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A rapid assessment of vegetable and irrigation systems in Tigray, Ethiopia, before and after the 2020-2022 conflict



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A rapid assessment of vegetable and irrigation systems in Tigray, Ethiopia, before and after the 2020-2022 conflict

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Summary

Before the 2020-2022 war, the food system in Tigray supported the livelihoods of most of the population, with 80% of Tigrayans relying on smallholder agriculture for food and income. The major crops were cereals, cultivated by 90% of farm households, with vegetables and root crops grown by 26% of farmers. The conflict that erupted in 2020 had devastating impacts on the food system, farmers and their livelihoods, but the extent of the impact on vegetable production is not documented.

This rapid assessment was thus undertaken to understand the situation before, during and after the conflict, on vegetable systems, including irrigation which is a key resource for production. A total of 10 focus group discussions and 24 key informant interviews were carried out in July and August 2023, in the Southern, Southeast, Eastern and Central zones of Tigray. The main vegetables grown before the conflict included pepper, tomato, cabbage, onion, and potato. There was also an increasing trend in vegetable production, the use of irrigation, and irrigation infrastructure development. Inputs such as fertilizer and seed were provided through the national and regional governments.

The conflict led to a disruption of the vegetable and irrigation systems as crops and infrastructure were destroyed, transportation blocked, and labor reduced due to migration. Inputs such as seeds and fertilizers became unavailable. Food insecurity increased and most people shifted their production patterns to prioritize cereals instead of vegetables. However, vegetable consumption reportedly increased as the vegetable market was not there and households opted to substitute common bean-based side dishes with vegetables because beans were not available or accessible.

The situation after the conflict is that vegetable production remains low with only 30% of total irrigable land being utilized, down from 70% pre-conflict. A diversity of vegetables is still be grown, however, including tomato, onion, peppers, cabbage, Swiss chard, and lettuce, among others. Most producers are selling their vegetables for income while little is kept for consumption. Food insecurity continues to be the greatest challenge, as most households cannot produce because of the loss of productive assets, and ability to purchase food is limited because of the loss of employment and income.

As efforts are channeled towards the recovery of the livelihoods in Tigray, vulnerable groups including refugees and internally displaced persons face the most challenges in recovering. Key interventions to support the vegetable and irrigation systems should concentrate on improving access to and availability of seed, and irrigation infrastructure, improving market linkages, and improving awareness of vegetables for nutrition and health, with a focus on the most vulnerable groups.

1. Introduction

Prior to the recent war (November 2020 to November 2022), the food system in Tigray supported the livelihoods of most of the population, with 80% of Tigrayans relying on smallholder farming for food and income (Crop-monitor, 2022). The main agriculture production system is mixed crop and livestock production, with crop production being dominant. Livestock are used as traction animals for plowing, and their manure for fertilizer, while crops provide residues for livestock feed. In 2019/2020 the major crops were cereals, cultivated by 90% of farm households, while vegetables and root crops were grown by 26% of households (Wilson, 2023).

Vegetables were produced for their nutritional and income benefits, but also because they complement other food production. Women and children were the main beneficiaries of vegetable cropping (Wilson, 2023). Tigrayan farmers were reported to be adaptable and resilient to multiple shocks like desert locust infestations and drought, but the eruption of the war in 2020 was a huge set-back. The armed conflict led to devastating impacts on the food system. Manaye et al. (2023) surveyed 4,376 households in Tigray and found that 81% of smallholder households lost their crops, 48% lost their farm tools, and most farmers then had very limited access to agricultural inputs and services. Oxen used to plow farmlands were looted and killed (Nyssen et al., 2023), and research infrastructure was damaged or destroyed, significantly affecting contributions to agricultural development in Tigray (WFP, 2022).

About 2.7 million people were internally displaced in the region (UNICEF, 2022) causing farm labor shortages, loss of employment and income, and increasing household vulnerability to food security shocks. A comprehensive assessment on food security by the World Food Programme, a year after the onset of the conflict in northern Ethiopia, revealed worrying trends. Around 83% of the population (4.6 million people) in the region became food insecure, and that the consumption of nutritious foods such as fruit and vegetables declined drastically, to an average consumption on less than one day a week (WFP, 2022).

Given the importance of vegetables, particularly for vulnerable groups in Tigray even before the conflict (Mahari et al., 2023), these crops can play a great role in livelihood recovery efforts. Vegetables are a source of vitamins, minerals, antioxidants and dietary fiber, that are essential for good health, especially during times of stress and hardship. In addition, irrigated vegetable production has high productivity and short growing cycles of up to 2-3 crops per year. In Tigray, irrigated vegetable production is not a new phenomenon, as the government invested extensively in developing surface and ground water resources before conflict. However, during the conflict, water infrastructure was destroyed and irrigated cultivation was much reduced. Using remote sensed data and telephone interviews, Nyssen et al. (2023), estimated a 30% drop in the area of irrigated land in Tigray, and a shift from vegetable growing to cereals that needed less irrigation.

As Tigrayan households return to rebuild their livelihoods, donors and development agencies are looking for sustainable solutions to improving food security and resilience, and irrigated vegetable production is one of them. As part of this, a rapid assessment involving a field mission to Tigray was conducted, to assess the current status of vegetable and irrigation systems, and make recommendations on key intervention strategies for recovery. A food systems approach was followed, which encompasses all elements and activities related to food production, storage, processing, distribution, consumption, and socioeconomic, health and environmental outcomes (HLPE, 2020). Focus group discussions with farmers and key informant interviews were carried out in which the following topics were discussed: (i) seed production and dissemination; (ii) vegetable production including use of irrigation; (iii) value chains (iv) consumer preferences, marketing channels, demand, diet, etc.; (v) governance factors; and (vi) outcomes. By delving into these dimensions, the results of this study provide valuable insights into how vegetable and irrigation systems can be improved, and so facilitating the recovery of Tigray's agriculture base.

The overall study objective was to assess the status of vegetable and irrigation systems pre- and post- conflict in the Tigray region, and determine potential areas of intervention. This included identifying the most important and preferred vegetable crops and irrigation practices, assessing the vegetable production and marketing situation, including policy and institutional issues, highlighting constraints and opportunities, particularly in seed and irrigation systems and recommending intervention strategies for supporting vegetable production and irrigation.

This study was a collaborative effort between World Vegetable Center (WorldVeg) and the International Water Management Institute (IWMI). WorldVeg started operations in Ethiopia in 2020 mainly through the Veggies for Planet and People (V4P&P) project which is developing vegetable businesses in East Africa for improved employment, human and environmental health. So far, the project has established 80 vegetable business networks with a total of 2451 members (mostly women and youth), who receive training on regenerative vegetable production practices such as use of vermicompost and bio-slurry to improve soil fertility on their farms, and production of healthy seedlings. In addition, seeds of many different vegetable crops and varieties have been introduced to help alleviate Ethiopian primary vegetable production issues.

WorldVeg is now expanding its projects to include other regions in the country. IWMI has a significant presence in Ethiopia, with its East Africa and Nile Basin Office in Addis Ababa, and has been actively engaged for over 10 years, in partnership with governments, civil society and the private sector to develop scalable agricultural water management solutions. These partnerships enable IWMI to undertake research tailored to local solutions and generate timely policy advice. It serves as a think tank, a provider of science-based products and tools, and is a learning and capacity-strengthening facilitator.

2. Methodology

Context

Tigray region is in the northernmost part of Ethiopia, bordered by Eritrea and Sudan, and the Ethiopian regions of Amhara and Afar. It has a population of 4.3 million (CSA, 2023), and an area of 54,000 km², divided into six administrative zones: Western, North-western, Central, Eastern, South-eastern, Southern and the administrative capital zone of Mekelle. The region has both an undulating terrain and steep slopes, with an average annual temperature of 12-37°C, and annual rainfall of 500-1,000 mm. Agriculture is the main source of livelihood for the Tigrayans. There is a long dry season between October and May and a wet season from June to September when 80% of river flow occurs (Shishaye et al., 2023).

Data collection and analysis

This rapid assessment was conducted from July to August 2023. The overall approach was qualitative, following a formative participatory process, complemented by a literature review. A checklist was used to guide focus group discussions and key informant interviews (Annex 1). Through discussion with the Tigray Horticulture Development Directorate and Woreda agricultural officers, 24 key stakeholders were identified, and in addition to meeting with government officials, field visits were made to understand the vegetable and irrigation systems and impacts of the conflict, including ten focus group discussions with farmers (Annex 2). Data collected covered major topics of vegetable cropping, farm inputs (vegetable seeds, agrochemicals, and irrigation), vegetable value chains, opportunities and constraints of irrigated vegetables, and possible interventions to support irrigated vegetable production. Thorough analysis allowed the identification of intervention strategies for the development of irrigated vegetable systems in the region. Preliminary results were presented to stakeholders in a workshop in Mekelle on 29 August 2023, validated by stakeholders and further enriched by the feedback obtained.

