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SOME IMPACTS OF ARMED CONFLICT ON AGRICULTURE: A CASE STUDY FROM SOUTH WOLLO, NORTHEASTERN ETHIOPIA

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ABSTRACT

The Ethiopian agriculture sector, supporting over 85% of the population's livelihood, has been severely impacted by armed conflict, disrupting nearly every element of its value chain. Key direct impacts of conflict include the destruction of essential assets like farmland, livestock, crops, seed reserves, and critical infrastructure. This study aims to evaluate the war's effect on agricultural inputs, management practices, and services in selected districts within South Wollo, northeastern Ethiopia, and to propose viable mitigation strategies. Both primary and secondary data were gathered, with primary data collected through surveys, focus group discussions, and interviews with key informants. Quantitative data were analyzed using SAS software, while qualitative data were examined through descriptive and narrative methods. The conflict has damaged agricultural inputs, management practices, infrastructure, and services, including irrigation canals, farmer training centers, veterinary services, and nursery sites, significantly exacerbating food insecurity. Agrochemical supplies were impacted for 53% of respondents, while 66.5% reported disruption in livestock management practices. Total irrigation infrastructure and agricultural institution damage in South Wollo was estimated at 17,988.90 million Ethiopian birrs (ETB). Therefore, immediate actions for the restoration of damaged agricultural infrastructures, institutions, and services are necessary, along with reinstating agricultural inputs, capacity building and community engagement, monitoring and evaluation, and networking and partnerships. These recommendations should be tailored based on the local context, existing conditions, and available resources. Engaging with communities to understand their unique needs and preferences is essential in making these initiatives effective and sustainable.

Keywords: Conflict, crop production, food security, livestock production, mitigation strategy.

INTRODUCTION

Ethiopians have relied for long on various agricultural practices as the foundation of their livelihoods (Diriba, 2020). This sector remains pivotal to the national economy, contributing approximately 34% to Ethiopia's gross domestic product (GDP) (Leul et al., 2023). Historically, subsistence farmers have dominated agricultural activities, accounting for nearly all production. However, these farmers often utilize outdated and rudimentary farming techniques that do not

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align with the specific requirements of their agro ecological zones, leading to inefficiencies and reduced crop yields. Moreover, the challenge is compounded by the fragmentation of farmland into small and scattered plots that limit the farmers' ability to adopt more modern and efficient agricultural practices. This fragmentation not only hinders economies of scale but also increases the susceptibility to environmental factors such as drought and soil degradation. Consequently, farmers struggle to achieve sustainable production levels, exacerbating issues related to food insecurity and poverty across the region (Knippenberg et al., 2020). These systemic challenges underscore the need for targeted interventions and support mechanisms that are considered to empower farmers towards a more sustainable and resilient transition to agricultural practices, ultimately enhancing their livelihoods and contributing to broader economic development in Ethiopia.

Despite facing challenges such as recurrent droughts, natural disasters, crop pests and diseases, moisture stress, lack of veterinary services, technological limitations, and political instability due to conflicts and wars, the agricultural sector has shown remarkable resilience for centuries. The primary causes of these issues can be attributed to political instability, deficiencies in previous strategic development programs, and the lack of financial assistance within the country. Additionally, farmers' reliance on conventional farming methods and equipment, coupled with a rapidly growing population, has compelled them to expand agricultural acreage into fragile ecological systems, endangering their way of life and contributing to environmental degradation (Wassie, 2020).

Conflicts remain a primary factor contributing to poverty across Africa, with increasing frequency over recent years (Shemyakina, 2022). In 2018, over 48% of the world's poorest populations resided in violence-affected areas, a figure anticipated to rise to 68% by 2030 (Corral et al., 2020). Recently, Ethiopia endured a prolonged conflict, affecting millions through disruptions in agricultural inputs, management practices, and essential services. This conflict, among other factors, has contributed to Ethiopia's persistent food insecurity, low living standards, and an underperforming agricultural sector, exacerbated by limited and inconsistent use of improved agricultural inputs. Other critical barriers to agricultural development include inefficiencies in input supply and distribution systems and inadequate skill levels among agricultural extension agents. Political instability compounds these issues, further destabilizing infrastructure, businesses, and the availability of agricultural inputs. Conflicts also disrupt supply chains, damage infrastructure, restrict access to credit and financial services, interrupt extension support, and result in labor shortages due to displaced farmers.

