



MITIGATING FOOD LOSS AND WASTE IN THE TOMATO VALUE CHAIN IN CAMEROON

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Degree project • 30 credits
Swedish University of Agricultural Sciences, SLU
Sustainable Food Systems
Molecular Sciences, 2025:35
Uppsala, 2026



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Credits: 30 Credit

Level: Advanced, A2E

Course title: Master thesis in Food Science

Course code: EX0875

Programme/education: Masters in Sustainable Food Systems

Course coordinating: Department of Molecular Sciences

Place of publication: Uppsala

Year of publication: 2026

Title of series: Molecular Sciences

Part number 2025:36

Keywords: Post Harvest Losses, Fruits and Vegetables, Developing Countries

1.1 Abstract

Food insecurity remains one of the most challenging- yet solvable problems of our time. As we grapple against a growing population, with food production being severely challenged by climate change; demographic change presents us with wide-ranging social, economic and environmental challenges. Many options are currently being debated and considered by decision-makers to tackle the threat of wide-spread food insecurity. One of such options is reducing food loss and waste.

Horticultural food crops like tomatoes are believed to be an essential part of our diet as not only do they add colours to our food, but they are also packed with essential micro and macro nutrient. In Cameroon, the tomatoes food supply chain is a very lucrative business for many stakeholders including input suppliers, producers, middlemen, wholesalers, retailers "buyam sellam" and consumers (hotels and restaurants). Latest statistical estimates reveal that Cameroon is classified as the fifth producer of tomato in Africa with an estimated production of 889,800 tons and annual growth of 9.4%.

The aim of this study is to investigate the causes and extent of food loss and waste along the tomato value chain in Cameroon and to propose evidence-based mitigation strategies for key chain actors. Qualitative analysis was used in this study to understand food loss and waste in the tomato value chain in Cameroon with questionnaires being used to collect data from the different chain actors.

The results showed that waste occurs at all stages in the tomato value chain. In Cameroon. However, farmers in Cameroon experienced more loss than any other chain actors. In conclusion, the study suggests that Food Loss and Waste interventions preharvest and postharvest management practices in the tomato value chain should be multi-level and context-sensitive, integrating economic insights.

Food loss, food waste, tomato, value chain

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Abbreviations

Abbreviation	Description
FL	Food Loss
FW	Food Waste
FLW	Food Loss & Waste
FSC	Food Supply Chain
SDG	Sustainable Development Goals
GHG	Green House Gas
FVC	Food Value Chain

1 INTRODUCTION

Food insecurity remains one of the most challenging - yet solvable problems of our time. There has been a rising interest in the topic at both national and global levels owing to concerns on feeding a growing population by the year 2050. As we grapple against a growing population, with food production being severely challenged by climate change; demographic change presents us with wide-ranging social, economic and environmental challenges. Many options are currently being debated and considered by decision-makers to tackle the threat of wide-spread food insecurity in the context of a rapidly growing world population and depleted natural resources, including increasing agricultural productivity in less productive areas (Aragie et al. 2018).

In September of 2015, the United Nations general assembly proposed the 2030 agenda for sustainable development better known as the Sustainability Development Goals (SDGs) which was ratified by multiple nations. These goals aim to promote prosperity and wellbeing through a call to action to end poverty and inequality, protect the planet and ensure that all people enjoy health, justice and prosperity.

The environmental, social and economic implications of food loss and waste (FLW) have attracted considerable attention in recent years; it has become a topic of interest for both national and international bodies. In Europe for example, the agricultural sector is one of the economic sectors with the highest environmental pressure and resource use accounting for approximately 15% of direct Green House Gas (GHG) emissions from all EU production (Scholz et al. 2015).

Furthermore, environmental constraints such as biodiversity loss, climate change and extreme weather conditions are making it hard to attain future food security (Porat et al. 2018). It is estimated that one-third of food that is produced for human consumption globally ends up as waste along the food supply chain; we are talking about 0.9 million hectares of land and 306 cubic kilometres of water used up in food production (Magalhaes et al. 2021) not to mention other environmental, social and economic capital invested in growing our food. The above statement makes you question how come we have over 800 million people being hungry and under nourished globally and the fact that we are facing a challenge to provide safe and nutritious food to a growing population which is expected to reach 10 billion by 2050 with production expected to go up by 70% (FAO 2019). It is therefore evident that FLW not only translates as a misuse of resources, but managing it presents the opportunity to feed the growing population without additional pressure on the already scarce resources (Magalhaes et al.

2021). Understanding our food supply chain, the causes of FLW and developing practical mitigation strategies throughout the entire food system is a sustainable way to achieve global food security (Mattsson et al. 2018). Evidently, reducing FLW to about half its current value could feed one billion people; a very progressive step towards eradicating global hunger (Magalhaes et al. 2021).