Location Map of Tigray Region, Ethiopia

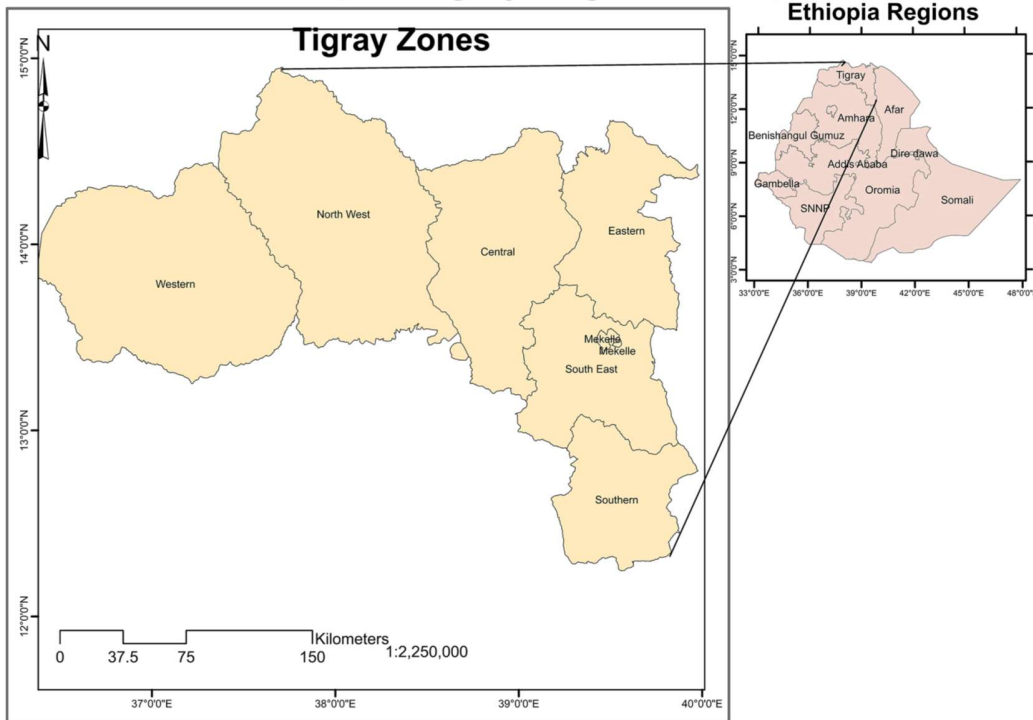


Figure 1: Location map of Tigray, Northern Ethiopia. Source: Weldegiargis et al. (2023)

3. Assessment findings

Pre-conflict

Vegetable production

Before the conflict, vegetable production in Tigray showed an increasing trend in terms of production area and vegetable crop diversity. For instance, the vegetable area was 29,000 ha in 2007, increasing to 120,000 ha in 2011 (Kahsay, 2011). According to data from the Tigray Bureau of Agriculture and Natural Resources (TBoANR, 2020), the most commonly grown vegetables before the war were eggplant, tomato, cabbage, onion, and potato (Table 1). This information is supported by Kahsay (2011) who identified onion, tomato, green pepper and lettuce as the common vegetables.

Table 1: Average productivity (t/ha) of major vegetables in Tigray

Productivity (t/ha)		Productivity (t/ha)	
Eggplant	25.0	Swiss chard	10.6
Tomato	21.6	Pepper	10.0
Cabbage	21.5	Lettuce	9.3
Onion	20.9	Brassica rapa	8.5
Potato	19.8	Garlic	8.4
Sweet potato	15.7	Carrot	8.2
Asparagus	12.0	Shallot	7.2

Source: Horticulture development directorate progress report, 2019/2020

Input and technical advice

Agricultural inputs such as seeds, seedlings, fertilizers, pesticides, and irrigation equipment were supplied to farmers by the Bureau of Agriculture, cooperatives/unions, water bureau, and agrochemical suppliers. Table 2 shows the quantity of seed in tons supplied by the government to vegetable growers from 2018-2020 as well as the quantity supplied by the Bureau of Agriculture. The major vegetable seeds included garlic, onion, tomato, Swiss chard, pepper, cabbage, carrot, potato, lettuce, and beetroot. More recently, asparagus, cauliflower, broccoli, eggplant and cucumber have emerged as important vegetables in the Raya Valley area. These figures exclude the quantity of seed used by investor farmers.

Table 2: Quantity of vegetable seed supplied to smallholder farmers in Tigray, 2018-2020 (tonnes)

	2018		2019		2020	
	Total	BoA supplied	Total	BoA supplied	Total	BoA supplied
Potato	1069.5	-	1093.6	-	1054.1	-
Garlic	361.0	-	423.4	-	98.0	-
Onion	34.1	3.4	37.7	3.1	84.1	1.6
Tomato	5.7	2.2	3.8	1.5	1.5	1.2
Pepper	3.0	-	2.5	-	2.6	-
Cabbage	2.5	1.7	2.2	1.0	0.9	1.1
Carrot	1.7	1.1	1.3	0.9	2.2	0.6
Lettuce	1.2	0.9	1.3	0.4	0.4	0.2
Beetroot	1.0	0.4	0.7	0.9	0.9	0.7
Swiss chard	3.2	-	2.8	0.8	4.1	0.2
Other vegetables	0.2	-	0.3	-	-	-
Total	1483.1	9.7	1568.3	8.6	1248.8	5.6

Source: Horticulture development directorate strategy document (TBoANR, 2022b)

The quantity of fertilizers utilized in irrigated crop production of cereals, vegetables and fruit (2018-2020) are shown in Table 3. In addition to own preparation of manure and compost, the Bureau of Agriculture via cooperatives supplied inorganic fertilizers to smallholder farmers.

Table 3: Quantity of fertilizers utilized in Tigray, 2018-2020 (tonnes)

Year	Inorganic fertilizers		Manures		Compost	
	Irrigated area (ha)	Fertilizer (t)	Irrigated area (ha)	Fertilizer (t)	Irrigated area (ha)	Fertilizer (t)
2018	59,900	3700	27,100	410	17,060	13
2019	62,300	3800	19,090	204	8,660	4
2020	66,400	5600	23,760	238	12,510	5
Average	62,900	4367	23,300	284	12,740	7

Source: TBoANR, 2022b

Though there was no specific data about the quantity of pesticides used in the region, the Bureau of Agriculture and agrodealers were the major suppliers. Growers also occasionally accessed and purchased pesticides from unknown private suppliers.

Irrigation

As of 2019/2020, the total area under irrigation in Tigray was 54,412 ha (TBoANR, 2020), which accounted for 3.9% of the total cultivable land. From these irrigated areas, 8.66 million quintals (86.6 million tonnes) was harvested, with vegetables accounting for 69.2 million tonnes (80%), and 30,541 ha (56%). The total irrigated land size and number of farmers in 2020/2021 at the regional level is shown in Table 4.

Table 4: Irrigable land size and number of farmers in 2020/2021 in Tigray

Zones	Woredas	Irrigable land (ha)	Number of farmers			
			Adult men	Youth	Adult women	Total
Southern	10	15,020	29,099	8,452	10,633	48,184
South-eastern	6	8,432	15,766	7,360	4,570	26,818
Eastern	11	10,958	25,208	8,062	11,647	44,712
Central	18	17,858	40,506	11,989	15,702	59,169
South-west	11	9,080	13,821	4,084	2,436	20,235
Western	4	5,714	3,952	1,974	1,095	7,021
Total	60	67,064	128,352	41,921	45,993	206,139

Source: TBoANR (2021)

Irrigation was practiced at small scale, with 53% of households irrigating less than 0.25 ha of land (Table 5) and a total of 76% of Tigrayan households having less than 0.5 ha of irrigable land. Most households who practiced irrigation were from rural areas, although some irrigation also happened in urban areas.

Table 5: Irrigable land size in ha per household in Tigray

Irrigable land size (ha/household)	Entire region % of households	Urban % of households	Small towns % of households	Rural % of households
≤ 0.25	52.5	29.0	54.7	55.3
0.25-0.5	23.1	37.0	15.1	22.5
0.5-1.0	16.0	20.0	22.6	14.4
1.0-1.5	0.5	0	0	0.5
1.5-2.0	4.2	8.0	5.7	3.5
> 2.0	3.8	6.0	1.9	3.7

Source: BoFP (2018)

Sources of irrigation water in Tigray were documented by the Bureau of Planning and Finance (BoPF, 2018) before the war (Table 6), that shows the percentage of water from specific sources (e.g. 15% of water in the whole of Tigray comes from dams).