Armed conflicts can disrupt the supply chains for agricultural inputs such as seeds, fertilizers, and pesticides. Insecurity and damaged infrastructure can impede the transportation and distribution of inputs to farmers, leading to shortages and increased prices (Jagtap et al., 2022). This can hinder farmers' ability to access and afford necessary inputs for their agricultural activities. Conflict also results in the destruction of agricultural infrastructure, including irrigation systems, storage facilities, and farm machinery (Adelaja and George, 2019). This damage hampers the productivity and efficiency of agricultural operations by decreasing the amount of food typically produces, making it more difficult for farmers to manage their crops and livestock effectively. Conflict situations result in significant losses in agricultural production, substantial damage to agricultural capital, and the destruction of agricultural areas due to limited labor access and poorly implemented government plans (Gelli and Masset, 2021). Various factors also affect the supply and demand for livestock and their products. During the conflict that occurred in Mali, for example, livestock prices initially fell as stolen livestock crowded the market. Livestock owners preferred to sell animals to avoid risks related to theft, disease, and death; however, the prices of livestock and their products increased steadily with the escalation of the conflict associated with low livestock availability in the conflict zone, and the basic diets of the armed groups were based on meat and milk (Kimenyi et al., 2014).

The Amhara region, particularly South Wollo, has been significantly impacted by the recent conflict, suffering extensive losses across public and agricultural sectors (Gebrehiwot and Hailemariam, 2021). Key institutions, including universities such as Wollo, Woldia, and Mekdela Amba, have faced damage and looting, resulting in the loss of critical resources like vehicles, laboratory equipment, and healthcare facilities, all of which are vital for community support and regional development (Bekele, 2022; Yimer et al., 2022).

The agricultural sector in South Wollo is especially vulnerable due to its reliance on an ecologically sensitive rain-fed farming system, where erratic rainfall patterns and limited resource availability already compromise productivity and resilience (Alemayehu et al.,

2017; Tesfaye et al., 2021). These compounding challenges underscore the urgent need for recovery efforts. Conflict has directly impacted agricultural production and resource availability and disrupted local economies, exacerbating food insecurity and reducing income sources for many families in the region (Shemyakina, 2022; Jagtap et al., 2022). This study focuses on the specific conflict impacts on agricultural inputs, infrastructure, and services within the South Wollo districts of Ambasel, Delanta, Kutaber, Tehulederie, and Werebabo. Through a thorough assessment of both the direct and indirect effects of conflict on agricultural resources, infrastructure, and extension services, this research was sought to provide a foundation for crafting evidence-based strategies that support immediate relief as well as sustainable, long-term resilience and agricultural recovery (Adelaja and George, 2019; Corral et al., 2020).

This study hypothesized that armed conflict has seriously affected the supply and proper handling of agricultural input, irrigation, and animal health service infrastructures in the study districts. Therefore, the objective of this study was to assess the impact of the conflict on agricultural input supply, infrastructures, and services in selected war-affected districts of the administrative zone of South Wollo, northeastern part of the Amhara region, Ethiopia.

MATERIALS AND METHODS

Description of the study area

The study was carried out in five selected districts (Ambasel, Delanta, Kutaber, Tehulederie, and Werebabo), Amhara National Regional State (ANRS), Ethiopia (Fig. 1). South Wollo is bordered to the east, south, west, northwest, and north by the Afar regional state, North Shewa, East Gojam, South Gondar, and North Wollo, respectively. The selected districts are interconnected and neighboring each other and are bordered by being in close proximity to the Afar regional state and the North Wollo zone, making them geographically closer to the Tigray regional state. It is home to 1487920 heads of cattle, 2098256 sheep, 760497 goats, 377141 equines, 2,642 camels, 1471914 poultry, and 93295 honeybee colonies. This enables it to be one of the zones with the largest livestock population in the region, ranking first and third in sheep and cattle populations, respectively. Wheat (*Triticum aestivum*), teff (*Eragrostis tef*), sorghum (*Sorghum bicolor*), and maize (*Zea mays*) are the main cereal crops grown in the zone. It also produces various horticultural and cash crops (CSA, 2022). The zone has a total human population of 2518862, of whom 1248698 are males and 1270164 are females (CSA, 2007).