But first, we need to understand what FLW is. Globally, the definition of FLW differ widely. For example, Garcia-Garcia et al. (2017) defines food waste as food material(including drinks) and the inedible parts originally intended for human consumption but not ultimately sold for human consumption, while Gustavsson, Cederberg and Sonesson, (2011) define food loss (FL) as the decrease in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption. Whatever the differences in definition, there is a common consensus that FLW occur throughout the food supply chain; which is a network of processes as shown in figure 1, from production, storage, transportation, distribution and consumption.

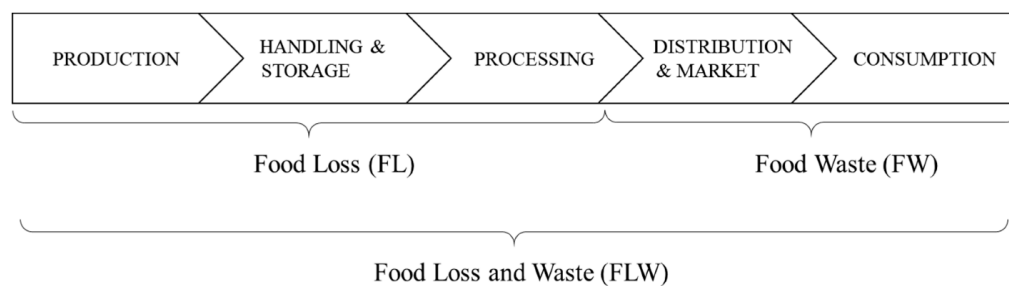


Figure 1 Framework of Food Loss and Waste(Ishangulyyev et al. 2019).

It is estimated that the global amount of food that is wasted throughout the food supply chain amounts to approximately 50% of what was initially produced for human consumption. It is reported that in developed countries, post-consumer activities is the major cause of recorded high waste (Nahman & de Lange 2013) whereas in developing countries, large amounts of food loss is recorded at the pre-consumer level. Financial, managerial and technical limitations as well as infrastructural, packaging and marketing systems limitations have been noted to play a major role in FLW (Sibomana et al. 2016).

Food loss and waste therefore stands at the intersection of food security, environmental sustainability, and economic development, making its mitigation central to achieving the SDGs by 2030. While developing countries grapple mainly with consumer-level waste, developing nations face greater losses earlier in the supply chain due to financial, technical, and infrastructural constraints.

Understanding these context-specific dynamics is essential for designing effective, locally relevant mitigation strategies. This sets the stage for examining FLW within specific value chains, such as the tomato sector in Cameroon, where pre-consumer losses are likely to dominate.

1.2 Background of the Study

Horticultural food crops like tomatoes are believed to be an essential part of our diet as not only do they add colours to our food, they are packed with essential micro and macro nutrients (Ambuko et al. 2025a). Tomato (*Lycopersicon esculentum* L.) is one of the most highly produced and important vegetables in the world, accounting for about 5.2 million hectares of globally cultivated land area, with an estimated yield of 172 million tons. It is rich in micro and macro nutrients essential for good health. The compound lycopene, which is present in high amounts, has an antioxidant property in reducing the incidence of chronic diseases such as prostate, breast, and cervical cancer, cardiovascular disorders (Dube, Ddamulira and Maphosa, 2020). In addition to the tomatoes' nutritive and health benefits, their versatility promote global cultivation and makes them ideal to be consumed in many forms, such as fresh fruits in a salad, cooked, and snacks. Currently, tomato is valued as an industrial crop in many parts of the world because of high economic returns and as it can be processed into different forms. However, it records the highest amount of waste and loss in the fruits and vegetables value chain in developing countries (Sibomana et al. 2016). Global postharvest losses in tomatoes are generally very high ranging between 25-42 (Wakene & Sharew 2024). FAO sights inefficiencies along the food supply chain such as poor infrastructure and logistics, lack of market access, absence of technology, knowledge and skills and management capacity of supply chain participants as the causes of the recorded losses (Ishangulyyev et al. 2019).

Despite tomatoes' significant nutritional, health, and economic value, the crop remains disproportionately vulnerable to loss and waste compared to other fruits and vegetables in developing countries. This paradox—high value yet high vulnerability—underscores the urgency of addressing the structural and systemic inefficiencies driving these losses. Tackling these challenges is therefore not only an economic imperative but also a critical step toward improving nutrition security and reducing pressure on already strained agricultural resources.

1.3 Statement of the Problem

Food Loss and Waste (FLW) is recognized as a major threat to food security, the environment and the economy. The International Labour Organization estimates

the global food and agricultural sector to be valued at USD 8 trillion; employing about one billion people and accounting for 1/3 of the world's labour force (Sawaya 2017). With a third of what is produced globally ending up being wasted and lost along the food supply chain, we are talking about 0.9 million hectares of land and 306 cubic kilometres of water used up in food production being wasted (Magalhaes et al. 2021) not to mention other environmental, social and economic capital invested in growing the food. For a food crop like tomatoes which is globally produced and consumed, meeting the food need of the growing population means the demand for tomatoes as a food crop will be critical.