Table 6: Irrigation water sources per geography in Tigray, in % of total irrigated water use per geography

Irrigation water source	Whole of Tigray % of total	Urban areas % of total	Small towns % of total	Rural areas % of total
Dams	14.8	10.4	23.7	14.0
Rivers	33.3	22.9	28.8	35.2
Springs	26.9	22.9	22.0	28.1
Ponds	1.9	2.1	1.7	2.0
Private hand-dug wells	13.5	16.7	15.3	12.8
Communal hand-dug wells	5.6	10.4	6.8	4.9
Deep wells	2.7	10.4	1.7	2.0
Other	1.2	4.2	-	1.0

Source: BoPF (2018)

Overall, most farmers (77%) used surface water (rivers, springs, dams and ponds) to irrigate their land. Some households used more than two water sources for irrigation. Groundwater was the main irrigation water source in Raya Valley where no rivers exist.

Various national organizations and international NGOs have built over 36,000 irrigation infrastructures such as dams, river diversions and shallow wells to supply irrigation to smallholder farmers before the conflict (TBoANR, 2022b). Of these, 134 were small and medium scale earth micro-dams (reservoirs), 1,250 river diversions, 24,008 shallow wells, and 308 deep wells and other water-holding structures. Smallholders were the main beneficiaries of these infrastructures. Tigrayan farmers used about 60,000 agricultural water lifting devices such as manual pumps, drip and sprinklers, and motorized pumps (TBoANR, 2022b; Fig 2).

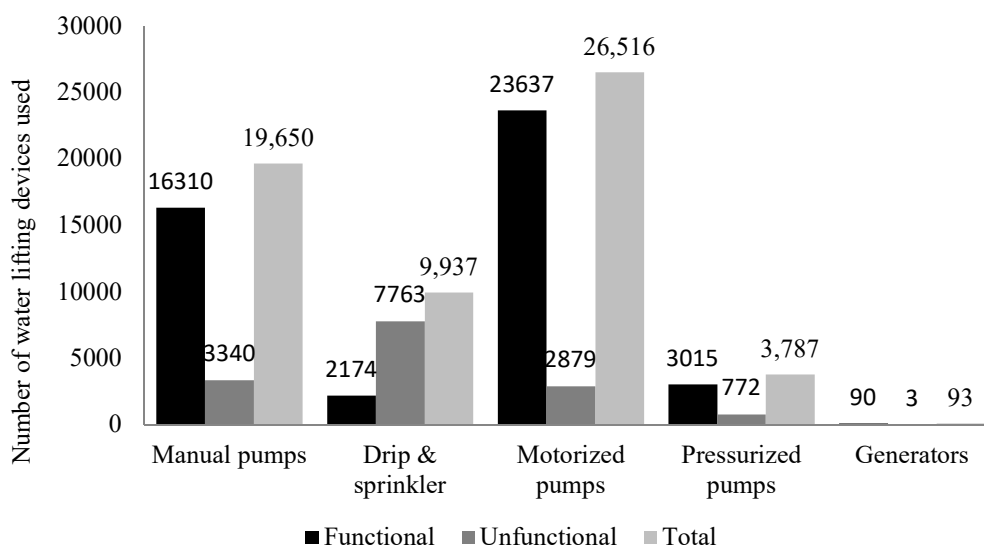


Figure 2: Type and number of water lifting devices used in Tigray. Source: TBoANR, 2022b

Marketing and consumption

Smallholder farmers grew vegetables mainly for sale, to multiple buyers, mostly brokers, who varied according to seasonal demands. Brokers acted as aggregators who gathered produce into sizable quantities and then sold on to consumers locally, or to regional or national wholesalers, and sometimes to export markets in Djibouti, (Gebru et al., 2019). Other marketing channels was direct selling by producers to local market wholesalers, retailers and consumers. Transportation was commonly by donkey and camelback, women transporting vegetables on their backs and men on their shoulders, and truck from the nearest road to nearby market center (Abrha et al., 2020). Transportation was generally challenging because of poor road infrastructure, no packaging or cooling facilities, lead to postharvest losses. Sometimes buyers were not available and prices were low as production from other regions flooded the markets.

Food security and nutrition

The Tigray Socio-Economic Baseline Survey report of 2018 provides details on the food security situation pre-conflict. The food poverty rate in Tigray in 2018 was the highest of all Ethiopian regions, at 33%. Macronutrient and micronutrient deficiency was rampant in the region, and iron deficiency/anaemia affected more than half (54%) of children aged 6-59 months in Tigray, and one in five (20%) of all women (UNICEF, 2019). However, the rates of child malnutrition showed a decline between 2011 and 2019, meaning that Tigray was slowly bridging the gap.

Policy and institutions

The government has for decades committed resources to agricultural development in Tigray, including for irrigated vegetable production. Key is the Bureau of Agriculture and Rural Development of Tigray (BoARD) which, before the conflict, mainly supported provision of extension, and supported development agencies in project implementation by identifying suitable beneficiaries and locations, and helped landless beneficiaries to access communal land (Abrha, 2015). It was the responsibility of extension officers from BoARD to deliver inputs such as chemical fertilizers and improved seeds which were subsidized by the national government. However, extension officers from the bureau had limited capacity to deliver extension advice, and only one extension officer to approximately 500 farmers (Abebe, 2023). The Tigray Agricultural Research Institute (TARI), especially the Mekelle Agricultural Research Center, and Ethiopian Institute of Agricultural Research (EIAR) were important research institutions for supporting innovations like improving vegetable varieties before the conflict (Woldewahid et al., 2011). TARI, for example, released some tomato varieties with longer shelf life. Other activities included the introduction of improved storage structures for potato, tomato and onion. The Regional Water Resource Bureau oversees large water supply systems, supervision of deep wells and drilling, and design and maintenance works (Admasu et al. 2011), and as of 2011, it provided capacity building and training on new irrigation technologies. However, regional officers working on water were reported to rarely visit woredas and had limited capacity in program management.

Vulnerable groups

Prior to the conflict, Tigray had a relatively high percentage of female-headed households, at 34% in 2018 compared to the national rate of 25% in 2016 (UNICEF, 2019). Three out of four Tigrayans lived in rural areas, and most depended on agriculture, mainly subsistence crop farming. According to the Tigray Socio-economic Baseline Survey, in 2011, 43% of women lived in monetary poverty compared to 22% of men. Tigray also hosted refugees even before the 2020-2022 conflict, mostly from Eritrea. As of October 2018, 14,000 refugees had arrived, of whom 90% were women and children, with 125,452 internally displaced people mostly from Oromia (49%) and Amhara (32%) (UNICEF, 2019). Livelihood opportunities were limited in camps, and only 2% of refugees in Tigray relied on agriculture, with most depending on humanitarian assistance (Admasu, 2021).

During the conflict

Vegetable production

The conflict disrupted the grain harvest season in 2020, also the peak season for vegetable growing, effectively halting production. A survey of 4,376 households in Tigray, reporting that 81% of smallholder farmers lost their crop, 48% lost farm tools, and most farmers had limited access to agricultural inputs and services during the conflict (Manaye et al., 2023). Nyssen et al. (2023) also indicated that around Mekelle, only a quarter to a half of the land was plowed during the conflict, and in terms of irrigated crop production, out of the 4,058 irrigated hectares pre-conflict, 31% was not cultivated in 2021, with irrigated plots planted to maize, teff, barley and pulses as farmers shifted from vegetables to staples to increase food security. Unavailability of production inputs including improved seeds and seedlings, fertilizers, pesticides, labor, fuel for water pumps, absence of extension support, limited movement of farmers between fields and home, and destruction and looting of irrigation infrastructure, led to a decline in vegetable production during the conflict (Asfaha et al., 2021).

Input and technical advice

In focus groups, farmers explained that they had minimal access to inputs during the conflict. The Bureau of Agriculture was no longer able to supply seeds to farmers. Occasionally however, seeds, fertilizers and pesticides were accessed through individual suppliers and NGOs. Privately supplied inputs, particularly seed, were poor in quality and unaffordable to most farmers. Labor shortages was experienced as a large share of farmers were absent, becoming refugees or fighters. In addition, oxen, which was an important source of labor were looted and killed (Nyssen et al. 2022). In a sample of 161 rainfed farms in Mekelle and its environs, one

third of the land were not sown in 2021 because of a lack of oxen for plowing (Asfaha et al., 2021). Destruction of farm tools and general lack of access to these were reported (Manaye et al., 2023) and most farmers had limited access to agricultural services. Further, many farmers did not use chemical fertilizers as supply was either late or very low.

Irrigation

The pre-war water supply in Tigray was about 50%, already below UN recommendations, that was reduced by 55% during the conflict, bringing water supply coverage to under 25% (Shishaye et al., 2023). As a result of the conflict 3,297 irrigation infrastructures (10% of the total) were damaged or destroyed (TBoANR, 2021), so 17,964 ha (29% of the irrigable land) and 49,543 farmers (22% of irrigated farms) could not irrigate. Irrigation infrastructure damaged or looted are summarized in Table 7. More than 50% of irrigated farms on the banks of the Tekeze River were destroyed. Moreover, no regular maintenance was made to water storage and diversion structures, and main and sub-main canals due to security reasons.