Sample size determination and sampling design

The study districts (Ambasel, Delanta, Kutaber,

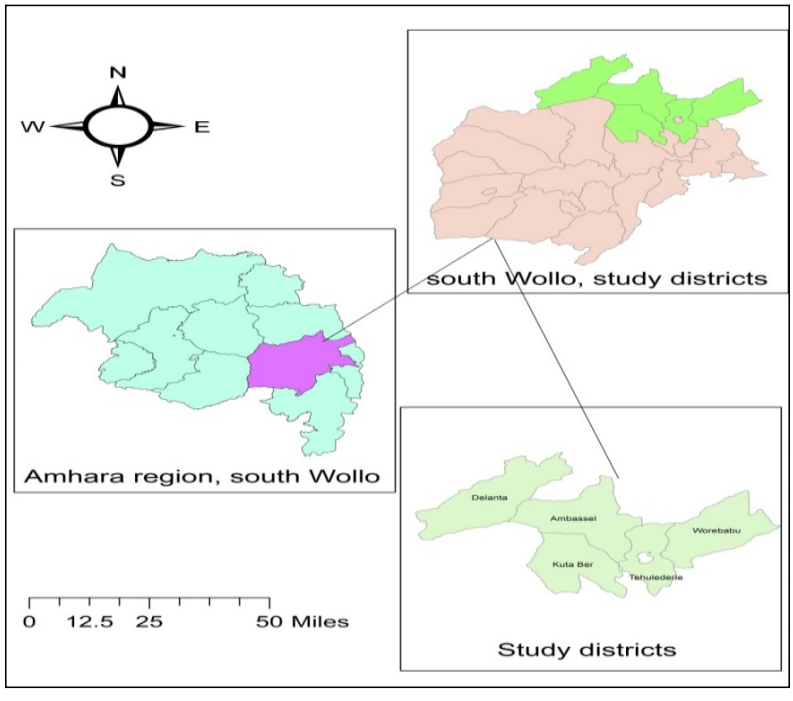

Fig. 1. Map of the study districts.

Tehulederie and Werebabo) were selected purposively for their proximity and for being significantly impacted by conflict. In each district, a rapid rural assessment (RRA) was conducted as a preliminary investigation survey to assess whether the *kebeles* (the smallest administrative units in a district in Ethiopia) had been affected by war.

The recent conflict that erupted on 4 November 2020 in northern Ethiopia, particularly in the Tigray region, extended to the peak of the main cropping season (summer, locally known as *meher)*, where an estimated 90% of crop harvest loss has been reported due to looting, burning and/or destruction. Additionally, 15% of the region's livestock population was reported to have been looted or slaughtered (Weldegiargis et al., 2023). Since the Tigray People's Liberation Front (TPLF) army invaded large areas of neighboring Amhara and Afar regions during this peak cropping season, after the withdrawal of the national army from the Tigray region to implement a unilateral ceasefire, similar impacts of the conflict were hypothesized on agricultural inputs, infrastructures, and services in these regions. Referring to one of the loss reports mentioned above, particularly the looting or slaughtering of 15% of the livestock in the Tigray region, and assuming a desired absolute precision of 5% and a 95% confidence interval (CI), the sample size was computed based on the random sampling formula for large populations described by Thrusfield (2007).

$$n = \frac{\left(\frac{Z\alpha}{2}\right)^2 P(1-P)}{d^2}$$

$$n = \frac{(1.96)^2\,(0.15)\,(0.85)}{(0.05)^2}$$

$$= \frac{(1.96)^2\,(0.15)\,(0.85)}{(0.05)^2} = 0.489804/0.0025 = 195.9 \approx 200.$$

Where, n = required sample size; $^{Z\alpha}/_{2}$ = reliability coefficient = 1.96 corresponding to 95% CI; P = expected impact of the conflict on agricultural inputs, infrastructures, and services; and d = desired absolute precision.

Therefore, a total of 200 respondent household heads (HHs), disaggregated into an equal number of 40 HHs per district, except for the Kutaber and Werebabo districts with respective sample sizes of 44 and 36, were selected at random for the study. In each district, two *kebeles* that faced conflict were randomly selected, with a sample size per *kebele* equal to 50% of the sample assigned to the respective district (Table 1). A semi-structured questionnaire was developed to collect data from the respondent household heads through face-to-face interviews. The questionnaire was pre-tested by interviewing household heads who were not included in the actual data collection. In the absence of the head of household at the time of the interview, an adult member of the household was interviewed. Ten enumerators, one per *kebele*, were selected among development agents to collect the survey data. The enumerators were oriented and trained before and during the questionnaire pre-test to ensure a common understanding of the questionnaire and the interview procedure. Based on feedback and recommendations obtained from researchers and enumerators during training and pre-testing, the questionnaire was updated for final printing (Glauben et al., 2022; Ndondo, 2023). A single-visit multiple-subject survey method of the ILCA (1990) was used to generate the actual primary data.

Data sources and methods of data collection

Both primary and secondary data sources were collected in this study. The primary data were collected through a combination of face-to-face questionnaire interviews (n = 200), 14 key informant interviews (KII), and 5 focus group discussions (FGD). At the beginning of the study, the 14 key informants from development agents and agricultural experts were identified based on their knowledge of the study area and the issues under consideration. Discussions with key informants led to the selection of study sites (*kebeles*) and respondent household heads.

Table 1. Summary of total *kebeles*, sample size and enumerators in the study districts.