In Cameroon, the tomatoes food supply chain presents a lucrative business opportunity for the stakeholders involved. Cameroon is classified as the fifth largest producer of tomato in Africa with an estimated production of 889,800 tons in 2014 and 1,279,853 in 2017 with annual growth of 9.4% (Dube, Ddamulira and Maphosa, 2020). Given its short life cycle of about 4 months, most farmers in Cameroon grow tomatoes twice a year; Between February and March which is the start of the rainy season and between August and September which is the end of the rainy season. One reason why farmers target start and end of the reason is because tomatoes farming is mostly rain-fed. Tomatoes is cultivated in large and small scales; with farmers cultivating tomatoes for commercial purpose on as small as 100m² piece of land, with an example illustrated in Figure 2.



*Figure 2 A small (100m²) Tomato Farm in the West Region, Cameroon.
(Photo, 2023)*

Despite these huge opportunities that the tomato value chain presents, it faces a plethora of challenges ranging from handling, storage, transportation, processing, and marketing, thereby resulting in the reduction of quantity and quality, as well as the market value (Njume et al. 2020). Given Cameroon's standing as a major tomatoes producer in Africa with consistent annual growth, the sector represents a significant economic opportunity for smallholder and commercial farmers alike. However, the reliance on rain-fed agriculture and the resulting twice-yearly production cycle exposes the value chain to seasonal vulnerabilities that can exacerbate losses. Understanding these production dynamics is therefore essential for identifying where and how food loss and waste occur within the Cameroonian tomatoes value chain.

1.4 Aim and Objective of the Study

1.4.1 General Aim

This study aims to investigate the causes and extent of food loss and waste along the tomato value chain in Cameroon and to propose evidence-based mitigation strategies for key chain actors.

1.4.2 Specific objectives

The first objective of this study is to quantify the level food loss and waste occurring at each stage of the tomato value chain; from the point of production right up to consumption. This will enable mapping at what level the biggest loss and waste is occurring, providing data driven evidence and justify the proposed mitigation strategies.

The second objective on its part tries to assess the socio-economic impact of food loss and waste along the tomato value chain on the livelihood of the different chain actors; farmers, middlemen, wholesalers, retailers and consumers. This will give a better understanding of who bears the most burden of the loss and waste along the chain and connect economic losses to food security and household wellbeing.

The third objective seeks to identify and propose feasible mitigation strategies for reducing food loss and waste along the tomato value chain. Proposed interventions will be actor specific and will assess cost, feasibility and practicality. The end goal is to come up with actionable recommendation for policy makers and chain actors.

1.5 Research Questions

Q1: What quantity of waste occurs at the different levels of the tomato value chain?

Q2: What is the impact of tomato loss and waste on the livelihood of the different chain actors?

Q3: What mitigation strategies are feasible to manage loss and waste in the tomato value chain?

1.6 Significance of the study

1.6.1 Empirical Contribution to Knowledge

Recognizing the role of FLW in achieving food security and sustainable food systems, this study contributes to understanding the magnitude of the impact of FLW on all chain actors in the tomato value chain. Tomato are one of the most cultivated crops globally, accounting for up to 5.2 million hectares of globally cultivated land area and an estimated yield of 172 million tons globally (Njume et al. 2020). Even so, they are amongst the most perishable crops because of their high-water content (approximately 90%) making them very susceptible to loss because of poor handling and marketing conditions especially in Sub-Saharan Africa. It is therefore imperative to contribute to the existing knowledge with the aim of providing chain actors and policy makers with enough information to make informed decisions.

1.6.2 Policy and Institutional Relevance

The Food and Agriculture Organisation (FAO) of the United Nations UN reports that a third of what is produced globally for human consumption ends up being wasted or is lost along the food supply chain. Additionally, FAO talk about increasing food production by 60% to meet the food needs of the growing population by 2050. In their effort to reduce food waste and lost, the UN's SDG 12.3 calls for halving per capita food waste by 2030. In that light, this study will provide evidence that stakeholders can use to design targeted policies, investment priorities and extension programmes along the tomato value chain.

1.6.3 Food Security and Nutrition

Tomatoes are rich in macro and micro nutrients that are essential for human health. These nutrients have been shown to reduce the incidence of chronic diseases such as prostate, breast and cervical cancer and cardiovascular disorder. These nutritive and health benefit values is a contributing factor to tomatoes being among the most cultivated crops together with the fact that they can be consumed in various forms (Njume et al. 2020). Reducing FLW will therefore mean more

food is reaching consumers and chain actors are making a better living off their trade hence contributing directly to food security and improved livelihood.

1.6.4 Direct Benefits to Chain Actors.

Input suppliers, farmers, middlemen, wholesalers, retailers and consumers all absorb significant losses without fully understanding the root causes. Studies such as this provide the various chain actors with a clearer picture of loss and waste points, identifying activities that are necessary but not value adding, eliminating those that are not necessary, highlighting those that are necessary and value adding with the aim to equip the actors with real practical recommendations that could be adopted to improve their livelihood and ensure food security.