Table 7: Damaged and looted irrigation infrastructure during the conflict in Tigray

Irrigation water source	Infrastructure damaged or looted (number)
Ponds	1260
Individual water pumps	744
Check dams	548
River diversions	188
Traditional river diversions	167
Deep hand dug wells	117
Reservoirs	95
Chain of reservoirs	50
Springs	48
Dams	44
Canals	31
Shallow hand dug wells	5
Total	3,297

Source: TBoANR, 2021

Marketing and consumption

Tigray residents reported challenges accessing markets because of insecurity and fear of public places (WFP, 2022). According to participants, some households increased vegetable consumption during the conflict especially those who grew vegetables as there was no or limited market for selling produce. They noted that vegetables contributed to immediate food supplies and reduced household food expenditures. For example, some respondents fed their children with boiled cabbage and Swiss chard with or without *injera*. Pulses that used in sauces were not available, forcing Tigrayans to replace them with vegetables. However, a World Food Programme report concluded that most people consumed cereals, while micro-nutrient dense foods like vegetables were not consumed even just once a week (WFP, 2022).

Food security and nutrition

A year after the onset of the conflict, worrying trends were revealed, that 83% of the population in Tigray (4.6 million people) were food insecure, and intake of nutritious foods such as fruit and vegetables declined drastically leading to less than one day a week consumption on average (WFP, 2022). These findings are supported by a recent study which used the household hunger scale and a sample of households with children under one year and reported that 36% households had moderate or severe hunger during the conflict compared to 3% during the pre-conflict period (Weldegiargis et al., 2023). Assessing the nutrition status of children aged between 6-59 months, Gebretsadik et al. (2023) notes that after the first nine months into the

conflict, the prevalence of severe, moderate, and global acute malnutrition was very high, estimated at 5%, 22%, and 27%, respectively. Reasons for increased food insecurity were low production, the blockade of food trade between Tigray and the rest of the country, and the inability of the households to buy food because of increased prices and decreased incomes (Abay et al., 2023).

Policy and institutions

Agricultural institutions were victims of war, as attackers aimed to destroy the agriculture and food system of the region. The World Peace Foundation estimated the damage inflicted on research institutions (WFP, 2022) as follows. At the headquarters of the Tigray Agricultural Research Institution, in Mekelle, which also hosts the Mekelle Research Center, laboratory equipment, greenhouses and irrigation systems were deliberately and completely destroyed. These included 17 field vehicles, 20 tractors, 7 motorbikes and a bus together with other farm machinery. At the onset of the war, 223 crop research projects were underway, all of which were destroyed. Invaluable genetic resources accumulated and stored for conservation were lost. Anecdotal evidence shows that farmer training centers were damaged, impeding provision of extension services by the Bureau of Agriculture (TGHAT, 2023). This was reiterated by farmers during interviews, who mentioned that provision of extension services, access to credit and market information, were unthinkable during the conflict.

Vulnerable groups

During the conflict, elderly people, women and children worked on irrigated lands. Adult men often left their villages to join the fighting, and also, if they remained, they were targeted by the Eritrean army (Nyssen et al., 2023). Some farmers adopted alternate tillage strategies such as men plow very early in the morning when they were less likely to be attacked, with women digging land that was not plowed by oxen during the day. Men above 50 years old took more risks plowing as they were less targeted, but still avoided farming activities on days they anticipated troop movements (Nyssen et al., 2023). In addition to affecting gender roles, the 2020-2022 conflict intensified the influx of internally displaced people. About 2.9 million new displacements were recorded in Ethiopia, and four times the displacement figure of 2017 (Yigzaw and Abitew, 2019). Camps that hosted Eritrean refugees in Tigray were destroyed and deserted during the conflict, and displacement of people caused labor shortages and affected agriculture in the region.

Post-conflict

Vegetable production

There are two vegetable production seasons: a wet season between June and August locally known as *meher*, when farmers rely on rainfall with supplementary irrigation, and a dry season that occurs between October and April, under full irrigation. Vegetables production is year-round in areas with access to water. Growing vegetables under full irrigation during the dry season is the most common practice as farmers tend to prioritize staple crops during the *meher* season. There are three main categories of vegetable production. The first is market-oriented production where smallholder farmers and investors grow irrigated vegetables on open fields (up to 30-50 ha), often near a water source and with hired labor. Such production is primarily in the semi-arid lowlands of the Raya valley and Rama Adi-4. Second, is mixed-market and subsistence production in Hintalo, Enderta, Tsira'e Wemberta, Kilte-Awulaelo, Hawzein, Keyih Tekli, and Adwa, where smallholders grow vegetables using small-scale irrigation from diverse water sources. Third, is subsistence family farming in home gardens and small plots, with vegetables grown for home consumption. Although post-war statistics on production areas are scarce, vegetable farms now use only 30% of total irrigable land, down from the 70% pre-war level (TGHAT, 2023). Farmers indicated that vegetable production is disorganized and unpredictable. Vegetables grown in Tigray include tomato, onion, peppers, cabbage, Swiss chard, lettuce, potato, garlic, carrot, sweet potato, and shallot. Tomato, onion, cabbage and pepper were found to be grown in all the ten Woredas visited, while Swiss chard and potato were common in nine Woredas and lettuce in eight Woredas. Pepper, onion, and tomato are recommended (TBoANR, 2022b), see Table 8.

Table 8: Major vegetables recommended for specific Woredas in Tigray

Crop	Zone	Woreda
Tomato	South	Raya Alamata, Raya Azebo, Raya Chercher
	South-Eastern	Hintalo, Degua-Tembien, Saharti, Samre
	Eastern	Kilite-Awulaelo, Tsira-Wemberta, Geralta, Sowuha-Saes'e, Tseda-Emba, Atsibi-Wemberta, Gulo-Mekhedha, Hawzein
	Central	Kolla-Tembien, Kyih Tekli, Rama Adi-4, Ahisa'a, Emba-Sneyti, Naeder, Adet, Endaba-Tsahima
	North West	Laelay-Adiyabo, Maekelay-Adiyabo, Tselemiti, Laelay Tselemiti, Laelay Koraro, Zana, Asgede, Tsimbla, Tahitay Koraro
Western	Kafta Humera, Tsegedie, Awurera, Welkayit,	
Pepper	South	Ofla, Zata, Emba-Alaje, Raya Alamata, Raya Azebo, Raya Chercher
	South-Eastern	Hintalo, Enderta, Saharti, Samre
	Eastern	Kilite-Awulaelo, Tsira-Wemberta, Hawzein
	Central	Tanqua, Abergele, Kolla-Tembien, Kyih Tekli, Naeder, Adet, Adwa, Endaba-Tsahima, Emba-Sneyti, Mai-Kintal, Rama Adi-4
	North West	Laelay-Adiyabo, Maekelay-Adiyabo, Tselemiti, Laelay Tselemiti, Laelay Koraro, Asgede, Tahitay Koraro,
Western	Kafta Humera, Tsegedie, Awurera, Welkayit,	
Onion	South	Enda-Mekhoni, Neqsege, Emba-Alaje, Bora, Slewa, Raya Alamata, Raya Azebo, Raya Chercher
	South-Eastern	Hintalo, Wejerat, Enderta
	Eastern	Kilite-Awulaelo, Tsira-Wemberta, Geralta, Hawzein, Irop
	Central	Naeder, Adet, Adwa, Endaba-Tsahima, Emba-Sneyti, Mai-Kintal, Ahferom, Hahayle, Egela, Tanqua, Abergele, Rama Adi-4, Ahisa'a,
	North West	Tselemiti, Laelay Tselemiti, Laelay Koraro, Zana, Asgede, Tsimbla, Tahitay Koraro
Western	Welkayit, Awura, Kafta Humera, Tsegedie	
Cabbage	South	Ofla, Enda-Mekhoni
	South-Eastern	Hintalo, Degua-Tembien, Enderta
	Eastern	Kilite-Awulaelo, Tsira-Wemberta, Sowuha-Saes'e, Tseda-Emba, Atsibi-Wemberta, Gulo-Mekhedha, Ganta-Afeshum
	Central	Ahferom, Hahayle, Tahitay Maichew, Adwa
Western	Tsegedie	
Garlic	South	Emba-Alaje, Bora
	South-Eastern	Degua-Tembien, Saharti, Samre
	Eastern	Hawzein
	Central	Ahferom, Hahayle, Endaba Tsahima,
	North West	Laelay Koraro, Zana
Western	Tsegedie	
Potato	South	Ofla, Enda-Mekhoni, Neqsege, Emba-Alaje
	South-Eastern	Hintalo
	Eastern	Kilite-Awulaelo, Tsira-Wemberta, Sowuha-Saes'e, Tseda-Emba, Atsibi-Wemberta, Gulo-Mekhedha, Hawzein
	Central	Tahitay Maichew
Western	Tsegedie	
Sweet potato	South	Raya Alamata, Raya Azebo, Raya Chercher,
	South-Eastern	Wejerat, Enderta, Saharti, Samre
	Central	Kolla-Tembien, Mai-Kintal, Tahitay Maichew
	North West	Laelay Tselemti, Aahitay Adiyabo
	Western	Kafta Humera

Source: Horticulture development directorate strategic document (TBoANR, 2022b)

Based on the views of focus group members, important vegetables after the conflict are same as they were before. Tomato and onion, followed by pepper, are the preferred vegetables in all the Woredas visited. Focus group members had difficulties naming specific preferred varieties, but could describe key traits, which are low perishability, high yielding, and early maturity (Table 9). The Horticulture Development Directorate of Tigray region and the Bureau’s Emergency and Recovery Support Plan for the 2022/23 (TBoANR, 2022a, b) lists major varieties suggested to be grown in specific Woredas (Table 9).