S/N	Description	Study districts					
		Ambasel	Delanta	Kutaber	Tehulederie	Werebabo	Total
1	No. of *kebeles*	2	2	2	2	2	10
2	No. of respondents	40	40	44	40	36	200
3	No. of enumerators	2	2	2	2	2	10

No. = number.

The five FGDs were carried out in the study districts (1 per district), each comprising 8-12 participants from elder smallholder farmers practicing mixed agriculture, local leaders, and agricultural experts. Participants for the FGD were selected with the help of key informants and local leaders. The data from the FGD and the key informants were recorded audio-based, contingent on the willingness of the participants. The 200 smallholder farmers were selected randomly in the war-affected *kebeles* to generate information on the impacts of the conflict on agricultural inputs, infrastructure, and services to supplement and triangulate the qualitative data captured from key informants and the FGDs (Gebreyes et al., 2016). Primary data related to the impacts of armed conflict, observed during and just after the war, were collected, including effects on: i) agricultural inputs (seeds, fertilizers, agrochemicals, farm implements, and draught animal power); ii) management practices in domestic animals (feeding, watering, and housing); and iii) infrastructures and services (irrigation infrastructure and vet services).

Secondary data were gathered from various sources, including reports from district agricultural offices, the South Wollo zone department of agriculture, other government offices, and published materials such as journal articles, books, and magazines.

Statistical Analysis

The Statistical Analysis System (SAS) version 9.1 (SAS Institute Inc., Cary, NC, USA) (SAS, 2008) was used to analyze the quantitative and categorical data collected through the survey. The PROC MEANS and PROC FREQ procedures of SAS were used to generate means and ranges for quantitative data and frequencies for categorical data, respectively. The quantitative data were coded manually. The SAS one-way chi-square procedure was used for the comparison of frequency data associated with categories of a particular variable. The data collected through focus group discussions and key informant interviews were analyzed through qualitative description or narration.

RESULTS AND DISCUSSION

Demographic and socioeconomic characteristics

Most of the respondents (72.5%) belonged to male-headed households, while a smaller portion (27.5%) was from female-headed households. This difference was found to be highly significant (P<0.001) across the districts (Table 2). The

Table 2. Demographic and socioeconomic characteristics of households in the study districts (n=200).

Variables	Study districts					Total	P Value
	Ambasel	Delanta	Kutaber	Tehulederie	Werebabo		
Sex							
Male	31 (21.4)	36 (24.8)	34 (23.4)	14 (9.7)	30 (20.7)	145a (100)	0.0001
Female	9 (16.4)	4 (7.3)	10 (18.2)	26 (47.3)	6 (10.9)	55b (100)	
Marital Status							
Single	3 (25)	2 (16.7)	3 (25)	3 (25)	1 (8.3)	12b (100)	0.05
Married	33 (19.3)	35 (20.5)	40 (23.4)	30 (17.5)	33 (19.3)	171a (100)	
Divorced	4 (30.80)	3 (23.10)	1 (7.7)	4 (30.8)	1 (7.7)	13b (100)	
Widowed	0 (0.00)	0 (0.00)	0 (0.00)	3 (75)	1 (25.00)	4c (100)	
Educational Status							
Illiterate	13 (22.8)	7 (12.3)	3 (5.3)	21 (36.8)	13 (22.8)	57ab (100)	0.05
Informal education	4 (14.80)	10 (37)	3 (11.1)	6 (22.2)	4 (14.8)	27c (100)	
Primary education (1-8)	16 (23.2)	20 (29)	16 (23.2)	6 (8.7)	11 (15.90)	69a (100)	
Secondary education (9-12)	7 (17.5)	2 (5)	17 (42.5)	7 (17.50)	7 (17.50)	40bc (100)	
Higher Education	0 (0.00)	1 (14.3)	5 (71.4)	0 (0.00)	1 (14.3)	7d (100)	
Age	50.12±2.1	47.72±2.1	43.54±1.8	41.37±1.9	41.5±2.1		
Family Size	5.05±0.3	5.65±0.3	6.16±0.3	4.53±0.2	5.42±0.3		
Major livelihood bases							
Crop production	0 (0.00)	0 (0.00)	0 (0.00)	3 (100.00)	0 (0.00)	3b (100)	0.0001
Livestock production	1 (100)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1b (100)	
Mixed Agriculture	39 (20.20)	40 (20.70)	44 (22.80)	34 (17.60)	36 (18.70)	193a (100)	
Off -farm activities	0 (0.00)	0 (0.00)	0 (0.00)	3 (100)	0 (0.00)	3b (100)	

n = sample size; the figures in parentheses are percentage.

mean age of the respondents varied between districts, ranging from 41.37±1.95 in Tehulederie to 50.12±2.13 in Ambasel. Similarly, the mean family size ranged from 4.53±0.22 in Tehulederie to 6.16±0.31 in Kutaber. In terms of marital status, 85.5% of the respondents were married, and no statistically significant difference (P>0.05) was observed in the districts.