1.6.5 Environmental Sustainability

Food loss, in addition to having an impact on the food security and the livelihood of those who depend on it, also has an impact on the environment. Food loss represents the waste in the resources used in producing the food such as land, water, energy and inputs. The hope is that the proposed mitigation strategies will contribute to reducing the environmental footprint of tomatoes and align with the broader goal of climate smart agriculture and sustainable food systems.

1.7 Scope and Delimitations

This study aims to investigate the causes and extent of food loss and waste along the tomatoes value chain and to propose evidence-based mitigation strategies for key chain actors. Data will be collected and analysed from chain actors in 4 regions; Littoral, Northwest, Southwest and West Region of Cameroon. In carrying out this study, we spoke to all chain actors; input supplier, farmers, wholesalers (most of whom are middlemen), retailers, consumers (at the level of restaurants and caterers and household).

1.8 Definition of Key Terms

Six thematic clusters are identified in this study and the terms to be defined are organized under these thematic areas:

1.8.1 Food Loss & Waste

When it comes to the definition of FLW, no common definition has been agreed upon till date, with various institutions coming up with definitions that best suits their studies and findings (Ishangulyyev et al. 2019). FAO sights inefficiencies along the food supply chain such as poor infrastructure and logistics, lack of market access, absence of technology, knowledge and skills and management

capacity of supply chain participants as the causes of the recorded losses (Ishangulyyev et al. 2019). Food waste is often defined as food that has spoiled with other possible causes being over supply, consumer shopping habits and aesthetic values put in place by supermarkets and store. FAO defines it as food that is appropriate for human consumption being discarded; whether it is left to spoil or being kept beyond its expiry date (Ishangulyyev et al. 2019). The High Level Panel of Experts of the UN (2014) defined food loss as, “*A decrease, at all stages of the Food Supply Chain prior to the consumer level, in mass of food that was originally intended for human consumption, regardless of the cause*”, and they defined FW as “*food appropriate for human consumption being discarded or left to spoil at consumer level—regardless of the cause*”. Figure 3 shows all the different stages at which FLW occur in the food supply chain as identified by Spang et al. (2019)

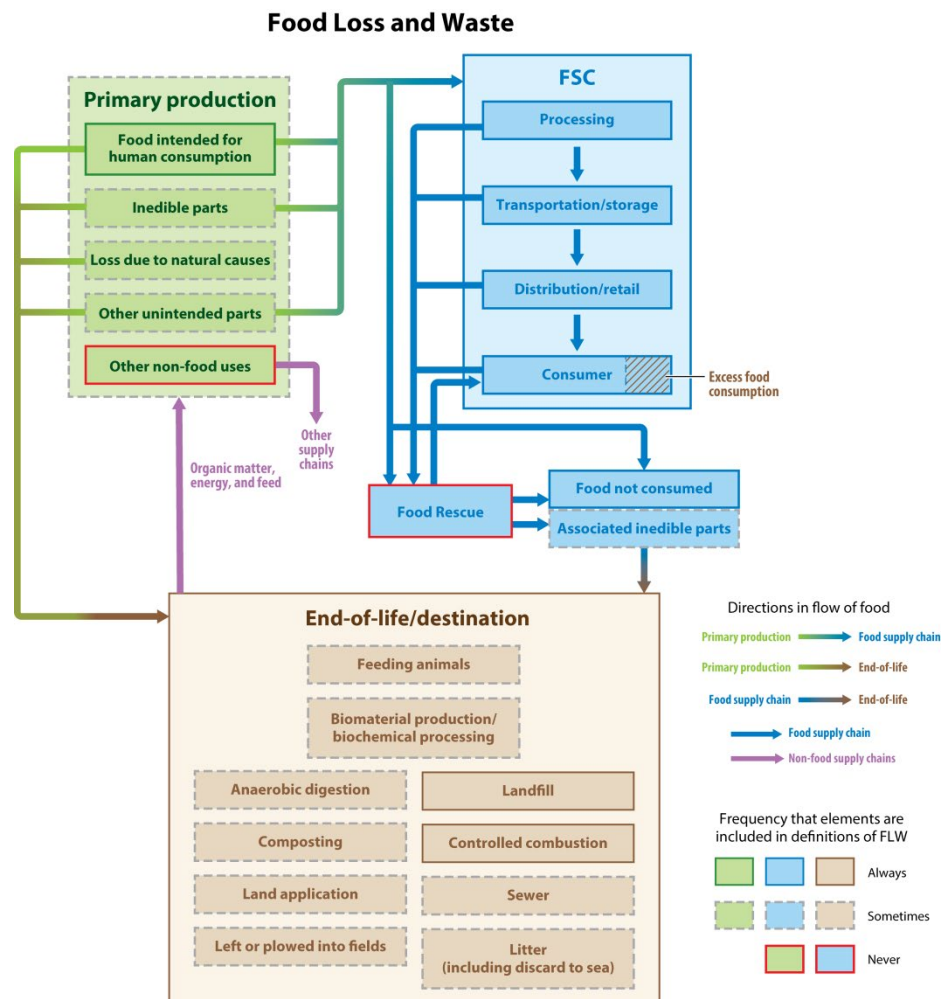


Figure 3 Illustration of Food Loss and Waste (FLW) and FSC (Food Supply Chain) Diagram (Spang et al. 2019).

