Nepal on dietary diversity, as indicated by food consumption scores (FCS), has been examined by Marchesi and Rockmore (2023). Their analysis compares data from before the onset of violence to that during its peak, employing household fixed effects to mitigate selection bias related to violence. Their findings reveal that a 100 percent rise in local violence intensity results in a 3 percent reduction in household FCS.

The economic repercussions of civil war frequently extend far beyond the duration of the conflict and can affect neighboring nations as well. These repercussions encompass disruptions in employment and investment, as well as significant refugee outflows. In the post-conflict phase, it is crucial to prioritize the restoration of investor confidence and the rebuilding of trust (Mueller & Tobias, 2016). The effects of conflict on the economy are influenced by two primary factors: the length and severity of the conflict. Research conducted by Mueller and Tobias (2016) indicates that during civil wars, GDP per capita is projected to decline by approximately 18% over a four-year span. Notably, the recovery from such economic setbacks is protracted. Even six years post-conflict, GDP per capita remains, on average, 15 percentage points lower than it would have been in the absence of the war (Mueller & Tobias, 2016).

Households in conflict-affected areas are at risk of violence and crime from various actors. A study by Kaila and Azad (2023) explores how differences in the timing, intensity, and spatial distribution of attacks on households in Nigeria impact their well-being. The findings indicate that experiencing conflict victimization results in increased food insecurity and reduced consumption of both food and non-food items. Evidence indicates that victimization has negative effects on welfare outcomes (Minoiu and Shemyakina, 2012). Dabalen and Paulin (2014) estimate the causal effects of conflict on dietary diversity in Côte d’Ivoire in their paper. To determine the true impact of conflict, they utilized (1) pre-war and post-war household data, (2) specific counts of conflict events across departments, and (3) self-reported victimization indicators. Their findings reveal robust and statistically significant evidence that households in the most severely affected conflict areas, as well as individuals who are direct victims of the conflict, experience lower dietary diversity.

Kafando and Sakurai (2024) examine the impact of terrorist violence in Burkina Faso on household dietary diversity, measured through food consumption scores (FCS), and explore the underlying mechanisms. To conduct this analysis, they utilize a nationally representative five-year panel dataset on households alongside spatial conflict data. Their findings reveal negative and significant effects of conflict intensity on household food consumption scores. The observed decline in household FCS is attributed to a marked decrease in dietary diversity stemming from both food production and purchases. Further analysis reveals that per-capita farm income and food expenditure serve as pathways connecting the intensity of armed conflict to a decrease in food consumption scores (FCS) in food purchases. Meanwhile, reduced dietary diversity in food production results from a decline in crop production (Kafando and Sakurai (2024).

The connection between armed conflicts, household dietary diversity, food security, and nutritional outcomes has garnered growing attention in recent agricultural economics literature (Dabalen & Paul, 2014; D'souza & Jolliffe, 2013; George et al., 2019; Marchesi & Rockmore, 2023; Serneels & Verpoorten, 2015). In this case, D'souza and Jolliffe (2013) analyzed conflict data from Afghanistan and found that Afghan households in provinces with higher levels of conflict experienced a decrease in per-capita calorie intake and food security. Empirical analysis of the effects of civil war on household dietary diversity shows that households in conflict-affected regions experience reduced dietary diversity (Dabalen & Paul, 2014; Marchesi & Rockmore, 2023). Similarly, Serneels and Verpoorten (2015) found that households in conflict-affected areas of Rwanda experienced lower levels of food consumption.

Additionally, George et al. (2019) conducted a recent study that integrated regional conflict data with household panel survey data to investigate the impact of the Boko Haram insurgency on food security outcomes in Nigeria. George et al. (2019) similarly suggested that the Boko Haram conflict impacted household food security through income and farm input pathways. The conflict in Ukraine has incurred significant expenses, amounting to approximately 1% of the global GDP in 2022, which translates to around $1.5 trillion when assessed using purchasing power parity (PPP) exchange rates. In Europe, GDP was projected to decline by over 1% in 2022, contributing roughly 2% to global inflation for that year and an additional 1% in 2023 (Liadze et al., 2023).

Studies in Burkina Faso indicate that armed conflict reduces dietary diversity and food consumption scores, primarily due to diminished agricultural production and purchasing power (Kafando & Sakurai, 2024). The connections between conflict and food insecurity involve declines in farm income and food expenditure, which are essential for understanding the impact of conflict on household nutrition (Kafando & Sakurai, 2024). A major methodological challenge is the difficulty of collecting data in conflict zones, which often forces researchers to rely on satellite imagery instead of household-level data. This reliance limits the understanding of individual experiences and the specific impacts of conflict on food security (Hendriks & Toit, 2024).

The existing literature offers strong evidence of the negative effects of conflict on food security, dietary diversity, and economic stability. However, significant gaps persist, especially regarding post-war recovery, gender disparities, and localized impacts in Africa. This study aims to address these gaps: Most studies (e.g., Marchesi & Rockmore, 2023; Kafando & Sakurai, 2024) focus on the immediate effects of conflict but overlook the severity of medium-term asset loss and its role in perpetuating food insecurity. While some research acknowledges the broad welfare impacts of conflict (e.g., Kaila & Azad, 2023), few rigorously analyze the gender-differentiated effects on food security. Existing studies (e.g., Dabalen & Paul, 2014; George et al., 2019) often treat conflict-affected populations as homogeneous and lack subgroup analyses—such as those based on livelihood, displacement status, or agroecology—that could identify vulnerability thresholds and resilience factors. While studies often utilize household fixed effects (Marchesi & Rockmore, 2023) or spatial conflict measures (Kafando & Sakurai, 2024), they rarely address endogeneity comprehensively.

2.4. The Analytic Framework and Hypothesis

Based on the theoretical and empirical review, the following working hypothesis is proposed: Armed conflicts negatively affect household dietary diversity and food security through multiple pathways, including destruction of assets, disruption of agricultural production, market access limitations, and income loss. These effects are exacerbated by conflict intensity, duration, and localized vulnerability factors (e.g., gender, displacement status, and agroecological conditions). Households in conflict-affected areas experience reduced food consumption scores (FCS) and dietary diversity due to lower agricultural productivity, restricted market access, and diminished purchasing power, with long-term consequences persisting well beyond the cessation of violence in the study region.

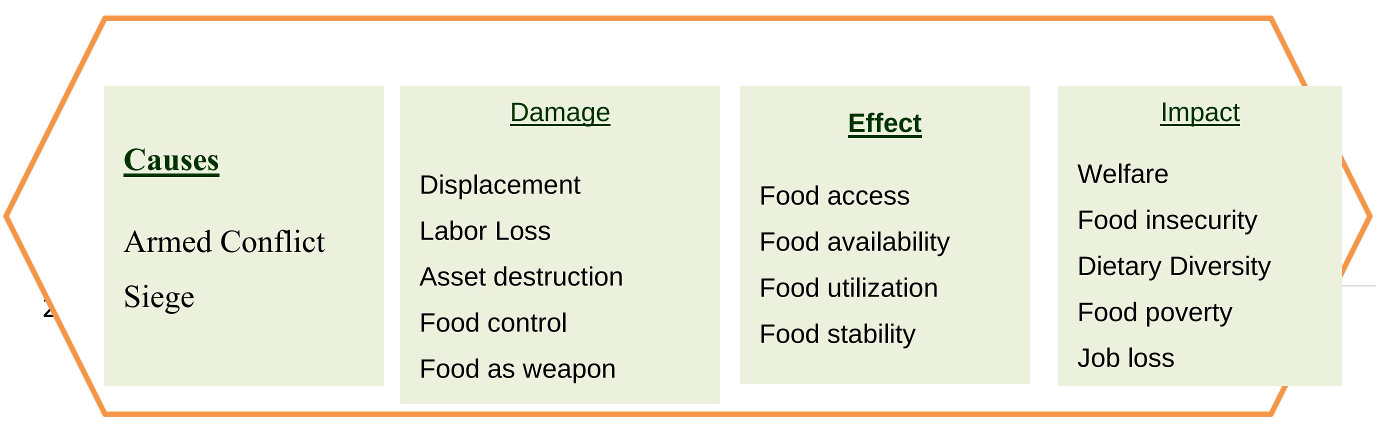

Fig1: Conceptual Framework: **Interplay among war, welfare, food & nutrition security. Source: own compilation**

Since 2020, the armed conflict in the Tigray region has severely affected food security. Three-quarters of households report anxiety about their food supply and have turned to a monotonous diet due to limited resources. Many are forced to consume a narrow range of foods, eat smaller portions, choose less preferred items, or even go entire days without eating. Key indicators of food insecurity—household food insecurity access, food insecurity experience, and hunger scales—have risen significantly by 43.3, 41.9, and 32.5 percentage points, respectively, compared to the prewar period (Weldegiargis et al., 2023).