Most of the respondents had no formal education (28.5%) or primary education (34.5%), with only a small percentage (3.5%) having higher education. In particular, 71.4% of those with higher education were from Kutaber, which was a statistically significant difference compared to other districts. Among the total of the respondents interviewed, a significantly higher proportion (p<0.001) of them relied on a mixed farming system for their livelihood (96.5%). Only a small proportion (1.5%) of the Tehulederie district participated solely in crop production and off-farm activities, while 0.5% of the Ambasel district participated in livestock production (Table 2). This indicates that livestock plays an important role in the agricultural sector.

Impacts of armed conflict on agricultural inputs

Farmers in war-affected areas of the studied districts were unable to manage their farms and obtain agricultural inputs during the conflict period. The supply of agrochemicals was severely affected, according to 53% of the farmers. Furthermore, other farmers needed chemical fertilizers (6%) and improved seeds (5%); however, the rest did not need these inputs at the time of the conflict (Table 3), as some areas where the conflict occurred had already been sown and covered with crops.

There was a demand for agrochemicals in all study districts; for improved seeds, mainly chickpeas and *Vicia* species (*Guaya*) in the Delanta and Kutaber districts; for chemical fertilizers in the Delanta, Tehulederie, and Werebabo districts. The conflict occurred during the main rainy season (*meher*), during which much of the cultivated land was covered with crops, leading to a lower demand for improved seeds for plots of land kept for relay cropping and for chemical fertilizers, which were to be partially applied at late maturity and on cash crops such as Chat (*Catha edulis*). However, many farmers were unable to obtain the type and amount of input they needed.

Traders faced limitations in their market participation due to fear of attacks and lack of transportation during the conflicts in Mali and Nigeria in 2012-2013. However, unlike the current study, the conflict in Mali during 2012-2013 mainly affected the availability of chemical fertilizers and improved seeds (Kimenyi et al., 2014). The differences between these findings and the current study could be attributed to variations in the types of crops cultivated, the timing of the conflict, and the degree of input use.

During times of conflict, transportation routes can be interrupted or unsafe, making it difficult to transport agricultural inputs such as seeds, fertilizers, pesticides, and machinery to farmers. This disruption can lead to delays or even a complete halt in the supply of these essential inputs. Infrastructure crucial to the distribution of agricultural inputs, such as roads, bridges, and storage facilities, can be damaged or destroyed during a conflict. This damage hampers the movement and storage of inputs, further exacerbating supply chain disruptions (Lin et al., 2022). Furthermore, conflict zones often face restricted access to markets, which can hinder the availability of agricultural input. Suppliers and distributors may be reluctant to operate in these areas due to safety concerns, resulting in limited access to inputs for farmers, which in turn can result in food insecurity in the region (Bane, 2022). In general, war and conflict create significant challenges for the supply of agricultural inputs, leading to disruptions in the availability and accessibility of these essential

Table 3. Impacts of armed conflict on agricultural inputs in the study districts (n=200).

Study districts	Agricultural inputs					Total
	Seed	Fertilizer	Agrochemicals	AI	NIR	
Ambasel	0	0	30	0	10	40
Delanta	6	3	26	2	3	40
Kutaber	4	0	18	2	20	44
Tehulederie	0	1	8	3	28	40
Werebabo	0	8	24	0	4	36
Total	10 (5)	12 (6)	106 (53)	7 (3.5)	65 (32.5)	200

AI = All input; NIR = No input required; the figures in parentheses are percentage.

resources for farmers.

Not only agricultural inputs but also agricultural implements were negatively impacted as a consequence of the conflict. Approximately half of the respondents (51.5%) lost their farm implements during the conflict, with the highest and lowest proportions recorded in the Werebabo and Tehulederie districts, respectively. Furthermore, about one-third (30%) of the respondents lost their draught animal power, with the highest and lowest proportions recorded in the Werebabo and Tehulederie districts, respectively (Table 4). Farmers lost their draught animals, such as oxen, donkeys, horses, mules, and camels.