Table 9: Preferred traits and varieties of some vegetables in Tigray

Crop	Preferred traits (FGDs)	Variety (government report)
Tomato	Attractive fruit shape and color (oval and nearly red), with few seeds, better shelf life (low perishability), firm, high yielding, need less support/staking, suitable for long distance transportation, less susceptible to pests, early maturing.	<i>Roma VF, Sambersana, Cochoro, Roma BF Holland, Melka Salsa, Melka Shola, Venus F1, Gelila F1, Golden F1, Gelilama</i>
Pepper	Tolerant to pests, yield, medium pod size, good pungency, and highly demanded in the market	<i>Marko-Fana, Bizet, Paprikanon, Melka-Awaze, Serenade F1, Harebard F1, Bako local, Mixcitizo F1, Artaele F1</i>
Onion	Good internal red color, bolt tolerant (better shelf life), tight neck, less susceptible to pests, high yielding, early maturing and highly demanded in the market	<i>Adama Red, Bombay Red, Red Creole, Russet F1, Nasik Red, Lambada F1, Red coach F1, Red King F1, Malbec F1, Sudan Red</i>
Cabbage	Strong leaves, good head quality (compactness), medium head size	<i>Early Drum Head, Copenhagen market, Landini F1, Thomas F1, Victoriya F1, Gloriya F1</i>
Garlic	White bulb color, and medium clove size are also preferred.	<i>Tseday</i>
Potato	not mentioned	<i>Belete, Gudeana, Jalani, local</i>
Sweet potato	not mentioned	<i>Tulla, Kulfo, Dila, Cambodia, Alamura</i>
Swiss chard	not mentioned	<i>Fordhookgiant</i>
Lettuce	not mentioned	<i>Greatleakes, tesfa mekelle</i>
Carrot	not mentioned	<i>Nants</i>

Source: Horticulture development directorate strategic document (TBoANR, 2022b) and emergency and recovery support plan 2022/23 (TBoANR, 2022a).

Vegetable value chains

Finding from focus group discussions showed that input supply, production, marketing, processing, and consumption were Tigray’s major vegetable value chain functions (see Fig 3). Agricultural inputs such as seeds, seedlings, fertilizers, pesticides, and irrigation technologies are supplied to farmers by cooperatives, agrodealers, individual traders, investors, and farmers. NGOs also purchase agricultural inputs and distribute them to farmers through development programs, and Woreda agriculture offices and farmer cooperatives and unions engage in input supply activities. Some investors in Raya Valley also raise vegetable seedlings and sell these to farmers, and a few farmers also produce seeds of vegetables like onion, tomato, Swiss chard, and use, sell or exchange them with other farmers. Few private investors are also engaged in vegetable farming, mainly in Raya Chercher and Raya Azebo woredas. Both smallholders and investors are involved in postharvest handling practices and marketing of produce.

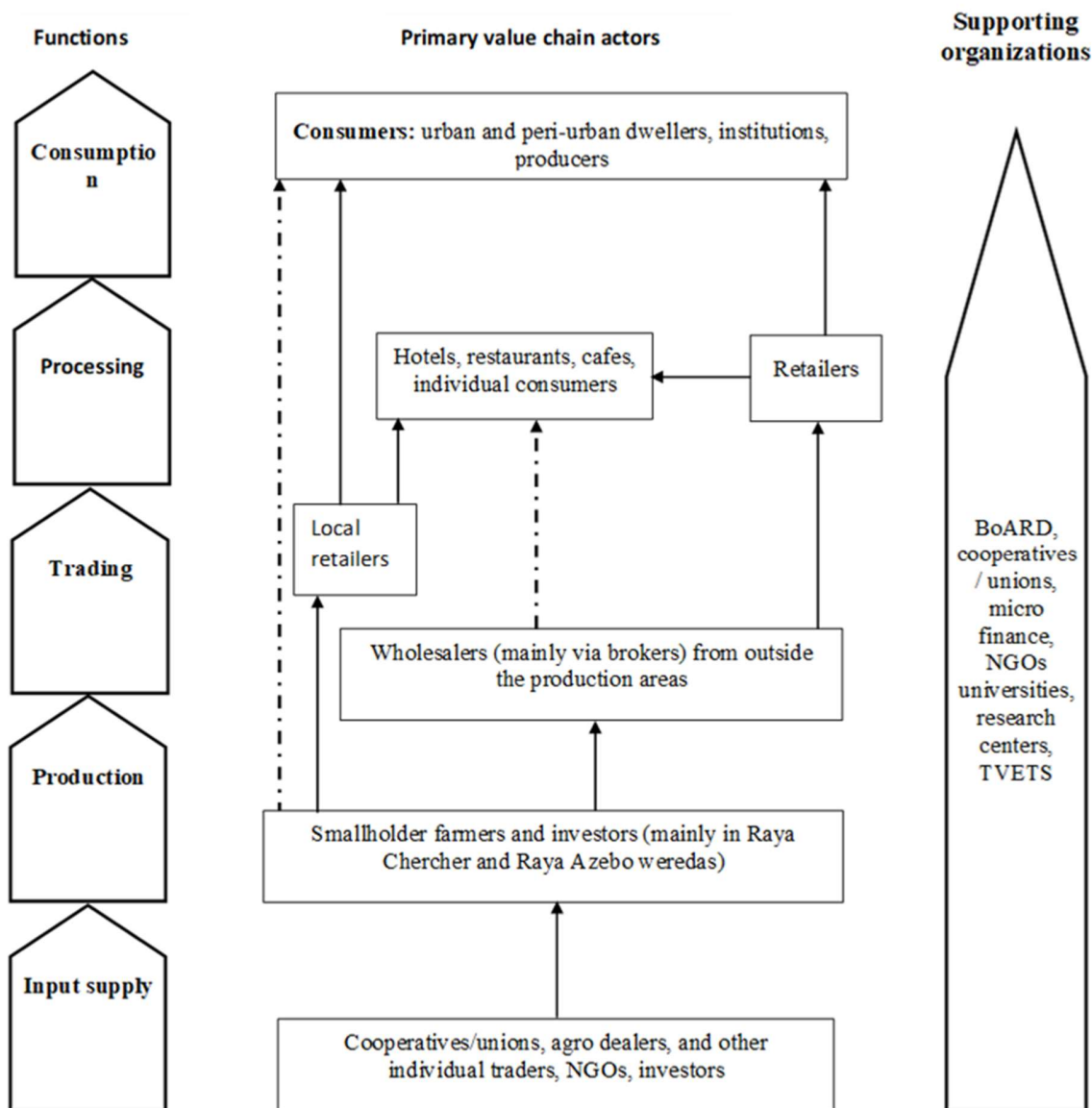


Figure 3: Map of vegetable value chains, actors, and supporting institutions in Tigray. Source: Authors

No temporary storage for vegetable products around irrigation schemes is available, and existing cooperatives do not store or sell produce, but are only engaged in supplying chemical fertilizers and pesticides. Marketing is handled by producers who sell to wholesalers outside production areas mainly through brokers, and to retailers and consumers around and outside production areas. Brokers are the key players in marketing and trading, who determine the pricing and earn higher margins than producers. The marketplace is primarily the Woreda market, as kebele markets are undeveloped and nonexistent in some rural areas. Transport is mostly with pack animals, often donkeys, and men or women who carry sacks, animal-drawn carts, wheelbarrows, and sometimes trucks and buses. Processing is done mostly by hotels or restaurants that sell fresh or cooked vegetables to consumers. Final consumers include urban and peri-urban dwellers and institutions that buy and consume a wide range of vegetables. Value chain enablers include Woreda Bureaus of Agriculture, cooperatives, microfinance institutions, NGOs, universities, research centers, and Technical and Vocational Education and Training Centers. These actors supply agricultural inputs, training, credit, production technologies, and extension services.