A UN report underscores the extensive damage caused by the conflict, which includes both material and human losses. Over 90% of the harvest has been lost due to various forms of destruction, while around 80% of the region's livestock have either been looted or slaughtered (World Peace Foundation, 2021). Additionally, a study by Manaye et al. (2023), based on a sample of 4,376 households, found alarming figures: 81% crop loss, 75% livestock loss, and 48% loss of farm tools in the area. The ongoing famine in Tigray has been characterized as a man-made crisis, with the deliberate destruction of agricultural production by the Ethiopian government and allied forces leading to widespread starvation—a grave violation condemned by the UN Security Council (Zappalá, 2019).

Conflict-induced destruction of agricultural assets, such as land and livestock, significantly reduces food availability and access, resulting in lower dietary diversity. It disrupts labor availability, limits access to essential inputs like fertilizers and seeds, and hampers market functionality. Additionally, resources that could be used for food security programs are often diverted to military spending, further worsening household food access. As a result of conflict, both farm and off-farm incomes decline, limiting households' ability to purchase diverse foods and decreasing dietary diversity. Female-headed households and displaced populations face even greater declines in dietary diversity due to increased economic instability and restricted access to resources. Even after a conflict ends, households continue to struggle with dietary diversity due to ongoing asset depletion, weakened institutions, and a slow economic recovery.

This hypothesis is supported by the reviewed literature (e.g., Collier, 1999; Ghobarah et al., 2003; Kafando & Sakurai, 2024) and addresses gaps related to medium-term impacts, gender disparities, and localized vulnerability factors. To validate these mechanisms, empirical testing could include panel data analysis, conflict event mapping, and subgroup comparisons.

Chapter Three:
Methodology of the Study

3.1. Area of the Study

The study examines the Bora and Samre Districts in the Tigray region of Ethiopia, which were severely impacted by the Tigray armed conflict (2020–2022). This conflict led to significant human and material losses, including widespread displacement, destruction of infrastructure, and disruption of livelihoods. Although the war officially concluded in November 2022 with the Pretoria Agreement, its effects continue to resonate within the communities. The Tigray War, spanning from November 2020 to November 2022, inflicted profound devastation on the region's social, economic, and physical infrastructure, particularly in southeastern districts like Samre and Bora, where intense fighting, looting, and displacement were rampant.

This research gathered data from 16 villages across the two districts, encompassing 21,116 household heads, to evaluate the socio-economic and humanitarian repercussions of the conflict. Bora and Samre are situated in the Southeastrn and southern Zone of Tigray, adjacent to the Amhara region. These two districts encompass a blend of highlands and semi-arid lowlands, with agriculture serving as the primary source of livelihood for residents. The combined population is estimated to exceed 100,000, most of whom rely on subsistence farming. The districts comprise small towns and rural villages, many of which experienced significant damage during the conflict.

The two districts were among the hardest hit, suffering from civilian casualties, forced displacement, and gender-based violence. Homes and infrastructure, including schools, health centers, and roads, were damaged or destroyed. Farmlands and livestock were either looted or abandoned, resulting in food insecurity. Disruptions in markets and trade further aggravated economic conditions, while blockades and violence restricted access to food, healthcare, and education.

Following the Pretria Agreement, some stability has returned, but significant challenges persist. Many households remain displaced or unable to return home due to destroyed properties, and the reconstruction of infrastructure and livelihoods is progressing slowly. There is an urgent need for food aid, psychosocial support, and economic rehabilitation. Evidence-based data is essential to understand the humanitarian and economic impacts of the conflict. This thesis will offer insights for recovery programs and policy interventions, emphasizing the importance of documenting community resilience and post-war coping mechanisms. The Bora and Samre districts serve as critical case studies of war-impacted communities in Tigray. By examining the experiences of 21116 households, this study aims to contribute to post-conflict recovery and advocate for sustainable rehabilitation efforts.

3.2. Sample Size and Sampling Technique

To calculate the sample size for the two districts, Bora and Samre, which together have a total of 21,116 household heads, we can apply Cochran's formula designed for finite populations. Cochran's (1977) Formula (for finite populations):

$$n = \frac{n_0}{1+\frac{(n_0-1)}{N}} \tag{1}$$

where:

- n = required sample size
- n_0 = initial sample size estimate (using Cochran's formula for infinite populations)
- N = total population

We proceed with the subsequent steps to determine the optimal sample size. In the first step, we calculate n_0 for populations that are considered infinite. Cochran's fundamental formula, applicable to large populations, is as follows:

$$n_0 = \frac{Z^2.p.q}{e^2} \tag{2}$$

where:

- Z = Z-score (standard normal deviate, e.g., 1.96 for 95% confidence)
- p = estimated proportion of an attribute (if unknown, use p=0.5 for maximum variability)
- q=1−p=0.5
- e = margin of error (e.g., 0.05 for ±5%)

This process yields a sample size of n_0=384.16, which is approximately 385. In the second step, by accounting for the finite population (N=21,116), we arrive at a total sample size of n≈378, utilizing the formula outlined in equation 1. In the third step, we divide the conflict zone into strata based on proximity to conflict epicenters (high, moderate, low exposure), agroecological zones (such as highland versus low land), and displacement status (internally displaced versus non-displaced). . Hence, the sample is divided between the two districts. Bora, which has 5,988.7 households, yields a proportional sample size of 107, calculated as (5,988.7)/(21,116)*378≈107. Meanwhile, the proportional sample for Samre district, with 15,127.8 households, amounts to 271, determined by(15,127.8)/(21,116)*378≈271. With a non-response rate of 6% taken into account, the overall sample size rises to approximately n= 400. Households are then randomly selected within each stratum to ensure representativeness.

3.3. Data and Data Collection Method

Data for this study will be collected from April to May 2025 through face-to-face administration of household survey questionnaires that include both semi-structured and structured questions. This section outlines the data collection method designed to gather information on war damage (material, agricultural, infrastructural, and human loss) as well as household-level data on food insecurity and dietary diversity from 400 household heads in conflict-affected areas. The approach employs mixed methods, incorporating quantitative surveys and qualitative interviews, to enhance robustness and facilitate triangulation.

The survey utilizes a closed Household Survey Questionnaire to capture detailed information on destruction and standardized metrics such as the Household Food Insecurity Access Scale (HFIAS) and the Household Dietary Diversity Score (HDDS) from 400 households stratified across various affected areas. It specifically focuses on dietary diversity scores, which necessitate recalling food consumption over a specified period. Therefore, the questionnaire includes sections for a 24-hour or 7-day recall of food intake and the HFIAS for the past 30 days. Data on household food security and nutrition will be collected using tools developed by the Food and Nutrition Technical Assistance Project for low-resource settings (Swindale & Bilinsky, 2006; Coates et al., 2007).

Based on the timeframe and logistics required to access conflict-affected regions, over ten local enumerators with at least a 10th-grade education will receive training. It is essential to train enumerators prior to fieldwork, particularly in sensitive locations. Ethical considerations, including informed consent and confidentiality, are imperative. To ensure data accuracy, validation methods such as pilot surveys, spot checks, or triangulation with secondary sources will be employed.

The Household Survey questionnaire encompasses several sections that address various aspects: (1) Demographics, which includes household size, age, gender, education, and displacement status; (2) Material Destruction, focusing on the loss of housing, vehicles, tools, livestock, and other assets; (3) Agricultural Destruction, detailing crop damage (including hectares affected and types of crops), livestock losses (by number and type), and the theft or destruction of farming tools and inputs such as fertilizers and seeds; (4) Infrastructural Destruction, which assesses damage to roads, markets, mobile infrastructure, power meters, and water meters (both reported and observed), as well as access to electricity, water, and sanitation before and after the conflict; (5) Human Loss, which records deaths and injuries among household members and the history of displacement (including duration and reasons); (6) Household Food Security, which involves a 30-day recall of food groups consumed (e.g., grains, vegetables, meat, dairy); (7) Household Dietary Diversity Score (HDDS), based on a 24-hour recall of dietary intake across 12 food groups; (8) Coping Strategies, which may include reduced meal frequency, reliance on wild foods, borrowing, or selling assets; and (9) Economic Impacts, examining income sources before and after the conflict (including farm, off-farm, and remittances) and changes in food prices and market access.

3.4. Method of Data Presentation

The data collection process involved editing, coding, classifying, and tabulating various items using both words and numbers. Ultimately, the processed data was analyzed using descriptive statistics and empirical models, with the Household Food Insecurity Access Scale (HFIAS) and the Household Diet Diversity Score (HDDS) as dependent variables. War exposure was represented by independent variables such as asset destruction, farm tool destruction, infrastructure destruction, and human injury.

3.4.1. Descriptive Statistics

Various statistical measures, including frequency, averages, bar charts, t-tests, and f-tests, will be used to determine the nature, extent, and financial impact of damage and loss in the residential sector. However, it is important to note that descriptive statistics provide only a preliminary understanding of the effects of war-related damage.