However, in Mali, the supply of urea fertilizer to the conflict zone was restricted due to the government suspicion that the armed groups would use it to produce explosives. In particular, institutions engaged in seed multiplication malfunctioned or relocated to conflict-free zones (Kimenyi et al., 2014; Masset et al., 2019). In Ukraine, availability and access to seeds, fertilizers, pesticides, equipment, and livestock supplies have been limited mainly due to disruptions in logistical services and financial problems faced by agricultural producers after the war with Russia (Chepeliev et al., 2023). To ensure access to essential needs, around 57% of rural households interviewed in Ukraine adopted crisis (negative) coping strategies through the sale of productive assets and a decrease in expenditure on agricultural inputs (fertilizers and pesticides), veterinary services, and animal feed, which exacerbated the reduction in the use of inputs and services (Mokouar, 2021). The delayed or missed application of even one of these agricultural inputs, such as fertilizer, has been reported to cause a national yield drop of 10% (Mokouar, 2021).

The interruption of agricultural input supply due to conflict has been reported as a major cause of food insecurity post-conflict in many countries, with decreased production yield due to reduced use of fertilizer reported as one of the indirect and cascading impacts of the Russia-Ukraine war that started in February 2022 with the full-scale military invasion of Russia over Ukraine (Weldegiargis et al., 2023). A war that occurs in a localized area can affect the socioeconomic and food security status of other parts of the world. Russia and Ukraine are exemplary in this context; as 'global breadbaskets' and major players in the production and export of vital global agricultural commodities and fertilizer, the impacts of the war between these two countries have been felt internationally (Ben Hassen and El Bilali, 2022).

Impacts of conflict on livestock management practices

Feeding, watering, veterinary services (vaccination and treatment), and housing were affected during the conflict, with a combination of two or more of these management practices reported by the majority (66.5%) of respondents (Table 5). According to the investigation carried out in northern Kenya, herd management practices were severely affected by armed conflicts (Detges, 2014). Different researchers have also reported similar findings in which the resolution of armed conflicts helps improve the management of cattle grazing routes (Pospisil, 2022).

Similarly, a higher proportion of respondents (72%) stated that they were unable to harvest grasses for hay production due to fear of violent conflict. The burning of stored livestock feed resources was another cause of inadequate feed supply, as reported by 16.5% of the respondents. However, 5.5% of the respondents did not report any impact on livestock feed resources related to the war (Table 6). During times of conflict, people are often forced to flee their homes, leaving their livestock behind or unable to take care for them properly. This can result in the loss of animals

Table 4. Impacts of conflict on farm implements and draught animal power in the study districts.

Study districts	Loss of farm implement (n=200)		Loss of draught animal (n=200)	
	Yes	No	Yes	No
Ambasel	24 (60.0)	16 (40.0)	9 (22.5)	31 (77.5)
Delanta	18 (45.0)	22 (55.0)	13 (32.5)	27 (67.5)
Kutaber	19 (43.2)	25 (56.8)	15 (34.1)	29 (65.9)
Tehulederie	12 (30.0)	28 (70.0)	6 (15.0)	34 (85.0)
Werebabo	30 (83.3)	6 (16.7)	17 (47.2)	19 (52.8)
Total	103 (51.5)	97 (48.5)	60 (30.0)	140 (70.0)

n= sample size; the figures in parentheses are percentage.

Table 5. Impacts of conflict on livestock management practices in the study districts.

Study districts	Affected management practices (n=200)					Total
	Feeding	Watering	VS	Housing	All Practices	
Ambasel	5	1	1	2	31	40
Delanta	4	2	10	1	23	40
Kutaber	11	5	2	3	23	44
Tehulederie	7	0	0	1	32	40
Werebabo	1	0	11	0	24	36
Total	28 (14)	8 (4)	24 (12)	7 (3.5)	133 (66.5)	200

n= sample size; VS = Veterinary Service; the figures in parentheses are percentage.

Table 6. Types of damage on livestock feed resources in the study districts.

Study districts	Impact of war on livestock feed resources (n=200)					Total
	Burning at storage	Theft	Unable to harvest	All	No impact	
Ambasel	8	0	31	0	1	40
Delanta	7	1	29	1	2	40
Kutaber	11	3	30	0	0	44
Tehulederie	1	5	25	2	7	40
Werebabo	6	0	29	0	1	36
Total	33 (16.5)	9 (4.5)	144 (72)	3 (1.5)	11 (5.5)	200

n= sample size; the figures in parentheses are percentages.

due to a lack of food, water, or veterinary care (FAO, 2016).

During the focus group discussions (FGDs) and key informant interviews, it was outlined that well-grown grasses that were ready for the cut and carry feeding or hay production have been used to ambush armed forces. This has led to trampling of feed resources, the placement of heavy artillery on such fields, debris from fired projectiles, area pollution caused by foreign materials such as plastic sheets and biscuit containers, and untimely harvesting of the remaining forage, all of which have caused a reduction in the quality and quantity of feed resources collected. Additionally, the burning of grazing lands and the destruction of water points for livestock by armed groups were key problems. Furthermore, veterinary services, particularly vaccination and animal treatment, were completely absent in all study districts throughout the invasion period. Supplies in government veterinary infrastructures were looted and/or damaged, while those in private veterinary clinics were either relocated to areas unoccupied by the armed group or confidentially kept in unsuspected places within occupied areas.