1.8.2 Value Chain

The food value chain (FVC) is a network of stakeholders involved in the various stages of the life of the food from farm to fork. This definition includes chain actors like producers, processing industries, sellers (both wholesalers and retailers), consumers, government and regulatory agencies which rule the entire process. It encompasses a number of stages; production, postproduction procedures, processing, distribution, and consumption with FLW occurring in different quantities at all the stages depending on the product and the geographic location (Delgado et al. 2014).

1.8.3 Post-Harvest Losses

Post-Harvest losses (PHL) represents FLW that occurs from the point of harvest till the food reaches the table of the consumer. In developing countries, PHL pose a serious problem as a result of farmers are not trained on postharvest handling, lack of postharvest specialists to train farmers on good postharvest practices, poor transport and storage facilities, and poor packaging materials. Furthermore, government policies in most developing countries pay little attention in the area of postharvest management (Njume et al. 2020). These PHLs not only represent a lost in valuable food but loss in resources like land, water, labour and inputs (Stathers et al. 2025).

2. Literature Review

2.1 GLOBAL FOOD LOSS AND WASTE: OVERVIEW AND MAGNITUDE

The topic of food loss and waste has gained significant attention in recent years with many publications recognizing its environmental, economic and social implications. Recent reports have underlined the significance of investing in FLW to improve food security and achieve sustainable food systems. The study by Gustavsson et al. (2011) report that a third of what is produced globally and intended for human consumption is either lost or wasted along the food supply chain (FSC) with the amount estimated to be about 1 billion tons.

One major human anthropogenic activity with significant impact on achieving these SDGs is agriculture; Agriculture and its related activities contribute to approximately eight of the SDGs; 2 (Zero Hunger), 6 (sustainable water management), 13 (climate change), 14 (Life Below Water), 15 (Life on Land) and many others (FAO 2019). Goal #12 of the SDGs highlights responsible production and consumption calling on all actors to make substantial progress by the year 2030 if we are to live in a planet that is equitable and just. More specifically, goal #12.3 dares to be ambitious by aiming to “to halve per capita global food waste at the retail and consumer level, and reduce food losses along production and supply chains by 2030” – and approved by governments and parliaments of both the US and EU and many other countries and by the G20 Agriculture Ministers’ meeting held in China in June 2016 (Porat et al. 2018). A major outcome of the SDGs will be poverty reduction to which countless reports have linked agricultural development to it. For example, McGuire (2013) stated that in developing countries, the impact of agricultural growth is strongly felt in poverty reduction particularly for smallholders (particularly women) who rely on agriculture and its related activities for a livelihood. This and many other reports show that the way we produce, handle, transport and consume food can greatly impact our lives and how we leave the planet for future generations. However, a number of factors have been reported to challenge the smooth functioning of our food supply chain such as climate change, natural resource scarcity, food insecurity, governance and organisation of the food system, population growth as well as food loss and food waste (Kayikci et al. 2022).

Preventing or reducing FLW and, consequently, making the best use of natural resources is a major challenge (Nicastro & Carillo 2021). In the definitions of FLW, available data stipulating that average food loss at the global level is 15% (and about 35% in Africa). Highly fragmented smallholder production, poor

handling practices, low levels of knowledge on proper handling, limited financing options to facilitate technology adoption, poor infrastructure, poor market forecasting brought about by misinformation from middlemen, low industrial processing capabilities and low exports have been attributed to the main causes of food loss in developing countries (Owino et al. 2025). Generally, FLW differ as per the products and geographical location. For example, in Africa cereals are lost mostly in the first stages of the food chain while in Europe, they are lost mostly at the consumer stage; 25% of consumer waste of cereals, against 1% in Africa. In Africa, processing and distribution are the weak stages. In Europe, it is at the consumption level that most FLW occur (Vincent , 2014). Overall, much food is waste in the industrialized world than in developing countries with per capita waste by consumers in Europe and America being 95-115kg per year and 6-11kg/year in Africa and Asia (Cederberg & Sonesson 2011).

In Sub Saharan Africa, multiple attempts (approximately 50-64%) to reduce FLW have been met with failure as a result of lack of ownership and insufficient adaptation interventions tailored to the needs of supposed beneficiaries (Plaisier et al., 2019). Given that many smallholders live on the margins of food insecurity, a reduction in postharvest losses has been identified as a rapid intervention strategy in achieving an immediate and significant impact on their livelihoods. Improving the efficiency of the food supply chain could help to bring down the cost of food to the consumer and thus increase access. Given the magnitude of food losses, as long as the financial gains do not outweigh the cost of reducing food loss, making profitable investments in reducing losses could be one way of reducing the cost of food (Cederberg & Sonesson 2011). Therefore strategic interventions to reduce FLW must be met with a clear mapping of the FLW points, geographic locations, commodities and stages of the FSC to be able to formulate effective policies and propose mitigation strategies that actually achieve the economic, social, economic and environmental goals of FLW reductions (Ambuko et al. 2025b).