3.4.2. Empirical Estimation Strategy

To enhance the analysis, the researcher explores the variations in asset damage resulting from armed conflicts, concentrating on their effects on livelihoods, food security, nutrition, and agriculture within the sampled households.

The researcher seeks to examine the relationship between exposure to war and its impact on Household Food Insecurity Access Scale (HFIAS) and the Household Diet Diversity Score (HDDS by employing Ordinary Least Squares (OLS) with a specific cross-sectional dataset. A war damage exposure variable serves as the treatment variable, indicating a value of one if the household's primary asset was partially or fully damaged due to the conflict. The choice of econometric model depends on the type of dependent variable: OLS with Instrumental Variable (IV) regression will be applied for continuous outcome variables, while a probit model with IV estimation will be used for binary outcome variables.

The following econometric model is designed to evaluate the effects of war exposure on food security and household dietary diversity.

$$Y_i = \beta_0 + \boldsymbol{\gamma} D_{ij} + \beta_i X_i + \eta_i \qquad (3)$$

The variable of interest in this study is the estimate for γ, which represents the effect of asset damage on war-exposed groups compared to non-war-exposed household groups. In this context, $\boldsymbol{Y_i}$ can take a value of 1 for food-insecure, poor households, and 0 for food-secured households. $\boldsymbol{X_i}$ represents a vector of exogenous explanatory variables that include demographic, household, institutional, and village characteristics. Moreover, D_{ij} equals 1 if household i experiences war asset damage type j (e.g., asset damage, farm tool damage, input damage, death and injury of oxen, occupation of cultivated land by intruders), and 0 otherwise.

The Ordinary Least Squares (OLS) estimates of γ in this study are likely to be biased due to the endogeneity between conflict and food and nutrition security. This bias arises because households' experiences of war-related damage are not random; rather, the actions of the Ethiopian National Defense Force (ENDF) and the Eritrean Defense Forces (EDF), along with the consequent damages, were deliberate and systematic. Damage to household assets and agricultural tools serves as a critical indicator of conflict exposure at the household level, as it reflects a targeted impact of the conflict.

Households with members actively participating in the fighting forces were particularly vulnerable to war-related damage and loss.

Furthermore, various factors may contribute to the endogeneity of conflict exposure, as indicated by the asset damage variable. It is conceivable that there are unobserved variables that affect both livelihoods and conflict exposure. Additionally, our assessment of conflict exposure may contain inaccuracies, potentially stemming from reliance on self-reported data concerning asset damages. The same considerations apply to the connection between conflict and food security. While I intend to demonstrate that conflict can adversely affect household food security, resilient individuals might unintentionally extend the conflict's duration, creating a possibility of reverse causality. This ongoing food insecurity can further intensify and prolong violent conflicts, resulting in a harmful cycle of violence and hunger (Martin-Shields and Stojetz, 2019), indicating a reverse relationship between armed conflict and food security. Unobservable factors associated with endurance could also empower households to resist the control of armed groups and the proliferation of violence.

The endogeneity concern surrounding the relationship between conflict and livelihood or food security is addressed by using an instrumental variable (IV) approach. Specifically, I employed the IV (2SLS) method proposed by Angrist and Evans (1998), where the war exposure variable is instrumented by the household's satellite distance of the village to the border and neighbors' exposure to asset damage. This approach is grounded in the observation that households near the region's entrance gates experienced more severe damage from Ethiopian, Eritrean, and Amhara forces compared to those located in the region's center. Similar methodologies have been applied by Ghorpade (2017) and Serneels and Verpoorten (2015) in different contexts. Additionally, this thesis incorporated extra instruments related to the presence of household members in the Tigray forces and the number of neighboring households that have experienced war damage.

Households closer to the borders of the region experience more severe damage, as intruders use these areas as gateways to invade and occupy for extended periods. The proximity of a household to the Eritrean and Amhara border is directly associated with a higher likelihood of damage to its assets and infrastructure during the 2020 conflict. The longer enemy troops remain in the vicinity, the more extensive the resulting killings, abductions, burnings, destruction, looting, and breakages become. This assertion is supported by data on property damage presented in the preliminary report. Furthermore, empirical literature consistently supports the use of geographical locations with high conflict intensity—often near borders—as a measure of war exposure (Akresh & de Walque, 2008; Voors et al., 2012; Rohner et al., 2013; Serneels & Verpoorten, 2015; Ghorpade, 2017). The first-stage model reflects this war damage exposure (hereafter referred to as the reduced equation) and is formulated as follows:

$$D_{ij} = \boldsymbol{\alpha} + \beta_i X_i + \boldsymbol{\delta Z_i} + \boldsymbol{\mu_i} \quad (\mathbf{4})$$

The equation estimates the probability of war damage exposure for the entire population by using X_i, which includes a vector of exogenous explanatory variables such as demographic, household, institutional, and village characteristics, and Z_i, which contains the instruments not included in X_i. This estimation is based on the work of Angrist and Krueger (1992).

Where X_i encompasses vector of exogenous explanatory variables containing demographic, household, institutional and village characteristics and Z_i contains the instruments, not included in X_i. This equation is estimated to predict probability of war damage exposure for the entire population (Angrist and Krueger, 1992). This equation is then estimated to predict probability of damage occurrence for the entire population. The predicted interest of variable, $\boldsymbol{\widehat{D}_i}$ is then re-entered as a new exogenous variable in the outcome equation as under:

$$Y_i = \beta_0 + \boldsymbol{\gamma \widehat{D}_{ij}} + \beta_i X_i + \eta_i \quad (4)$$

This equation is then estimated using the Two-Stage Least Squares (2SLS) method, with the household's village location, number of neighboring households experienced war damage and satellite distance to the border taken as instruments (Z_i) for damage exposure. This approach is commonly employed as an instrumental variable estimator (Angrist and Evans, 1998). Assuming no heterogeneity in damage exposure, the estimated value of γ represent the average treatment effect of war exposure. The village distance to the border and village location are appropriate instruments, provided they do not directly influence the outcome variables of interest except through war damage. Both standard over-identification tests and a Conley test support the validity of these instruments (Stock & Yogo, 2002). Additionally, this thesis includes further instruments related to the presence of household members in the Tigray forces and the number of neighboring households that have experienced war damage.

The impact of exposure to asset damage on household food insecurity (rated from 1 = food secure to 4 = severely food insecure) and household dietary diversity (rated from 1 = low to 3 = high) was assessed using an ordered probit model. This model addressed the endogeneity of the binary asset damage variable through a control function approach. In this approach, asset damage is treated as an endogenous variable, and is instrumented by the neighbor's exposure to asset damage (a binary variable) and the distance from home to the enemy entry gate (measured in hours). Additionally, a Poisson model was used to estimate the effect of asset damage on both the household dietary diversity score and the household food insecurity scale score (Wooldridge, 2015).

The model assumes an underlying latent (unobserved) continuous variable, often denoted as y*, representing the "level of food insecurity." The observed category y (food insecurity level) is determined by where y* falls relative to estimated threshold parameters (cut points).

$$y_i^* = \beta_0 + \boldsymbol{\gamma}\widehat{\boldsymbol{D}}_{\boldsymbol{ij}} + \beta_i X_i + \eta_i \tag{5}$$

The observed food insecurity level Y_i is then:

$$Y_i = \begin{cases} 1 \quad if\ y_i^* \le \mu_1 & (food\ secured) \\ 2 \quad if\ \mu_1 < y_i^* \le \mu_2 & (mildly\ food\ insecured) \\ 3 \quad if\ \mu_2 < y_i^* \le \mu_3 & (moderately\ food\ insecured) \\ 4 \quad if\ y_i^* > \mu_3 & (severly\ food\ insecured) \end{cases}$$

where μ_1,μ_2, $and\ \mu_3$are the estimated cut points in the output

3.5. Variable Measurements

Data regarding household food security and nutrition will be gathered utilizing the instruments established by the Food and Nutrition Technical Assistance Project guidelines (Swindale & Bilinsky, 2006; Coates et al., 2007) in low-income environments. This approach aims to assess the Household Food Insecurity Access Score (HFIAS) and the Household Dietary Diversity Score (HDDS), both of which are based on practical, real-world situations. Coates et al. (2006) highlighted that these two measures of food insecurity encompass the universal experiences associated with food insecurity, including insufficient quantity, inadequate quality, and the uncertainty and anxiety surrounding food availability.

The research employs both the Household Food Insecurity Access Score (HFIAS) and the Household Dietary Diversity Score (HDDS) to assess the food security conditions of households in the Tigray region, which has been affected by war, during the years 2020 to 2022. The HFIAS serves as a continuous metric that gauges the level of food insecurity faced by households over the preceding 30 days. The total HFIAS score, which can range from 0 to 27, reflects the extent of insufficient access to food. Although there may be some limitations, the HFIAS is recognized for its clarity and versatility across different contexts. This measure captures the household's perception of their food circumstances, independent of the nutritional quality of the food available. It suggests that the experiences of food insecurity among households lead to predictable reactions and responses, which can be systematically assessed through surveys and summarized into a score.