War and conflict can lead to the destruction of critical infrastructure for livestock management, such as barns, fences, and water sources. This damage hampers the ability to shelter animals, resulting in increased risks of disease transmission, theft, or straying. It can also disrupt the availability and distribution of feed and water for livestock (Jagtap et al., 2022). Farmers may be unable to access pastures or markets to buy feed, leading to malnutrition and weight loss in animals. This can seriously affect livestock and forage products as well (Ebsa and Abate, 2022). Water sources can also be contaminated or destroyed, further exacerbating the challenges of providing adequate water to livestock. Conflict zones often suffer from a lack of access to veterinary services due to damaged infrastructure, displacement of veterinarians, or limited resources. This can lead to a decrease in the availability of vaccines, medications, and expertise needed to prevent and treat livestock diseases, resulting in increased morbidity and mortality rates (Ivanov et al., 2020).

Impacts of conflict on irrigation infrastructure

Irrigation allows farmers to use water consistently for their crops throughout the growing season. This ensures adequate moisture

supply to crops, increased yields and improved crop quality (Jambo et al., 2021; Yang et al., 2023). Using irrigation, farmers can cultivate their lands more efficiently, maximize their production potential, and reduce the risks associated with rainfall variability (Mume et al., 2023).

According to an independent study on the impact of war on irrigation structures and developments in the Amhara region (South Wollo) has lost an estimated amount of ETB 15,664.41 (fifteen million, six hundred sixty-four and forty-one cents) (Table 7), where the current study districts are included (Adane et al., 2022). In these areas, canals, ponds, water harvesting structures, and crops grown under irrigation were damaged. During the focus group discussions (FGDs) and key informant interviews, it was observed that the war caused substantial damage and disruption of irrigation infrastructure, causing water scarcity, reduced agricultural productivity, and increased vulnerability to drought and food insecurity. The long-term impacts of this damage may require extensive resources and time for rehabilitation and reconstruction to restore irrigation systems and support agricultural development.

In support of the present investigation, researchers reported that bombs and artillery fire can result in the destruction of irrigation systems, rendering them inoperable and disrupting the water supply to agricultural lands (Jaafar et al., 2017). Irrigation infrastructures, such as canals, pipelines, pumps and reservoirs, can be targeted or damaged inadvertently during armed conflicts. Conflict can also restrict access to irrigation facilities due to security concerns and the control of territory by armed groups. Farmers may not be able to reach their fields or irrigation systems, resulting in reduced agricultural productivity and reliance on rainfall-dependent farming practices (Hussainzada and Lee, 2022). In a similar study, deliberate destruction of irrigation infrastructures and other farm equipment has been carried out to starve farmers and impede future agricultural productivity (Manaye et al., 2023).

Impacts of conflict on agricultural institutions

Agricultural institutions such as veterinary and plant clinics, farmer training centers, and livestock breed improvement centers were also disrupted during the war. According to data from the 'Amhara War Damage Assessment Report', an estimated loss (in millions of ETB) of approximately 175.07, 30.36, 543.52, 127.71, 1600.12, and 9.55 was assessed from institutions of livestock and plant clinics, farmers training centers, nursery sites, laboratories and research centers, cooperatives and unions, and others, respectively (Table 8). Research institutions can be damaged or destroyed, resulting in the loss of valuable scientific knowledge, germplasm collections, and research infrastructures. This disruption hampers the development of new technologies, crop varieties, and farming practices that are critical to improving agricultural productivity and resilience (Batsurovska and Kurepin, 2023).

Among damaged animal and plant clinics, nearly 143.34 and 27.93 million ETB was lost in Kombolcha and Ambasel districts. Regarding the maximum damage to farmer training centers, losses of 16.28, 2.49, 1.85, and 1.69 million ETB was reported from Delanta, Tenta, Tehulederie, and Werebabo districts, respectively (Table 8). Therefore, the veterinary services were not functioning as they were heavily affected by the outbreak of armed conflict. Furthermore, their

Table 7. Estimated cost of damage on irrigation infrastructures in war-confronted areas of the Amhara region.

Zone	ECD (millions of ETB)
North Gondar	677.98
South Gondar	948.33
North Wollo	5,687.16
South Wollo	5,750.04
North Shewa	816.20
Waghimra	1,417.13
Oromo special zone	367.55
Dessie city	0.02
Total	15,664.41

Source: Adane et al. (2022); ECD=estimated cost of damage; ETB= Ethiopian birr (local currency), in which 1 US dollar = 55.9628 Ethiopian birr during this research was conducted.