2.2 The Tomato Value Chain in Cameroon: Structure and Actors

Tomato (*Solanum Lycopersicon*) is a major vegetable/fruit extensively grown world over for human consumption. It belongs to the *Solanaceae* family, which includes more than 3000 species. Global production of tomato is estimated to be above 171 million metric tonnes over an area of 5 million hectares of cultivated land (Njume et al. 2020), with major producers being China, United States, Turkey, Egypt and India. Africa contributes 11.8% of total global tomato production. Within the African continent, tomato is one of the most widely grown vegetables due to its versatility with production cutting across smallholder and commercial farming communities. In Sub Saharan Africa, the tomato fruit is an important cash crop. The fruit plays an important role in human nutrition, where it

can be eaten as a fresh salad vegetable, processed, stewed, fried, baked and can also be used to produce soup or juice. It may also be put into various dishes as the main ingredient. Tomato is rich in vitamins like vitamins A, B and C. It also contain the B complex vitamins, thiamine, niacin and riboflavin which are essential in a healthy diet, minerals, and antioxidants that are good for human health (Dube, Ddamulira and Maphosa, 2020). Tomatoes contain high amounts of lycopene, a pigment type of carotenoid with an antioxidant property in reducing the incidence of chronic diseases such as prostate, breast, and cervical cancer, cardiovascular disorders (e.g., stroke) and others (Njume *et al.*, 2020; Dube, Ddamulira and Maphosa, 2020).

In Cameroon, the tomato food supply chain is a very lucrative business for many stakeholders including input suppliers, producers, middlemen, wholesalers, retailers, also called "buyam sellam", and consumers (hotels and restaurants). Latest statistical estimates reveal that Cameroon is classified as the fifth producer of tomato in Africa with an estimated production of 889,800 tons and annual growth of 9.4%. Tomatoes are grown twice a year in both small and large scale. Harvesting is done by hand picking and packed in traditional raffia baskets to be transported to the markets. Transportation is done in lorries of different sizes depending on the number of baskets to be transported. These raffia baskets do not allow enough aeration between the fruits hence increasing fruit deterioration. Furthermore, farmers overfill the raffia baskets with tomatoes, exerting more pressure on the fruits at the bottom of the basket and causing mechanical damage on the fruits in the course of transportation (Njume *et al.* 2020).

2.3 CAUSES OF LOSS AND WASTE ALONG THE TOMATO VALUE CHAIN

Understanding what causes FLW is a prerequisite for proposing solutions that work. According to Njume *et al.* (2020), several factors contribute to the low availability of tomatoes throughout Cameroon's national territory such as recent global climate change challenges, pre-harvest factors, time of harvest, and postharvest handling.

2.3.1 Pre-harvest Causes

Pre-harvest factors tend to affect the post-harvest quality and shelf life of tomatoes. Unavailability of certified seeds, open field production and failure to stake the tomato plant tend to prevents tomato fruits from direct contact with soils, result in higher incidence of pests and diseases (Owino *et al.* 2025). Sibomana *et*

al. (2016) stated that the quality of produce at and after harvest is significantly influenced by pre-harvest treatments and conditions. One of such factors is fertilizer application. Nitrogenous fertilizers on crops tend to produce succulent stems and fruits while calcium deficiency suffer fruit end rot leading to loss in yield (Njume et al. 2020). The purpose for which the crop is grown determines the type of fertilizer to be used and the quantity. For instance, fruit colour and fruit acidity can be improved with the application of potassium fertilizer (Zewdie *et al.*, 2021). Research shows that, plant nutrition impacts the quality of the fruits produced. For example, insufficient supply of potassium in soilless tomato production can result in ripening disorders (Arah et al. 2015). Unlike potassium, an increase in nitrogen supply to greenhouse-grown tomatoes, beyond a certain threshold level, may reduce fruit quality by decreasing the sugar content of the fruits. However, the variation of phosphorus supply in soils for growing tomato crops does not significantly influence quality traits such as the total soluble solids, pH, acidity of the tomato juice, or the fruit colour characteristics (Arah et al. 2015).

Another preharvest factor which affects the quality of the postharvest tomato fruits is the process of pruning. Flowers and fruits usually compete for nutrients and reducing the number of flowers and fruits has been proven to be an effective way of reducing nutrition competition between fruits. Pruning has been seen to improve the fruit size in most cultivar as pruning ensures nutrients are channelled to fewer fruits sinks leading to increased fruit sizes (Arah et al. 2015).