Inputs and technical advice

Currently, the Bureau of Agriculture, via cooperatives, is the sole provider of fertilizers, while private providers and NGOs provide other inputs, mainly seed. The regional interim government is planning to privatize agricultural input provision. Humanitarian and non-governmental organizations also provide inputs such as vegetable seed of mainly tomato, onion, pepper and cabbage, fertilizers, pesticides, irrigation equipment and fuel. Vegetable seed and irrigation technologies are also sold by private companies and some NGOs. Vegetable seeds are often imported from the Netherlands, India and Israel, while irrigation technologies are imported from Israel, Kenya, Germany, Australia and Turkey, or produced locally. The proportion of interviewed NGOs providing support is shown in Figure 4. In terms of labor, the availability of and access to agricultural labor opportunities, including income from migratory labor, remains limited.

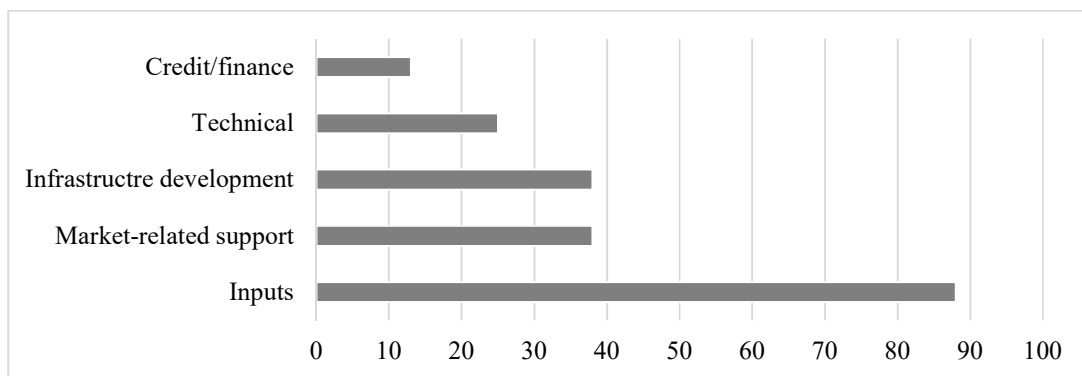


Figure 4. Proportion of interviewed NGOs providing irrigation and vegetable support in Tigray

Irrigation

The most common sources of water are hand-dug wells, springs, river diversions, check dams, flowing rivers and dams (Figure 5). Sources that were least mentioned are underground water, and drip irrigation. In 80% of the Woredas surveyed, farmers preferred private hand-dug wells, mainly due to their suitability for individual management. However, drip irrigation was the preferred irrigation technology in semi-arid lowlands of southern Tigray, mainly Raya Chercher and Raya Azebo, due to its precise application and efficient use of water directly applied to the root zone of plants. Damaged and looted irrigation infrastructure have not yet been repaired or replaced, as spare parts and other essential machinery and equipment are lacking in Tigray (TBoANR, 2022a). Thus, the impact of the conflict on irrigated agriculture prevails and compromises the development of the region's agriculture.

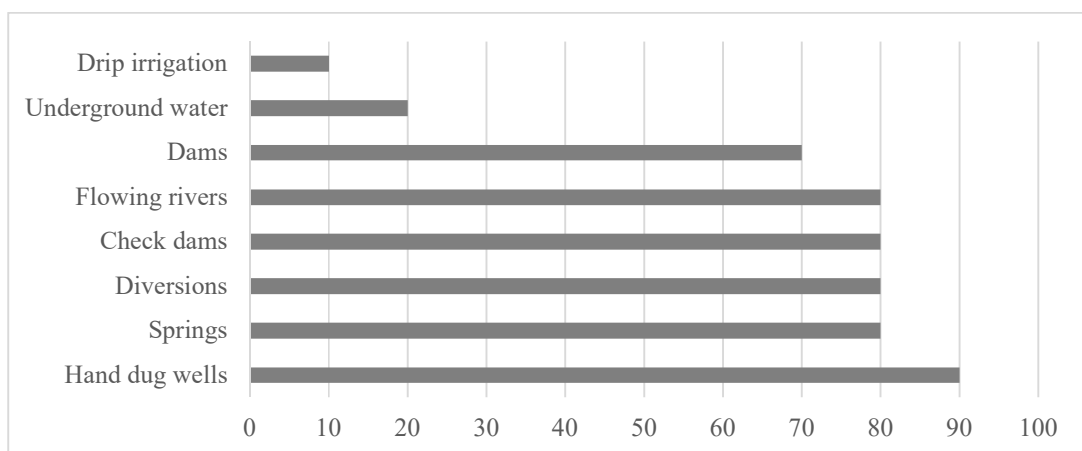


Figure 5: Irrigation water sources reported by farmers in Tigray (mention by % of focus groups, n=10)

Marketing and consumption

During focus group discussions, it was clear that vegetables are mainly produced for sale to urban and peri-urban consumers and institutions, while little is kept for home consumption. Marketing of food crops is still disrupted in some zones of Tigray due to the conflict. Furthermore, movement of food is below normal due to the ongoing conflict in the neighboring Amhara region.

Food security and nutrition

The Famine Early Systems Network recently published a report on the food security situation in Ethiopia in general and also Tigray specifically (FEWS-NET, 2023). The report shows that food security continues to be a threat because of the effects of the conflict in Tigray and neighboring Ahmara, but also due to climate related shocks, and in particular drought that has severely impeded the ability of poor households to engage in food and income generating activities. Most households do not have the capacity to produce due to the loss of productive assets and also cannot purchase food. Although there was some harvest in the 2023 *meher* season, this was not sufficient for the need of Tigrayans. The harvest was below average and many households were sharing their harvested stocks. The malnutrition status is high, with the outcomes raging from serious to extremely critical (FEWS-NET, 2023). Tigrayan officials estimated that 3.5 million people need urgent aid in 2024, including 2.3 million farmers (TGM, 2024).

Policy and institutions

As indicated above, the Bureau of Agriculture is the key provider of agricultural inputs. Technical support is provided by the government, NGOs and private companies. For instance, one private company provides knowledge transfer and technical advice using contract farming and demonstrations, market-related support, credit and finance access. From discussions with farmers, extension services are still not available and accessible. Overall, however, there is no documentation at the policy and institutional level that has assessed the situation after the conflict.

Vulnerable groups

In focus group discussions, participants indicated that men are responsible for decision making on vegetable production while women contribute to management. Societal definition of gender roles could provide one explanation for why men dominate irrigated vegetable production in Tigray. Generally, farming is considered in most Tigrayan communities to be the work for men, while women traditionally focus on domestic tasks while also providing farm labor. Respondents stated that women are mainly responsible for vegetables in home gardens because they bear primary responsibility for activities around the home. According to the International Organization for Migration data, updated in September 2023, 3.46 million people were internally displaced in Ethiopia with most displaced populations (2.5 million) concentrated in Tigray (IOM, 2024). Conflict and drought remained the primary reasons for displacement. Internally displaced people rarely engage in farming and continue to depend on humanitarian food aid. Internally displaced households are considered most at risk of severe food insecurity, and are being prioritized for the targeting food aid (FEWS-NET, 2023). In addition, there are about 2.5 million returnees in Ethiopia, most of them in Tigray (IOM, 2024).

Swot analysis

Strengths

- High emphasis and priorities given to the development of the Tigray agricultural sector in general and the horticultural sector specifically, particularly for livelihood recovery post-conflict.
- Government agricultural services are decentralized at kebele level.
- Introduction of diversified irrigation technologies for smallholders.

Weaknesses

Policy gaps and institutional constraints

- No seed quality declaration mechanisms.
- Lack of technical capacity among farmers regarding the use and maintenance of irrigation facilities.
- Lack of a clear monitoring and evaluation system for irrigation technologies.
- The Horticulture Development Directorate in Tigray, mandated to provide this service, is under-resourced in terms of staff, logistics, budget, lab facilities, etc., and horticulture professionals placed at regional, Woreda, and kebele levels lack practical knowledge and skills to advise growers.
- Poor road network.
- The lack of organized marketing systems.
- Shortage of hard currency.
- Limited research to support irrigated vegetable production.
- Farmer associations do not exist or are weak.
- Conflict between upstream and downstream water users.
- No institutions safeguarding farmers' interests.

Input related constraints

- Critical shortage of improved seed and planting material in local markets, when needed.
- Purchasing planting materials from other regions is costly, for example, seedlings from Debre Zeit cost 8 Birr (US\$0.14) per seedling excluding transport and other transaction costs.
- Limited affordable and appropriate irrigation technologies.