Table 8. Types of agricultural institutions and estimated cost of damage in districts of South Wollo Zone, Amhara region, Ethiopia.

	Estimated cost of damage on agricultural institutions (millions in ETB)						
Districts	**LPC**	**FTC**	**NS**	**LRC**	**CU**	**Others**	**Total**
Albuko	0	4.09	29.98	0	88.05	0	122.12
Ambasel	27.93	0	38.27	0	115.57	0	181.77
Delanta	0	16.28	51.67	0	136.75	0	204.7
Dessie Zuria	0.25	0	49.57	0	132.08	0.16	182.06
Haik	1.19	0	0	0	0	0	1.19
Jamma	0	0.32	25.38	0	66.04	0	91.74
Kalu	0	1.64	55.17	0	148.59	0	205.4
Kelala	0.34	0.44	54.46	0	167.74	0	222.98
Kombolcha	143.34	0.71	32.18	127.71	9.44	2.92	316.3
Kutaber	0	0	39.37	0	115.57	0	154.94
Legambo	0	0	31.28	0	157.18	0.28	188.74
Mekdela	0.25	0.85	0	0	0	0	1.10
Tehulederie	1.77	1.85	31.47	0	110.89	0.02	146.0
Tenta	0	2.49	38.27	0	121.08	0	161,84
Wereilu	0	0	38.47	0	132.08	0	170.55
Werebabo	0	1.69	27.98	0	99.06	6.17	134.9
Total	175.07	30.36	543.52	127.71	1600.12	9.55	2,324.49

Source: Adane et al. (2022); ETB= Ethiopian birr (local currency), in which 1 US dollar = 55.9628 Ethiopian birr during this research was conducted; LPC=Livestock and plant clinics; NS = Nursery sites; LRC= Laboratories and research centers; CU = Cooperatives and Unions.

functioning was greatly affected, as concerned professionals fled their residential areas due to fear, panic, and the destruction of government buildings. Different researchers worldwide have revealed the impact of war and armed conflict on agricultural institutions and the sector as a whole, resulting in huge direct and indirect losses. For example, the effects on agriculture production, inputs, infrastructure, and human capital are seen as direct effects, while the loss of talent and other environmental factors are considered indirect effects (Adelaja and George, 2019). Another group of researchers also stated that the most visible impact of violent conflicts on food security is the destruction of agricultural land, irrigation schemes, and infrastructures (Kemmerling et al., 2022).

Additionally, houses, land, labor, utensils, livestock, and other productive assets are lost or destroyed either as casualties of fighting or due to deliberate destruction and looting (Justino, 2012). Institutions may also face challenges in maintaining staff, accessing resources, and delivering programs due to security concerns, infrastructure damage, and limited funding (Appau et al., 2021). Conflict disrupts the normal functioning of agricultural institutions, hindering their ability to provide essential services. Consequently, researchers, extension workers, and other agricultural professionals may be forced to flee or may lose their lives during the conflict. This loss of human capital reduces institutional capacity and hampers the ability to provide technical expertise and support to farmers (Lukongo, 2021). Conflict can weaken farmer organizations, such as cooperatives or associations. These organizations play a crucial role in representing farmers' interests, providing collective bargaining power, and facilitating access to markets and resources. The breakdown of farmer organizations reduces the voice and agency of farmers, making it harder for them to advocate for their needs and access support services (Kimenyi et al., 2014).

CONCLUSIONS

The findings of the current investigation reveal that the war that occurred in South Wollo administrative zone of the Amhara region in the last two years has resulted in a significant loss in the agriculture sector. It has affected the supply of agricultural inputs, management practices, and services. The supply of agrochemicals was severely affected. Moreover, multiple livestock management practices were affected

by the conflict. Agricultural infrastructures and institutions, including livestock and plant clinics, farmer training centers (FTC), nursery sites, laboratories, agricultural research institutions/ centers, cooperatives and unions, and irrigation facilities (canals, ponds, water harvesting structures, and crops grown under irrigation) were seriously affected, resulting in huge capital loss. Therefore, restoring agricultural systems, infrastructures, and inputs is crucial post-conflict for rebuilding communities and ensuring food security.

The specific recommendations for immediate actions include restorations of agricultural infrastructures based on assessment; increasing the supply of agricultural inputs through facilitation of financial resources and supply chain reestablishment; provision of capacity building and community engagement activities to conflict-victim communities; adopting a monitoring and evaluation mechanisms; and networking and partnerships with concerned local and international organizations to promote peace building and restoration of affected resources.

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