Maturity is another interesting pre-harvest factor. Being a climacteric fruit, tomatoes can be harvested at different maturity stages (green maturity, pick maturity and red maturity stages) and are generally very prone to rapid quality loss post-harvest (Arah et al., 2015; Sibomana, Workneh and Audain, 2016). Different macro and micronutrients are heightened during the different maturity stages of tomatoes. For instance, maximum acidity is recorded at the pink stage of tomato maturity, sugar content increases during maturation from green to red ripen, the total soluble solids increased from green to red ripen stage (Khandaker et al. 2009). Recognizing that improper harvesting time (maturity), ripening conditions and lack of suitable storage facilities cause a glut during the peak harvesting period, suitable harvesting stage of fruit (maturity) and optimum ripening conditions to have the best quality and longer storage of tomato has not completely been recognized for developing countries (Khandaker et al. 2009).

Cultivar type is yet another factor that affects FLW in the tomato value chain. Certain characteristics make some cultivars more desirable to producers and consumers giving them a more marketable value. Selecting the right cultivar is usually the first choice to make for a farmer, the cultivar with desired fruit quality, pest resistance and longer shelf life is the one to select. Failure to select an

appropriate cultivar may lead to lower yield, low quality fruits, or less market acceptability (Arah et al. 2015).

Irrigation is another factor affecting FLW in the tomato value chain. Tomato production in Africa is rarely done without some form of irrigation, due to the constant water supply required by the vegetable (Dube et al. 2020). Tomato is not a drought resistant crop and therefore yields decrease considerably after short periods of water deficiency during production. Proper irrigation scheduling in tomato production is therefore crucial for the crop development. However, with water being a scarce resource in most production areas, growers in recent years have therefore had to develop a more efficient water management scheme that maintains crop yield but has a moderate and controlled level of moisture stress on their crops. (Arah et al. 2015; Zewdie et al. 2021). Irrigation water quality has been reported to influence the microbial load in harvested produce with microbial agents of deterioration with both pre- and post-harvest origins seen to play roles in postharvest quality and losses (Sibomana et al. 2016).

2.3.2 Harvest causes

The most important factors to be considered being the maturity of the fruit, the time of harvesting and the method of harvesting (Shezi 2016). The postharvest process begins at harvest at which point the producer makes the decision on when it is ideal to harvest and retain the features being demanded by the customers (Khan et al. 2024). Harvesting under ideal physiological conditions is crucial for obtaining high-quality characteristics such as aroma, firmness, colour, flavour, and extended shelf life. Owino et al. (2025) noticed that farmers sometimes delay harvesting citing lack of storage facilities and socio-cultural concerns as a challenge. However, delayed harvesting produces over ripe tomatoes at the farm.

2.3.3 Post-harvest & handling causes

More often than not, farmers overlook the little processes when handling fruits and vegetables which could have dire consequences later in the chain. For instance Owino *et al.*, (2025) found that farmers often neglect washing after harvest which removes dirt and reduce the incidence of diseases. They also identified sorting as a relevant post-harvest step though farmers did not do sorting at the maturity stage. Information exchange between farmers and brokers are sometimes deterring and tend to delay tomato transportation leaving tomatoes to be kept in ambient temperatures which further accelerates deterioration (Hussein et al. 2020).

2.3.4 Processing & packaging causes

Some common packaging materials used in developing countries are cardboard crates, cardboard boxes, plastic buckets, nylon sacks, clay pots, jute sacks, and polythene bags. Most of these packaging materials do not allow adequate aeration within the packaged tomato fruits, which increases fruit deterioration. In Cameroon, tomato is packed, stored and transported to the market in raffia baskets and covered with grass as shown in figure 4 below. These raffia baskets are often overfilled with tomato fruits, which exerts more weight on the fruits at the bottom of the basket. Over-loading also causes mechanical injury during transportation as a result of excessive compression (Njume et al. 2020).



Figure 4 Illustration of Traditional raffia baskets filled with tomatoes and padded with dry grass at a Cameroonian market (Atim Mbah, 2026).

2.3.5 Distribution and Retail Causes

The distribution and retail stage of the FSC includes the activities of transporting food from one place to another usually in the appropriate conveyance conditions to avoid food waste. This stage also includes market activities that allow customers to access food such as retail or wholesale (Ishangulyyev et al. 2019).

Transport infrastructure and logistics represent a significant driver of postharvest food loss in developing countries. Roads that are poorly maintained inflict physical damage on produce during transit, with fruits particularly susceptible to bruising and surface injury caused by uneven road surfaces and excessive vibration. Seasonal conditions further aggravate these challenges: during the rainy season, rural roads are frequently rendered impassable by flooding, blockages, or landslides, causing prolonged delays in delivery; conversely, the dry season introduces the risk of dust contamination, which compromises produce hygiene and marketability.

Extended transit times present an additional problem when journey durations exceed the natural ripening timeline of perishable commodities. Under such conditions, shelf life is effectively shortened before the produce even reaches the market, reducing its commercial viability and prompting buyers to reject portions of the delivered consignment. This dynamic is compounded by systemic factors including traffic congestion, vehicle breakdowns, adverse weather, and the limited financial and logistical capacity of smallholder farmers to access faster or more reliable transport options.