Technical constraints and knowledge gaps

- Low capacity of technical personnel and farmers on irrigation technologies and practices.
- Lack of marketing information especially on price.
- Lack of tailored and context specific training materials on vegetable production.
- Limited knowledge on improved vegetable varieties.
- Vegetable supply and demand fluctuation.

Opportunities

- Vegetables can be produced two or three times annually, provided water is available and an effective supply chain exists.
- The demand for vegetables is increasing locally, in Mekelle and in other cities outside Tigray. Export opportunities to are also available.
- There are numerous water sources, which if tapped, can promote year round vegetable production.
- The availability of diversified irrigation infrastructure serves as a key entry point for reviving and boosting the irrigated vegetable sector.

Threats

- Strong farmer dependency on humanitarian food aid.
- Strong farmer dependency on external support for seed and maintaining irrigation technologies.
- Insecurity and ethnic conflicts.

4. Recommendations

Potential intervention strategies to support household livelihood recovery through irrigation and vegetable systems were thoroughly assessed from site visits and interviews with farmers, regional and woreda level government officers, other stakeholders and also from literature.

Increase seed supply

Developing a strong seed system is required to meet the target of providing emergency support of 1,380 tonnes of vegetable seeds to 224,450 farmers with irrigated land, as recommended by the Tigray Bureau of Agriculture. The government agricultural offices in Tigray provide recommendations on vegetable seed varieties suitable for specific woredas, but the shortage of improved seed is a major constraint. Farmers mainly access seeds through the Bureau of Agriculture. Humanitarian and development agencies supply cereal seed, with some also providing vegetable seed in conflict recovery programs offered by NGOs (BASF, 2023). Further, investment on developing adaptable and suitable seed varieties for Tigray is limited, particularly post-conflict, because of the destruction of research facilities during the war, with no information available on the characterization of traditional vegetable species. Improving the availability of seed through liberating seed provision services to include more actors other than government, and establishing links with seed producers and suppliers is recommended. Furthermore, promoting local seed production models is needed to not only make seed available at the right time, but that are also affordable. Supporting research on testing adaptability and suitability of recommended varieties is encouraged, through strengthening partnerships between research and government institutions. Humanitarian and development agencies could also partner with research institutions to ensure seed support, including seed quality testing, and procuring seeds from trusted suppliers. Efforts to rescue and conserve genetic resources, particularly traditional vegetables, should be emphasized.

Develop irrigation

The most pressing challenge for irrigation is the lack of technical capacity among farmers and local staff on the maintenance and construction of irrigation infrastructure. This is critical, given that most was damaged during the conflict. Empowering local communities to rehabilitate and maintain such infrastructure is urgent for improving the production of vegetables under irrigation. In addition, research and provision of suitable and user-friendly irrigation technologies should be promoted. Irrigation equipment is not easily accessible and available, pointing towards the need to improve the supply chain of these inputs.

Improve agronomic practices

Irrigated vegetable crops are susceptible to pests and diseases. As mentioned by farmers, a lack of technical know-how on good agricultural practices is a constraint to irrigated vegetable production. Moreover, the absence of tailored training materials that are specific to vegetable and the Tigray context is a key barrier. Rebuilding the livelihoods of Tigray households through vegetable production cannot be successful if suitable training is lacking. The capacity of staff in local government extension offices need to be strengthened to provide agronomic advice when needed. Training materials should be produced and made available to farmers and local government staff in printed and digital form, such as manuals, text messages, audio or video messages and through radio or television media.

Strengthen market links

The lack of access to market during the conflict and afterwards have reduced farm incomes. Price information is not available and brokers are not transparent on this. Brokers actually use the information access barrier among farmers to their advantage, so offering low prices. Farmers cannot negotiate because they do not have bargaining power, also partly due to lack of strong farmer associations. Storage facilities are not available, transportation means are traditional and quality control systems are lacking, that all has a negative effect on farmers due to postharvest losses. Strong farmer associations could be a solution to most of these problems.

Associations can also boost farmers access to inputs at lower prices, thus improving profits. Processing of vegetables at local level through cooperatives, if introduced, can offer a solution to postharvest losses, thus improving availability of vegetables even during times of shocks.

Enhance policies and institutions

The regional agricultural offices are mandated to provide agricultural and irrigation advice to farmers. However, the lack of funding, capacity and technical know-how, even before the conflict, limits the extension provision. For research centers, the damage during the conflict has had a negative implication for agricultural research and development. Significant investment will be needed to rehabilitate research centers, laboratories, experimental sites and genetic conservation units, that could be provided by international organizations that support and promote agricultural research. Effective partnerships between government, development agencies and international research institutions should be developed, to contribute to extension delivery in Tigray.

Support vulnerable groups

Internally displaced people, refugees and returnees are among the most vulnerable groups in Tigray, and who require emergency and resilient livelihood options. Inclusion of vulnerable groups in irrigated vegetable production cannot be ignored. Before the conflict, the refugee hosting areas in Tigray had more than 10,000 ha of privately owned and communal irrigable land (UNHCR, 2019) but this could have reduced, post-conflict. Vegetable production can be done in small spaces making it the most feasible options for improving food security and nutrition for vulnerable groups in the region especially if water is available.

Promote vegetable consumption

Before the conflict, farmers produced vegetables for commercial sale. However, during the conflict, most households consumed the vegetables as there was no access to markets, and as a coping mechanism to replace legumes that were not available due to blocked trade. The situation now is going back to the pre-conflict situation, with farmers are producing for market. This is however, a threat to household nutrition given the high cases of malnutrition existing in Tigray. Promotional campaigns and training are recommended that involves cooking demonstrations and nutritional education, to increase awareness and promote vegetable consumption for healthier diets.

5. Conclusions and next steps

A peace treaty was signed between the government of Ethiopia and the Tigray People's Liberation Front on 2 November 2022 to end the Tigray War. Now, the production of irrigated vegetables is expected to expand, but only slowly, as most of the problems created during the conflict have not been resolved. The government, development agencies and international research institutions have a key role to play in improving irrigated vegetable production. Support to extension, strengthening the seed system, promotional campaigns on vegetable consumption and improving supply linkages are among the recommended intervention strategies for vegetable and irrigation systems to increase production and boost the livelihood recovery of the vulnerable population in Tigray.

Partnerships need to be strengthened, in order to realize a rapid recovery of livelihoods in Tigray. In particular, humanitarian staff need to closely work with local organizations to ensure the sustainability of projects. In addition, partnership between humanitarian staff and research institutions is highly recommended for the transfer of technical knowledge to farmers, and to efficiently and effectively promote and scale innovative irrigated vegetable technologies, including adaptable crop varieties. Humanitarian staff can also leverage the partnership with research institutions to conduct and adopt robust and rigorous monitoring and evaluation systems for learning and adaptation of projects.

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Annexes

Annex 1: Key informant interview participants

Name of organization	Position
Regional Bureau of Agriculture and Natural Resources	Horticulture Development Directorate Director,
International Fund for Agricultural Development - IFAD-PASIDP-II	Regional Program Coordinator
Raya Azebo Office of Agriculture & Natural Resources	Horticulture Coordinator
Raya Chercher Office of Agriculture & Natural Resources	Horticulture Expert
Hintalo Office of Agriculture & Natural Resources	Horticulture Expert
Enderta Office of Agriculture Natural Resources	Horticulture Coordinator
Tsirae-Wemberta Office of Agri. & Natural Resources	Horticulture Coordinator
Kilte-Awulaelo Office of Agri. & Natural Resources	Horticulture Coordinator
Hawzein Office of Agri. & Natural Resources	Irrigation Expert
Keyih Tekli Office of Agri. & Natural Resources	Irrigation Expert
Adwa Office of Agriculture and Natural Resources	Irrigation Expert
Rama Adi-4 Office of Agr. and Natural Resources	Irrigation Expert
ZOA	Area Manager
Relief Society of Tigray - REST	Agriculture Division Head
CultivAid	
The Netherlands Development Organization - SNV-Horti	Tigray Hortilife Regional Manager
Tigray Agricultural Research Institute - TARI	Biotechnology and vegetable researchers
Agricultural Transformation Agency - ATI	Agri. Commercialization Cluster (ACC) & Projects Director
Feed the Future Ethiopia Transforming Agriculture	Crop Market System Officer
Adey Agri-tech Development PLC	
Tigray Agri Marketing Promotion Agency	Marketing Development and Linkage Directorate Director
CARE Ethiopia	CARE Ethiopia - Bruh Tesfa Project Manager
BoA Agri. Input supply	Agri. Input Supply Team Leader
Bruh Tesfa Irrigation & Water Technology PLC	Water Works Construction and Electromechanical Dep't Head

Annex 2: Participants and gender composition in the focus group discussions per Woreda