The household nutrition security status was assessed using the Dietary Diversity Score (DDS) approach, which relies on 24-hour food intake recalls across 12 food groups. According to Swindale & Bilinsky (2006) and Coates et al. (2007), the DDS is a valuable indicator of nutritional status, as it reflects household food access, correlates with food consumption, and is associated with improved birth weight and child anthropometric measures. Research indicates that a higher DDS is linked to greater nutrient adequacy in the diet (Swindale & Bilinsky, 2006; Coates et al., 2007). The DDS evaluates household nutrition security by determining whether a family consumed at least one food item from each of the 12 categories in the previous 24 hours. The total score can range from 0 to 12, depending on the variety of food categories consumed.

The Household Dietary Diversity Score (HDDS) was used to assess the food diversity of vulnerable groups. The HDDS includes twelve food groups: legumes, fruits, vegetables, roots and tubers, nuts and seeds, cereals, fish and seafood, meat, beverages, oils and fats, sugar and honey, and milk and dairy products (FAO, 2007). Households receive a score of 1 for each food group consumed and 0 for those not consumed. The HDDS is calculated by summing the number of food groups eaten by the household over a specified period and dividing this total by 12, the number of food groups. The resulting score ranges from 0.10 to 1.00, with scores from 0.10 to 0.42 indicating low dietary diversity and scores from 0.43 to 1.00 indicating high dietary diversity (FAO, 2008).

This document is the third in a series on the Household Hunger Scale (HHS), which measures household food deprivation. The HHS was developed to adapt the United States household food security survey module for use in developing countries. It is based on the last three occurrence questions of the Household Food Insecurity Access Scale (HFIAS) — Q7, Q8, and Q9 — which have been found to be comparable across different country settings. These three questions, along with follow-up frequency-of-occurrence questions, form the basis of the Household Hunger Scale (HHS) (Coates et al., 2007; Ballard et al., 2011).

Chapter Four;
Results and Discussions

4.1. Descriptive Statistics

The descriptive statistical analysis in this report compares households (HHs) whose assets were damaged during the war in the Tigray region in 2020–2022 with those whose assets were unaffected. Data from a random sample of 400 households in two districts (Samre and Bora) and five administrative villages (Frehiwot, Metkel, Mebal, Samre, and Deqera) was gathered in May 2025 for the analysis. A group of ten enumerators, all of whom had completed more than grade 10, collected the data under the researcher's careful supervision, guaranteeing the accuracy and dependability of the information. The 400-sample size was stratified by exposure to war damage, and the nearly equal distribution of conflict impacts in these areas was reflected in the roughly 49 percent of households reporting exposure to property damage and the 51 percent reporting damage to safe assets.

In order to identify notable differences that might be related to the experience of asset loss, the main goal of this analysis is to outline the demographic, socioeconomic, and food security profiles of the two groups—the "Safe group" (N=203 or 50.75 percent) and the "Damaged group" (N=197 or 49.25 percent). An instrumental variable for damage exposure, economic indicators, important outcome variables pertaining to food security and dietary diversity, and important household head characteristics are among the variables being examined. Descriptive statistics for a variety of variables that capture household demographics, economic status, asset holdings, and war-related losses are provided in Tables 4.1 and 4.2, along with means, standard deviations, and sample sizes.

4.1.1. Demographic Profile by Asset Damage

Demographic characteristics in Table 4.1 highlight notable differences between safe and exposed households, underscoring how war exposure may intersect with household structure. On average, households with damage have much younger heads (42) than the safe group (48 years old). This implies that younger household heads either lived in conflict-prone areas or engaged in activities that put them at higher risk of exposure. The explanation is that the enemy during the war in the Tigray region systematically targeted youngsters more than old people because young people are often seen as future fighters or potential threats. By attacking youngsters, the enemy aims to weaken the community's ability to resist or rebuild in the future.

In addition, a higher percentage of households in the damage-exposed group (76.6%) are headed by men than in the safe group (67.5%), suggesting that there may be a gender component to the asset loss pattern, perhaps related to the gendered division of labor and mobility. This difference, which is statistically significant at the 5 percent level, may be the result of war-related factors that are specific to gender, such as increased male participation in defense or labor migration in vulnerable villages like Samre and Mebal, where there has been reported conflict of higher intensity.

Marital status differences are evident as well. The proportion of married heads of households was higher among the damage-exposed group (80.7%) compared to the safe group (67.5%), while divorced heads were more common in the safe group (18.7%) compared to the damage-exposed group (10.2%). Single household heads were slightly more common in the safe group (13.8%) versus 9.14% in the damage group. These variations point to different household structures potentially influencing resilience or exposure to asset loss.

Table 4.1: Household Mean Comparison by Asset Damage Exposure

	(Safe Group)		(Damage Group)	
VARIABLES	Mean	SD	Mean	SD
Independent Variables				
Sex of HH (Male=1,0=Female)	0.675	0.470	0.766	0.424
Age of HH (in years)	48.03	14.13	42.26	10.13
Marriage	2.049	0.569	2.010	0.440
Single (1=Yes.0=No)	0.138	0.346	0.0914	0.289
Married (1=Yes.0=No)	0.675	0.470	0.807	0.396
Divorced (1=Yes.0=No)	0.187	0.391	0.102	0.303
Family size (in number)	4.187	2.100	3.959	1.914
Schooling of HH (in years)	7.517	3.006	6.274	2.614
Animal death of drought,2013-2017 (#)	5.901	4.295	4.898	3.536
Log of total HH income (in ETB[A])	11.11	0.570	11.13	0.576
Owned land area of HH (in hectare)	0.653	1.021	0.563	0.512
Instrumental Variable				
Distance from home to enemy entry gate (hr)	1.813	1.507	1.538	1.605
Neighbors Exposure to asset damage (1/0)	0.158	0.365	0.335	0.473
Outcome Variables				
HH Food Insecurity Access Scale Score	12.99	7.620	14.70	7.279
Food Secure (1= Yes,0=No)	0.472	0.500	0.0788	0.270

Mildly Food insecure (1=Yes, 0=No)	0.0254	0.158	0.0739	0.262
Moderately Food insecure (1=Yes, 0=No)	0.0355	0.186	0.113	0.318
Severely Food insecure (1=Yes, 0=No)	0.467	0.500	0.734	0.443
HH Dietary Diversity Score (total score)	4.527	1.520	3.883	1.591
Low Dietary Diversity (1-3) 1=Yes, 0=No	0.264	0.442	0.468	0.500
Medium Dietary Diversity (4-6) 1=Yes, 0=No	0.386	0.488	0.468	0.500
High Dietary Diversity (7-12) 1=Yes, 0=No	0.350	0.478	0.0640	0.245
Observation	203		197	

NB: ETB[A]: 1USD is approximately exchanged to 125 Ethiopian Currency during the data collection period as of May,2025

Between the two groups, the household structure seems to be fairly comparable. Family size was fairly similar across groups, with a mean of 4.187 members in the safe group and 3.959 in the exposed group, indicating slight but likely not significant differences in household composition. Schooling also differed with a notable gap; exposed households had an average of 6.274 years of schooling compared to 7.517 years in the safe households, which may have implications for economic opportunities or access to resources during and after the conflict. This could reflect pre-war inequalities, as exposed households in frontline villages like Samre may have had limited access to schools, or war-related interruptions that disproportionately affected less resilient groups. Such differences in human capital likely amplify long-term vulnerabilities, as lower education correlates with reduced adaptive capacity in Tigray's agrarian economy, where literacy aids in accessing extension services or aid programs.

4.1.2. Economic Factors by Asset Damage

Pre-war shock exposure and economic indicators in Table 4.1 reveal mixed patterns of resilience. Regarding economic indicators, the log of total household income in Ethiopian Birr (ETB) was nearly identical between groups, approximately 11.11 to 11.13, suggesting that income levels did not vary substantially based on asset exposure during the conflict period. This could imply that the war's impact on immediate income generation was widespread, affecting both groups equally, or that the damage-exposed group has other coping mechanisms.

Conversely, a notable difference exists in productive assets. Owned land area was marginally smaller on average for households exposed to damage (0.563 hectares) compared to the safe group (0.653 hectares). This difference in a key agricultural asset highlights a potential pre-existing economic vulnerability that may have been exacerbated by the conflict. Animal deaths due to drought from

2013 to 2017 were slightly higher in the safe group (5.90 animals) compared to the damage-exposed group (4.90), a significant difference at the 1% level suggesting that safe households endured greater livestock losses from prior environmental shocks. This counterintuitive finding might indicate that safe areas, often more arid or remote in Bora district, were historically drought-prone, while exposed households in fertile zones like Metkel benefited from better grazing.