No	Zone	Woreda	FGD composition		Total
			Male	Female	
1	Southern	Raya Chercher	8	3	11
		Raya Azebo	9	1	10
2	South-eastern	Hintalo	8	2	10
		Enderta	8	2	10
3	Eastern	Tsira'e-Wemeberta	7	3	10
		Kilte-Awulaelo	7	3	10
		Hawzein	7	3	10
4	Central	Keyih Tekli	7	0	7
		Adwa	9	2	11
		Rama Adi-4	8	1	9
Total			78	20	98

Annex 3: Topic and guiding notes for focus group discussions

Topic	Guiding notes
Vegetable cropping	<ul style="list-style-type: none"> ○ Important vegetable crops and their seasonal calendar ○ Consumer preferences of vegetable traits of different crops ○ Consumption of vegetables ○ Market access post-conflict
Seed	<ul style="list-style-type: none"> ○ Seed varieties - rank seed varieties based on preference and reasons; desired traits of the seed varieties ○ Seed production - producers, sources of training, sources of seed production material, seed multiplication methods ○ Access to seed: source of seed, reasons for using these sources, types of seed by sources, time seed is mostly accessed, ways of accessing seed i.e. cash, donations, contract, etc, quantity of seed accessed ○ Seed suppliers - location, capacity, main functions related to seed, quantity of seed, seed variety and quality, months seeds are sold, price, main customers. ○ Seed quality - access to quality seeds, challenges
Irrigation	<ul style="list-style-type: none"> ○ Access to irrigation water: source, type, quality, availability ○ Available irrigation facilities: list types of irrigation systems, size, ownership of irrigation equipment, population using irrigation, preferred irrigation technologies and reasons
Other inputs	<ul style="list-style-type: none"> ○ Inputs for vegetable production other than irrigation and seeds (e.g., agrochemicals, fertilizers)- types, availability, source
Institutional factors	<ul style="list-style-type: none"> ○ Identify institutions involved in vegetable and irrigation systems: roles, services. ○ Describe the social and cultural factors influencing vegetable production, marketing, and use of irrigation (e.g., Water user association presence and functionality)
Impacts	<ul style="list-style-type: none"> ○ Economic, social, and environmental impact of vegetable production, use of irrigation, vegetable marketing and consumption: gender impacts, nutrition, income, employment, etc
Value chains	<ul style="list-style-type: none"> ○ Vegetable value chain - map the actors and linkages between them, location of actors, and roles. ○ Map the irrigation technologies' availability and pre- and after-sale services. ○ Understand opportunities and challenges for irrigation technology availability and distribution post-war (including construction material for scheme rehabilitation)

Annex 4: Checklist for data collection

General introduction

Good Morning/Afternoon: My name is _____ and I am a researcher from Mekelle University conducting rapid assessment of irrigated vegetable production systems in Tigray in collaboration with World Vegetable Center (WorldVeg) International Water Management Institute (IWMI) that aim to offer a comprehensive understanding of the vegetable and irrigation system in the post-war scenario, using a food system perspective. Thus, your genuine response is of paramount importance for the success of the assessment, and the researcher kindly requests your cooperation in so doing. Please be sure that any information you provide will be kept. *Please be sure that everything you tell us in this interview, including your name and personal information, will be kept completely confidential and be used purely for the purpose of the assessment. You are also free to terminate the interview at any point; to skip any questions that you do not wish to respond to; and to refuse to participate in the study. Thus, participation in the study will be voluntary. No inducements will be made. I on my behalf and the organizations I represented appreciate your cooperation in advance.* Thank you!

A. Questions to farmers

1. Can you tell us about your most important vegetable crops in normal times, their production seasons, and uses? What vegetable crops have become important during and after the conflict, and why?
2. Do you irrigate your vegetables? (y/n) if yes, what technology do you use to irrigate? Where and how did you obtain this technology and when? What irrigation source do you use? Has your irrigation practice been affected post-war? (e.g., fuel shortage, spare parts availability, collapse of infrastructure, etc.)
3. What is your opinion on the cultivation and consumption of traditional vegetables grown in the wild and other places?
4. Are there important or preferred seed varieties, by crop and why. Are there important and preferred consumption traits for different vegetables and why?
5. Tell us how the conflict-affected vegetable production, marketing and consumption and how it affected use of irrigation, supply of irrigation facilities, etc?
6. What are your views on improving quality, availability, access and affordability of vegetable seed, vegetables for consumption and irrigation facilities after conflict?
7. What vegetable inputs and management practices might be essential for particular crops and varieties and why?
8. Who in the household is responsible for decision-making and actual management of irrigation technology, irrigation practices and the diverse crops, at various stages of production and post-production?

B. Questions to humanitarian staff and NGOs

1. Identification details

Detail	Response
Organization’s name and year of establishment	
Location (address), and regions of operation in Ethiopia	
Type of organization (local, regional or international)	
Name, position of respondent, email and gender	

2. Provide details of vegetable and irrigation support you offer to farmers in normal conditions in Tigray? (For irrigation technologies, ask which technologies). What support activities became important post-conflict?
3. What are the main outcomes of your vegetable and irrigation support projects?
4. Tell us the vegetable seed and input (particularly irrigation equipment) channels that you use (before and

after the conflict). Do you have challenges accessing them at this moment? Please explain.

5. Describe the challenges faced in providing vegetable production and irrigation support post-conflict.
6. What support do you need to succeed in implementing vegetable and irrigation interventions, especially post-conflict?

C. Questions to input suppliers

1. Identification details

Detail	Response
Input supplier name and year of establishment	
Location (address)	
Type of supplier (e.g. agrovet dealer)	
Your name, gender	

2. Tell us about the vegetable seed you sell.

Name of the vegetable crop seed	Variety	Type of seed (certified, QDS, local)	Source of seed

3. Tell us what irrigation equipment you sell.

Name of the irrigation equipment	Type of pump (manual, diesel, petrol, solar, ...)	Where do you get it from?	What pre and after sale service do you provide?

4. Which other agrochemicals, fertilizers and farm tools do you sell?
5. Who are the main customers of seed, irrigation technologies and other inputs and how is the purchasing arrangement?
6. What other services do you provide to the farmers purchasing your seeds and other inputs, e.g. advisory?
7. Tell us the main challenges you face related to selling vegetable seed, irrigation equipment, agrochemicals, fertilizers, farm tools and other inputs post-conflict?

Item	Explain the challenge
Vegetable seed	
Irrigation equipment	
Agrochemicals	
Farm tools	
Fertilizers	
Other inputs, name them	

8. What support do you require to improve your operations, especially post-conflict?

D. Questions to seed companies

1. Identification details

Detail	Response
Company name	
Location/Address	
Type of company	
Gender of owner	
Years of establishment	
Your name	

2. Tell us about your seed production

Name of vegetable crop seed you sell	Variety	Age of the variety	Source of parent seed	Annual quantity sold

3. Do you have any challenges in acquiring parent seed? Yes ___ No ___; Please explain

4. What percentage of your seed do you produce by yourself and what percent is imported?

	% of total sales
% of certified seed from own production in Ethiopia	
% of certified seed imported	

5. Who are your main customers and what is the purchasing arrangement?

Type of customer	% of annual sale
% of annual sales to government or other public institutions	
% of annual sales to agrodealer or other retail channels	
% of annual sales to relief agencies	
% of annual sales directly to farmers	
% of annual sales to institutional buyers	

6. What factors hinder or promote your operations and how have these changed post-conflict?

7. What support have you received on your seed production and from who?

8. What support interventions would you like to receive?

E. Questions to irrigation equipment companies and suppliers

1. Identification details

Detail	Response
irrigation equipment supplier name	
Location (address)	
Type of supplier (e.g. agroveter dealer)	
Gender of the owner	
Year of establishment	
Your name	

2. Tell us what irrigation equipment you sell.

Name of the irrigation equipment	Type of pump (manual, diesel, petrol, solar, ...)	Where do you get it from?

3. Do you sell other agrochemicals, fertilizers and farm tools? if yes which ones?
4. Who are the main customers of irrigation technologies and other inputs and how is the purchasing arrangement?
5. What other pre and after sale services do you provide to the farmers? (e.g. advisory, repair, ...)
6. Tell us the main challenges you face related to irrigation equipment, and other inputs post-conflict?

Item	Explain the challenge
Vegetable seed	
Irrigation equipment	
Agrochemicals	
Farm tools	
Fertilizers	
Other inputs, name them	

7. What support do you require to improve your operations, especially post-conflict?





The World Vegetable Center is an international non-profit institute for vegetable research and development. It mobilizes resources from the public and private sectors to realize the potential of vegetables for healthier lives and more resilient livelihoods.



WorldVeg's globally important genebank, improved varieties, production and postharvest methods help farmers to increase their vegetable harvest, raise incomes in poor rural and urban households, create jobs, and provide healthier, more nutritious diets for families and communities. With headquarters in Taiwan, field operations are led from regional centers in Benin, India, Mali, Tanzania and Thailand, and through offices in other countries.



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