Instrumental variables in Table 4.1, used potentially for causal modeling, exhibit expected patterns related to war proximity. The instrumental variable, distance from home to enemy entry gate measured in hours, averaged 1.81 hours in safe households versus 1.54 hours in exposed households, supporting the notion that closer proximity to conflict zones increased the risk of asset damage. This geographic factor likely heightened vulnerability to looting and shelling, as shorter distances facilitated rapid incursion. Similarly, the average number of neighbors experiencing asset damage was substantially higher in the exposed group (33.5%) than the safe group (15.8%). A highly significant disparity that reflects clustering of damage in affected villages like Mebal and Deqera, where communal impacts amplified individual losses through spillover effects like shared resource depletion.

4.1.3. Food Insecurity and Dietary Diversity by Asset Damage

The most profound differences between the groups are observed in the outcome variables related to food security and dietary diversity, painting a stark picture of the war's humanitarian impact. The Household Food Insecurity Access Scale (HFIAS) score, a measure of food access severity, is higher in the Damage Group (mean = 14.70, SD = 7.279) than in the Safe Group (mean = 12.99, SD = 7.620), indicating greater food insecurity among damaged households. This is powerfully reflected in the food security categories. A mere 7.9% of the Damage Group is classified as Food Secure, compared to 47.2% of the Safe Group—a disparity of nearly 40 percentage points. Conversely, severe food insecurity is rampant in the Damage Group, affecting 73.4% of households, compared to 46.7% in the Safe Group. The rates of mild and moderate food insecurity are also elevated in the Damage Group.

This descriptive result is consistent to the theory that conflict exposure disrupts food systems by damaging assets, reducing agricultural production, limiting market access, and increasing food prices. These disruptions lead to decreased household income, loss of livelihoods, and reduced access to diverse foods, directly increasing food insecurity and lowering dietary diversity (Kafando & Sakurai, 2024; Lin et al., 2022; Mesfin et al., 2024; Weldegiargis et al., 2023; Yazbeck et al., 2022; Adekunle et al., 2024). Empirical findings further claims that asset damage—such as loss of livestock, destruction of crops, or loss of productive tools—further undermines households' ability to produce or purchase a variety of foods (Kafando & Sakurai, 2024; Mesfin et al., 2024; Weldegiargis et al., 2023).

The patterns in dietary diversity are straight forward. The mean Household Dietary Diversity Score (HDDS) is actually lower for the Damage Group (3.88) than for the Safe Group (4.53). This low mean score coincides with higher prevalence of low dietary diversity for damage group. While a larger proportion of the Damage Group falls into the "Medium" diversity category (4-6 food groups) (46.8% vs. 38.6%), they are severely deprived in the "High" diversity category (7-12 food groups). Only 6.4% of the Damage Group enjoys high dietary diversity, compared to 35.0% of the Safe Group. Simultaneously, nearly half (46.8%) of the Damage Group has Low dietary diversity (1-3 food groups), a much higher rate than the Safe Group (26.4%). This suggests a polarization in dietary patterns within the Damage Group and in line with the findings of (Marchesi & Rockmore,2022; Dabalen & Paul, 2014 & Yazbeck et al., 2022).

Table 4.2 provides a cross-tabulation that reinforces the findings above and adds depth. It clearly shows that food security status is strongly associated with dietary diversity. Among food-secure households, over half (55.05%) have high dietary diversity. As insecurity intensifies, the ability to maintain a diverse diet collapses. For the severely food insecure—a group overwhelmingly composed of the Damage Group—only 6.64% achieve high dietary diversity, while almost half (49.79%) are stuck with low diversity.

Table 4.2: Distribution of HH by Food Insecurity & Dithery Diversity Category

Household Food Insecurity Prevalence	Household Dietary Diversity			
	Low (1-3)	Medium (4-6)	High (7=12)	Total
Secure	14	35	60	109
	12.84	32.11	55.05	100.00
Mildly Food Insecure	2	15	3	20
	10.00	75.00	15.00	100.00
=Moderately Food Insecure	11	16	3	30
	36.67	53.33	10.00	100.00
Severely Food Insecure	120	105	16	241
	49.79	43.57	6.64	100.00
Total	147	171	82	400

	36.75	42.75	20.50	100.00

NB; Own Compilation, 2025

This table underscores that asset damage from the war has not merely caused caloric insufficiency but has also triggered a severe nutritional crisis, degraded the quality of diets and likely increased the risk of micronutrient deficiencies (Kafando & Sakurai, 2024; Mesfin et al., 2024; Weldegiargis et al., 2023; Marchesi & Rockmore,2022; Dabalen & Paul, 2014).

4.2. Empirical Results

The empirical analysis focuses on household food insecurity and dietary diversity using instrumental variables approach with control functions to address endogeneity issues related to asset damage from conflict exposure. The Ordered Probit and Poisson regressions are conducted with asset damage instrumented by distance from home to the enemy entry gate and neighbor asset exposure**.** The primary methodological challenge in establishing this causal link is endogeneity. For instance, households that are already food insecure may be more likely to suffer asset damage due to their vulnerable position, creating reverse causality. Moreover, it was clear that material destruction during the conflict was not random but rather intentional and systematic, targeting households whose adult son or daughter was a member of the Tigray Defense Force or where the head is a member of the militia, making asset damage a further endogenous variable.

To overcome this, the researcher employs an instrumental variable (IV) strategy via a control function approach. Asset damage is instrumented by two plausibly exogenous variables: 1) the household's distance from the enemy entry gate (a geographic instrument affecting exposure to conflict). The claim is that households living close to the enemy entry points are more exposed to asset damage than counterparts living farther from the gate entry and 2) whether a neighbor experienced asset damage (a social/spatial instrument capturing localized conflict spillover effects). It is also likely that neighbor asset damage exposure has spillover effects across households within the cluster village. This allows for a more robust identification of the causal effect of asset damage

4.2.1. Asset Damage & Household Food Insecurity

Table 4.3 presents an ordered probit model with a control function approach to assess the impact of asset damage exposure on household food insecurity in the Tigray Region. The outcome variable, household food insecurity, is ordered (1 = food secure, 2 = mildly food insecure, 3 = moderately food insecure, 4 = severely food insecure). Asset damage is treated as an endogenous variable, instrumented by the distance from home to the enemy entry gate (in hours) and the neighbor's exposure to asset damage (a binary variable). The control function approach addresses endogeneity in ordered probit models when an explanatory variable is correlated with the error term, often due to omitted variables, measurement error, or simultaneity. For a binary endogenous covariate (e.g., a dummy variable), the control function framework within a maximum likelihood estimation (MLE) jointly models the ordinal outcome and the binary endogenous variable, accounting for their correlated errors.

The correlation between the error terms of the first-stage (exposure to asset damage) and main outcome (food insecurity) equations is -0.932, with p = 0.000. This substantial and negative correlation validates endogeneity (e.g. Unobserved elements that impact both food insecurity and asset destruction include systematic targeting. A substantial correlation suggests that bias had to be corrected using the control function approach. When the p-value is less than 0.01, exogeneity is rejected, indicating that an ordered probit control function approach is required (Wooldridge, 2015). Starting from the second stage outcome, the coefficient on gender is positive but not statistically significant (P > 0.05). A study by Quisumbing et al. (2014) in Ethiopia found no significant gender differences in food security outcomes when controlling for asset ownership.

A one-year increase in household head age raises the latent food insecurity by 0.012 units, statistically significant at $p < 0.05$, making it more likely to fall into higher insecurity categories (e.g., from secured to severely insecure). Older individuals are more likely to report higher food insecurity categories (e.g., severely food insecurity). This is consistent with the intuition about older households facing resource constraints, possibly due to declining physical capacity, limited income diversification, or dependency burdens. This finding is consistent with that of Gebre (2021), where age of the household head was negatively associated with the probability of being food-secure using ordered probit models on household data from East Africa (2014-2018), but conversely relates to the study of Fikre & Tsige

(2025), in which a one-year age increases boosted food security likelihood by 11.11%, with older heads benefiting from wealth and experience—reducing insecurity probabilities in Ethiopia.

A one-person increase in family size raises latent food insecurity by 0.086 units ($p < 0.05$), shifting toward higher insecurity categories, is supported by evidence from Ethiopia, where larger households face amplified vulnerabilities due to divided resources in labor-intensive but low-yield agricultural settings (Wubetie et al., 2024). In contrast, research from Malawi indicates that larger household sizes can mitigate food insecurity, potentially through more labor for farming (Adeyemi et al., 2025).

Table 4.3: Asset Damage Exposure on Household Food Insecurity

Ordered Probit	Coefficient	SE	Z	P. Value
2nd Stage HH Food Insecurity Catagory				
Sex of HH (Male=1,0=Female)	0.042	0.141	0.300	0.765
Age of HH (in years)	0.012	0.005	2.210	0.027
Family size (in number)	0.086	0.035	2.460	0.014
Single Base				
Married (1=Yes.0=No)	-0.193	0.220	-0.880	0.381
Divorced (1=Yes.0=No)	0.337	0.245	1.380	0.169
Schooling of HH (in years)	0.185	0.024	7.820	0.000
Log of total HH income (in ETB)	-0.254	0.117	-2.180	0.030
Cultivated land area of HH (in hectare)	-0.158	0.083	-1.910	0.057
Animal death of drought,2013-2017 (#)	-0.020	0.016	-1.240	0.216
Predicted Asset Damage	0.703	0.148	4.770	0.000
1st Stage: Asset damage				
Sex of HH (Male=1,0=Female)	0.264	0.155	1.700	0.088
Age of HH (in years)	-0.021	0.006	-3.470	0.001
Family size (in number)	-0.078	0.040	-1.920	0.055
Single Base				
Married (1=Yes.0=No)	0.579	0.237	2.440	0.015
Divorced (1=Yes.0=No)	0.125	0.271	0.460	0.644
Schooling of HH (in years)	-0.146	0.024	-5.980	0.000
Log of total HH income (in ETB)	-0.026	0.125	-0.210	0.837
Cultivated land area of HH (in hectare)	-0.322	0.106	-3.040	0.002
Animal death of drought,2013-2017 (#)	0.042	0.026	1.590	0.111
Distance from home to enemy entry gate(hr)	-0.306	0.106	-2.900	0.004
Neighbor's exposure with asset damage (1/0)	1.437	0.342	4.210	0.000
Constant	2.007	1.384	1.450	0.147
Correlation	-0.932	0.046	-20.210	0.000
Observation	400			

NB: Own estimation ,2025

A one-year increase in education level increases the latent food insecurity by 0.185 units, statistically significant at p < 0.01, shifting probabilities toward lower (worse) categories. Higher education without securing job for young household heads likely to strain resources, increasing insecurity. This aligns with intuition: young households living in small towns without land and formal job may become food insecure in East Africa. In Ethiopia, young household heads with secondary or higher education face elevated food insecurity due to limited formal job opportunities in rural and small-town settings, exacerbating resource constraints without agricultural land access. This mirrors the intuition about East African small towns, where educated youth migrate but encounter underemployment, increasing household vulnerability by 15-20% compared to less-educated peers (Adeyanju et al., 2023; Dessie et al.,2022), but contradicts with the results of Gebre (2021), where each additional year of household head education increased the probability of food security by 8-12% in East Africa.

The negative coefficient of log of income (-0.254, p=0.030) suggests that higher household income significantly reduces the latent propensity for food insecurity, aligning with economic theory. Intuitively, increased income provides households with greater financial resources to purchase food, invest in agricultural inputs (e.g., seeds, fertilizers), or diversify livelihoods, creating buffers against shocks. This is consistent with evidence from Ethiopia, where income boosts food security through improved purchasing power and resilience (Wubetie et al., 2024).

Land has significant negative coefficients (--0.158, p=0.057). This strongly aligns with economic theory—higher land represents greater productive buffers against shocks, enhancing food security. This finding aligns with evidence from Ethiopian of Wubetie et al. (2024), who found that a 1-hectare increase in land size reduced the odds of household food insecurity by approximately 7% (p < 0.05), as larger plots enabled diversified cropping and higher yields, enhancing resilience against climate shocks in rural Ethiopia. In contrast, a study in Malawi by Adeyemi et al. (2025) reported that larger land holdings were linked to higher food insecurity. The coefficient for animal death is negative but not significant (p=0.216). This result aligns with findings from Ethiopia, where Dessie et al. (2024) found that livestock loss due to climate shocks had a negative but statistically non-significant effect on household food insecurity when controlling for income and land (Wubetie et al., 2024),

Conflict exposure disrupts food systems by damaging assets, reducing agricultural production, destroying infrastructure, and limiting market access (Kafando & Sakurai, 2024; Mesfin et al., 2024;

Weldegiargis et al., 2023).These disruptions lead to decreased household income, loss of livelihoods, and reduced access to diverse foods, directly increasing food insecurity and lowering dietary diversity (Kafando & Sakurai, 2024; Lin et al., 2022; Mesfin et al., 2024; Weldegiargis et al., 2023;Yazbeck et al., 2022; Adekunle et al., 2024). The coefficient for the, variable of interest, asset damage is 0.703 and is highly statistically significant (p=0.000). This positive sign indicates that experiencing asset damage significantly increases the probability of a household being classified into a more severe category of food insecurity. Based on marginal effect, asset destruction decreases the probability of being food secure by 21% but increases the probability of being sever food insecure by 22.8%, holding other variables constant. This is the central, expected finding of the analysis, confirming that the loss of productive assets severely undermines a household's ability to secure sufficient food.

In the First-Stage Regression, distance to entry gate has a negative coefficient (-0.306, p=0.004), meaning households farther from the conflict point are less likely to suffer asset damage. The intuition behind the negative coefficient is that households located farther from conflict zones, such as entry points for hostile forces, are less exposed to direct violence, looting, or destruction associated with active fighting. Proximity to conflict hotspots increases the likelihood of asset damage (e.g., livestock, crops, or infrastructure) due to targeted attacks, collateral damage, or opportunistic theft, while greater distance provides a protective buffer, reducing the risk of such losses. A study by Pellillo (2012) indicates that closer proximity to conflict was associated with greater asset damage and worse economic outcomes, consistent with the negative coefficient on distance in your findings.

The positive coefficient (1.437, p=0.000) for neighbor's exposure to asset destruction reflects spatial clustering of damage, indicating that households located near others that suffered asset damage are also more likely to experience damage themselves. Mueller et al. (2021) showed that destruction events cluster geographically, reinforcing the idea that neighbors of damaged households often face similar damage risks. The highly significant F-statistic (implied by the Z-scores) confirms these are strong instruments, validating the IV strategy.

Below is a Poisson regression output for the household food insecurity scale score, a count variable representing food insecurity (e.g., 0 to 27, higher values indicate greater food insecurity).

4.2.2 Asset Damage Exposure on Household Food Insecurity Access Scale

Table 4.4: Asset Damage Exposure on Household Food Insecurity Access Scale Score

Poisson regression							
HH FI Scale Score	Coefficient	St.Err.	T-value	P-value	[95% C	I]	Sig
Sex of HH (Male=1,0=Female)	.062	.032	1.93	.054	-.001	.125	*
Age of HH (in years)	.003	.001	2.35	.019	.001	.006	**
Family size (in number)	.016	.008	1.99	.047	.000	.032	**
Single Base							
Married (1=Yes.0=No)	.034	.054	0.64	.524	-.071	.139	
Divorced (1=Yes.0=No)	.105	.056	1.86	.062	-.005	.215	*
Schooling of HH (in years)	.041	.007	6.16	.000	.028	.054	***
Log of total HH income (in ETB)	-.126	.026	-4.82	.000	-.177	-.075	***
Cultivated land area of HH (ha)	-.168	.022	-7.48	.000	-.212	-.124	***
Animal death of drought,2013-17(#)	-.013	.004	-3.62	.000	-.021	-.006	***
Asset damage(1=yes,0=No)	.182	.095	1.91	.056	-.005	.368	*
Residual error	-.196	.06	-3.25	.001	-.314	-.078	***
Constant	3.507	.315	11.13	.000	2.89	4.125	***
Mean dependent var	13.860	SD dependent var			7.489		
Pseudo r-squared	0.057	Number of obs			400		
Chi-square	228.135	Prob > chi2			0.000		
Akaike crit. (AIC)	3828.066	Bayesian crit. (BIC)			3875.963		

*NB: Own estimation ,2025: *** p<.01, ** p<.05, * p<.1 represents sig. level at 1%, 5% and 0% respectively*

Poisson regression coefficients (Table 4.4) represent the change in the log of the expected count of the outcome variable for a one-unit increase in the predictor, holding other variables constant. The exponentiated coefficients (incidence rate ratios, IRR) provide a more intuitive interpretation. A negative and significant ($\beta = -0.196$, $p < 0.01$) error term indicates that the unobserved factors increasing asset damage are associated with lower food insecurity scores. This suggests that the endogeneity bias is downward, meaning that failing to account for endogeneity would underestimate the effect of asset damage on food insecurity (Wooldridge, 2015).

Households with asset damage had a significantly higher food insecurity score than females ($\beta = 0.182$, $p < 0.1$). The incidence rate ratio (IRR = 1.199, $p < 0.1$) suggests that the expected food insecurity score for asset damage exposed households is 19.3% higher than for females, holding other variables constant. The result aligns with evidence from (Kafando & Sakurai, 2024; Mesfin et al., 2024; Weldegiargis et al., 2023), where conflict-induced asset destruction worsened household food security outcomes.

4.2.2. Asset Damage & Household Dietary Diversity

The results in Table 4.5 are from an ordered probit model estimating the impact of asset damage exposure on household dietary diversity categories (1 = low, 2 = medium, 3 = high), accounting for endogeneity of the binary asset damage variable through a control function approach. Asset damage may be connected with the error term in the dietary diversity equation (e.g., due to unobservable factors like household resilience or managerial ability that affect both the likelihood of suffering damage and dietary outcomes).The first stage is a probit model predicting asset damage (1 = yes, 0 = no), instrumented by distance from home to enemy entry gate (in hours) and neighbor's exposure to asset damage (1/0).The predicted values from this first stage are included in the second stage ordered probit model for dietary diversity. The correlation coefficient ($\rho = 0.958$, $p = 0.000$) indicates strong positive correlation between the error terms of the two equations, confirming endogeneity and justifying the control function method (Wooldridge, 2015). Since marginal effects are not reported, interpretations focus on the direction, magnitude, and significance of coefficients, which reflect changes in the latent variable underlying the ordered outcome. Positive coefficients increase the likelihood of higher dietary diversity categories, while negative coefficients decrease it.

Households that suffered asset damage are significantly more likely to fall into a lower dietary diversity category (low) than a higher one (medium or high). Asset damage (e.g., loss of farming tools, livestock, or storage facilities) directly depletes the productive capital and wealth necessary for a household to produce or purchase a variety of foods. Asset damage ((β: -0.928, p=0.000) is the key variable of interest. After correcting for endogeneity, experiencing asset damage has a statistically significant and strongly negative effect on a household's propensity for higher dietary diversity. Asset damage strongly reduces dietary diversity, decreasing the latent variable by 0.928 units. Based on marginal effect, asset destruction increases the probability of having low dietary diversity by 31.8% but depresses the probability of being in high food dietary diversity by 30%, holding other variables constant.This aligns with the stablished fact proximity to conflict zones and asset loss are linked to higher food insecurity and lower dietary diversity, and asset loss (e.g., livestock, land) exacerbates food insecurity (Lin et al., 2022; Yazbeck et al., 2022; Dabalen & Paul, 2014).

Table 4.5: Asset Damage Exposure on Household Dietary Diversity

Ordered Probit	Coefficient	SE	Z	P.Value
HH Dithery Diversity Catagory				
Sex of HH (Male=1,0=Female)	0.076	0.128	0.600	0.552
Age of HH (in years)	-0.016	0.005	-3.330	0.001
Family size (in number)	-0.115	0.033	-3.510	0.000
Single Base				
Married (1=Yes.0=No)	0.371	0.197	1.880	0.060
Divorced (1=Yes.0=No)	0.021	0.225	0.100	0.924
Schooling of HH (in years)	-0.112	0.021	-5.460	0.000
Log of total HH income (in ETB)	0.191	0.105	1.810	0.070
Cultivated land area of HH (ha)	-0.063	0.071	-0.880	0.377
Animal death of drought,2013-2017 (#)	0.004	0.014	0.290	0.773
Predicted Asset Damage	-0.928	0.109	-8.530	0.000
Sex of HH (Male=1,0=Female)	0.193	0.149	1.290	0.196
Age of HH (in years)	-0.023	0.006	-4.110	0.000
Family size (in number)	-0.076	0.039	-1.940	0.053
Single Base				
Married (1=Yes.0=No)	0.649	0.225	2.880	0.004
Divorced (1=Yes.0=No)	0.259	0.262	0.990	0.322
Schooling of HH (in years)	-0.135	0.023	-5.770	0.000
Log of total HH income (in ETB)	0.015	0.127	0.120	0.904
Cultivated land area of HH (in hectare)	-0.151	0.083	-1.820	0.069
Animal death of drought,2013-2017 (#)	0.020	0.023	0.880	0.378
Distance from home to enemy entry gate(hr)	-0.168	0.092	-1.820	0.069
Neighbor's exposure with asset damage (1/0)	1.188	0.310	3.830	0.000
Constant	1.436	1.388	1.030	0.301
Correlation	0.958	0.032	30.210	0.000

NB: Own estimation ,2025,

The coefficient of age (β: -0.016, p = 0.001) implies that older household heads are associated with lower dietary diversity categories. For each additional year of age, the latent dietary diversity decreases by 0.016 units. Intuitively, older heads may have reduced productivity, limited adoption of diverse farming practices, or health constraints that restrict access to varied foods. Asma & Kotani (2023) found that elderly household members have significantly lower dietary diversity than adults (fathers), confirming that age is negatively associated with dietary diversity, even after controlling for poverty and residence. However, Yu et al. (2022) reported that dietary diversity scores of older adults in China actually increased with age and across successive cohorts.

Regarding family size (β = -0.115, p = 0.000), larger families are linked to lower dietary diversity, with the latent variable decreasing by 0.115 units per additional member. This suggests that bigger households strain resources, leading to less diverse diets as food is spread thinner, aligning with Malthusian pressures on per capita consumption. Kera et al. (2024) found that, among adolescent girls in Ethiopia, living with more than five family members was significantly associated with inadequate dietary diversity, reinforcing the negative impact of larger family size on dietary diversity but inversely related to that of Jateno et al. (2023) in that larger family size was positively and significantly associated with higher household dietary diversity. Married household heads show a positive association with higher dietary diversity categories compared to singles, increasing the latent variable by 0.371 units. Intuitively, marriage may provide pooled resources, labor sharing, or stability that enables better food access and variety. Jateno et al. (2023), in a large Ethiopian survey, confirmed that married household heads had a 37% higher chance of consuming diverse foods compared to single heads.

More education is associated with lower dietary diversity, decreasing the latent variable by 0.112 units per year. Higher education without securing job for young household heads likely to strain resources, increasing insecurity. Young households living in small towns without land and formal job may become food insecure in East Africa. In rural Uganda, higher education levels of household heads were significantly associated with lower household dietary diversity (β=-1.276), especially in rural areas (Oyet et al., 2025) but men's education was causally linked to significantly higher household and women's dietary diversity in rural India (Sunder et al., 2023).

The coefficient of Log of total household income (β = 0.191, p = 0.070) implies that higher income positively affects dietary diversity, increasing the latent variable by 0.191 units for a 1% income rise. Intuitively, greater income allows purchasing a wider variety of foods, enhancing diet quality beyond subsistence levels. Hou et al. (2021), in rural China, found that higher family income was significantly and positively correlated with multiple dietary diversity indices while, higher average monthly income was unexpectedly associated with lower household dietary diversity in peri-urban areas in rural Uganda (Oyet et al., 2025). While the focus is on the second stage, the instruments validate the control function: Distance to enemy entry gate (β = -0.168, p = 0.069) negatively predicts asset damage, as closer proximity increases exposure risk. Neighbor's exposure (β= 1.188, p = 0.000) positively predicts it, capturing spillover effects. These are significant and intuitively relevant, supporting instrument validity (Pellillo, 2012; Mueller et al., 2021).

4.2.3 : Asset Damage Exposure on Household Dietary Diversity Score

The results in Table 4.6 are from a Poisson regression model estimating the impact of asset damage exposure on the household dietary diversity score (HDDS), a count variable based on the frequency of responses to 9 dietary diversity questions. The model accounts for endogeneity of the binary asset damage variable (1/0) using a control function approach, with the first stage instrumented by distance from home to enemy entry gate (in hours) and neighbor's exposure to asset damage (1/0). The residual error term is included in the second stage to correct for endogeneity, and its significant coefficient (β=0.243, p = 0.032) confirms the presence of endogeneity. The positive coefficient on the residual corrects for endogeneity, suggesting unobserved factors that increase both asset damage risk and HDDS are controlled, ensuring unbiased estimates. Intuitively, this accounts for correlated errors between stages, validating the instruments' role in isolating exogenous variation.

Since incidence rate ratios (IRRs) are not reported, interpretations focus on the direction, magnitude, and significance of coefficients, which reflect changes in the expected log count of HDDS. Positive coefficients increase the HDDS count, while negative coefficients decrease it.

Table 4.6: Asset Damage Exposure on Household Dietary Diversity Score

Poisson regression							
HDDS	Coef.	SE.	T	PV	[95% C	I]	Sig
Sex of HH (Male=1,0=Female)	.023	.058	0.40	.691	-.091	.138	
Age of HH (in years)	-.001	.003	-0.55	.585	-.006	.004	
Family size (in number)	-.025	.015	-1.65	.098	-.054	.005	*
Single: Base							
Married (1=Yes.0=No)	-.023	.095	-0.24	.812	-.21	.164	
Divorced (1=Yes.0=No)	.047	.096	0.49	.624	-.141	.234	
Schooling of HH (in years)	-.006	.013	-0.49	.628	-.031	.019	
Log of total HH income (in ETB)	.021	.046	0.46	.647	-.069	.112	
Cultivated land area of HH (ha)	-.008	.034	-0.22	.824	-.075	.06	
Animal death of drought 2013-17(#)	.004	.006	0.60	.549	-.009	.017	
Asset damage(1=yes,0=No)	-.473	.18	-2.63	.009	-.825	-.12	***
Residual error	.243	.113	2.15	.032	.021	.465	**
Constant	1.61	.572	2.82	.005	.49	2.73	***
Mean dependent var	4.210	SD dependent var				1.587	
Pseudo r-squared	0.018	Number of obs				400	
Chi-square	27.499	Prob > chi2				0.004	
Akaike crit. (AIC)	1532.447	Bayesian crit. (BIC)				1580.345	

*NB: Own estimation ,2025: *** p<.01, ** p<.05, * p<.1 represents sig. level at 1%, 5% and 0% respectively*

Asset damage exposed groups had a significantly lower dietary diversity score than safe groups (β = -0.473, p < 0.001). Experiencing asset damage reduces the log expected HDDS by 0.473 units. Moreover, the incidence rate ratio (IRR = 0.623, p = 0.009]) suggests that the expected food dietary diversity score for asset damage exposed groups is 37.7% than for safe groups, holding other variables constant. Intuitively, asset destruction (e.g., from conflict) impairs productive capacity, such as farming tools or livestock, leading to lower food production and affordability of diverse diets. Kafando & Sakurai (2024) found that increased conflict intensity—often resulting in asset destruction—significantly reduced household dietary diversity and food consumption scores in Burkina Faso and Households directly affected by conflict had significantly lower dietary diversity compared to unaffected households in Côte d'Ivoire (Dabalen & Paul, 2014).

Larger family size reduces the log expected HDDS by 0.025 per additional member (about 2.5% decrease). Intuitively, bigger households face resource dilution, where food budgets stretch thinner, leading to reliance on staple foods and lower dietary diversity. Families with five or more members were significantly more likely to have inadequate dietary diversity, highlighting resource dilution in larger household in Indonesia (Utami & Ani, 2023). Although not detailed in Table 4.6, the first stage mirrors prior tables (e.g., 4.5), where instruments like distance to entry gate (negative, significant) and neighbor exposure (positive, significant) predict asset damage, supporting their relevance and the control function's validity

Chapter Five;
Conclusion and Suggestions

5.1. Conclusions

This study has assessed the enduring impacts of asset damage from the 2020–2022 Tigray conflict on household food insecurity and dietary diversity in the Tigray region of Ethiopia. Employing a robust methodological framework—specifically, an instrumental variable (IV) approach with a control function to address endogeneity—the analysis moves beyond correlation to establish a more credible causal link between war-related asset loss and deteriorating food and nutrition outcomes. Through a rigorous analysis of 400 households, stratified by exposure to asset damage, the findings paint a stark picture of how the systematic destruction of productive assets during the 2020-2022 conflict has precipitated a severe humanitarian crisis, eroding household resilience and deepening vulnerability.

The descriptive statistics reveal profound disparities between households that suffered asset damage ("Damage Group") and those that did not ("Safe Group"). The Damage Group is characterized by a demographic profile suggestive of targeted violence—younger, more likely male, and more frequently married household heads. They also exhibited pre-existing vulnerabilities, such as lower levels of education and smaller landholdings. Most critically, the outcomes are starkly different: a mere 7.9% of the Damage Group was food secure compared to 47.2% of the Safe Group, while severe food insecurity afflicted 73.4% of the Damage Group. Similarly, dietary diversity was significantly lower, with nearly half of the Damage Group consuming a low-diversity diet and only 6.4% enjoying high dietary diversity, compared to 35.0% in the Safe Group. This preliminary evidence strongly suggests that asset damage is a key mechanism through which conflict translates into food and nutritional deprivation

The core of the empirical analysis confirms this relationship. Empirically, employing ordered probit and Poisson regressions with a control function approach to address endogeneity—via instruments like distance to entry gates and neighbor exposure—the results confirm asset damage as a significant driver of adverse outcomes. In food insecurity models (Tables 4.3 and 4.4), asset damage increases the latent propensity for severe insecurity by 0.703 units ($p<0.001$), reducing food security probability by 21% and elevating severe food insecurity by 22.8%. The Poisson model shows a 19.3% higher insecurity score ($IRR=1.199$, $p<0.1$) for damaged households, highlighting how asset loss erodes productive capacity, income, and market access. The analysis also sheds light on the role of other determinants. Covariates like age (positive), family size (positive), education (positive), and income/land (negative) further modulate these effects, aligning with theories of resource dilution and human capital constraints in conflict zones.

For dietary diversity (Tables 4.5 and 4.6), asset damage depresses the latent variable by -0.928 units ($p<0.001$), increasing low diversity probability by 31.8% and decreasing high diversity by 30%. The Poisson regression indicates a 37.7% lower HDDS (IRR=0.623, $p<0.01$), reflecting diminished ability to produce or afford varied foods. Factors such as age and family size negatively influence diversity, while income shows marginal positive effects, emphasizing the role of economic buffers. The strong error correlations ($\rho=-0.932$ for insecurity, $\rho=0.958$ for diversity) validate the endogeneity correction, revealing unobserved biases like systematic targeting of youth or militias.

The strength of the instrumental variables—distance from home to enemy entry gate and neighbor's exposure to asset damage—lends credibility to these causal claims. The significant, negative coefficient for distance confirms that proximity to conflict zones increased the risk of damage, while the positive coefficient for neighbor's exposure indicates spatial clustering of destruction, both aligning with intuitive and theoretical expectations of conflict dynamics.

Overall, these findings affirm that conflict-induced asset destruction perpetuates a cycle of poverty and malnutrition, polarizing food security outcomes: only 7.9% of damaged households are food secure (vs. 47.2% safe), with 73.4% severely insecure (vs. 46.7%). Dietary polarization is evident, with damaged groups showing higher low/medium diversity (46.8% each) but minimal high diversity (6.4% vs. 35.0%). This nutritional crisis risks long-term health consequences, including micronutrient deficiencies, stunting, and reduced resilience to future shocks like drought.

The implications extend beyond Tigray, informing post-conflict recovery in similar settings. By quantifying asset damage's causal role, the study highlights the need for targeted interventions to rebuild assets, enhance human capital, and foster inclusive growth. Ultimately, sustainable peace and equitable development are prerequisites for breaking this vulnerability nexus, ensuring households can thrive rather than merely survive in Ethiopia's fragile agrarian landscape.

5.2. Recommendation

Future research should build upon the limitations of this study to enhance the understanding of the long-term effects of conflict on affected communities. A longitudinal design is essential, involving the tracking of the same 400 households over a period of 3-5 years to evaluate recovery trajectories. This approach should incorporate time-varying factors such as climate shocks and aid receipt, utilizing panel data models to establish causal inferences. Such a method would provide a dynamic perspective on how households adapt and recover, offering insights into the sustainability of resilience strategies in post-conflict settings.

Additionally, research should delve deeper into intra-household dynamics by incorporating gender- and child-specific outcomes. This can be achieved by disaggregating data to examine women's and children's dietary diversity through qualitative methods, such as focus groups. These efforts will help uncover hidden vulnerabilities that may not be apparent in aggregate data, shedding light on how gender roles and child nutrition are impacted by asset damage. Expanding the geographic scope is also critical; replicating the study in other Tigray districts or conflict-affected regions like Amhara and Afar with larger samples exceeding 1,000 households will test the generalizability of findings. Including urban-rural comparisons will further enrich the analysis by highlighting contextual differences in vulnerability and recovery.

Further exploration of mediating mechanisms is necessary to understand the broader implications of asset damage. This includes investigating how psychological factors, such as trauma, and social capital interact with asset loss, employing structural equation modeling to disentangle these relationships. Finally, policy evaluation through randomized trials assessing interventions like cash transfers or insurance schemes will quantify their cost-effectiveness on food security metrics. These research avenues, which are feasible with collaborative funding, will generate robust evidence to inform the development of resilient, evidence-based policies for post-conflict societies.

Recommends for Government: Targeted Aid Programming Findings on asset loss severity can guide NGOs and governments in prioritizing compensation (e.g., livestock restocking, farm tool distribution) for the worst-affected households.Nutrition-Sensitive Interventions: By quantifying dietary diversity gaps, the study informs emergency food aid and long-term programs (e.g., fortified food distribution, maternal-child nutrition support). Gender-Responsive Policies: Evidence on female-headed households’ disproportionate burdens can advocate for policies like cash transfers, women’s access to credit, or protection programs. Resilience Building: Identifying subgroups with heterogeneous effects (e.g., displaced vs. non-displaced) helps tailor recovery programs to enhance community resilience.

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