At the point of sale, informal market practices introduce yet another dimension of risk. In many traditional markets across the developing world, and as shown in figure 5, vendors (middlemen and retailers) spend long hours sitting under the sun with little or no shades to sell their products. Note that the fruits remain in the raffia baskets, with little or no air circulation and only removed for display or when they are being sold as shown in figure 5 below. These long hours of exposure to direct sunlight will impact the appearance of the fruits and have them routinely sprinkle water of questionable quality onto fresh fruits and vegetables to preserve their appearance — counteracting the wilting and shrivelling caused by prolonged exposure to heat and sunlight. While this practice is intended to slow visual deterioration, it frequently introduces microbial contamination, rendering the produce unsafe for consumption. Food treated in this manner is often rejected by buyers and ultimately disposed of as waste, negating whatever effort was made to bring it to market in the first place (Ishangulyyev et al. 2019).



Figure 5 Illustration of A retailer (buyam sellam) selling tomatoes alongside raffia baskets at a local market in Cameroon (Author, 2026).

2.3.6 Consumer-Level Causes

In 2020, the European Union published a Farm to Fork Strategy as part of the European Green Deal with its goal being to address the challenges of the sustainable food systems. This strategy emphasized the role of consumers in reducing food waste stating that no sustainable transition can be achieved without consumers making conscious informed decision on their food choices and habits (Fernqvist, 2021). Consumers desired features such as firmness, ripeness in a crop determine when farmers harvested these crops to maintain these attributes (Khan et al. 2024). However, as food travel along the FSC, different factors account for the damages which contribute to food loss and waste as shown in figure 6 below with the end of the chain(household) representing the largest fraction of food waste and loss (Schanes et al. 2018). Salume et al. (2026) reports that in high income countries, Food waste is because of distribution and consumption habits at the level of the household with a substantial amount of food waste (approximately 46%) occurring at the consumer level with 69% originating in household, retails and food services. They noticed that food waste is a result of consumer behaviour with the consumer's purchasing habits being the driving force behind household

food waste. Furthermore, studies reveal that per capita consumption resulted in the discard of between 95-115 kg of food annually in the developed world and only 6-11 kg in Asia and sub-Saharan Africa (Wani et al. 2024).

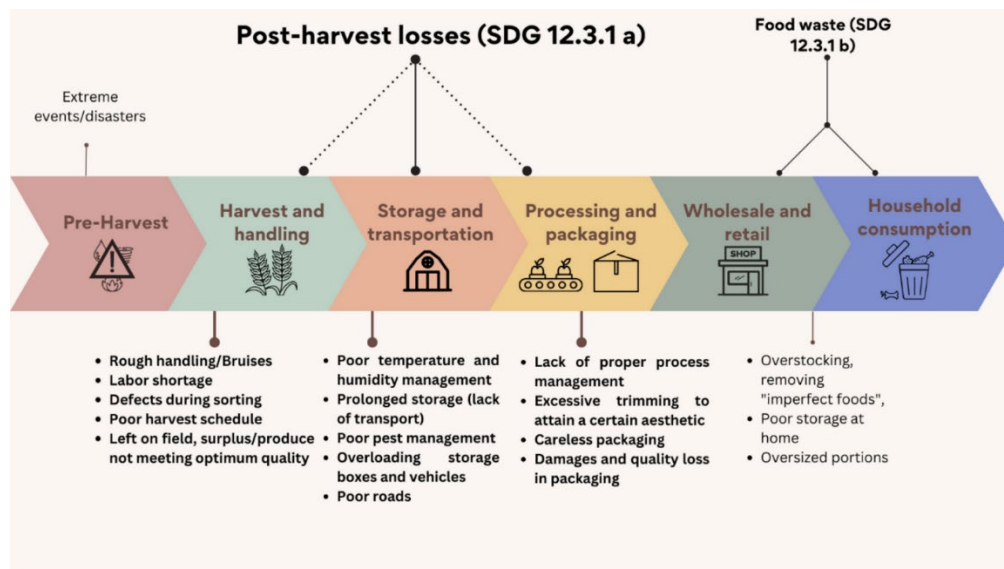


Figure 6 Illustration of the different causes of FLW along the FSC (Khan et al. 2024).

2.4 SOCIO-ECONOMIC IMPACTS OF TOMATO LOSS AND WASTE

Being the second most cultivated crop globally, one could say reducing FLW in the tomato value chain could have considerable potential in improving food security and alleviating poverty for all chain actors. Gustavsson et al. (2011) suggest that the reduction of avoidable FLW has a positive impact on the income of both consumer and producer. For example, in Ethiopia approximately 18% of postharvest losses occur at level of the market resulting in reduced economic value and farmers' income (Wakene & Sharew 2024). In 2014, FAO Stats reported that the South African tomato supply chain experienced a loss of produce estimated at 10.2% of the total production (loss estimated at USD 22.03 million) because of inadequate storage and transportation. It also reported fresh tomato losses of 13.4% (estimated at USD 180.9 million) and 10.1% (estimated at USD 19.99 million) in the Nigerian and Kenyan supply chains respectively (Sibomana et al. 2016).

2.5 Environmental Implications

Food Waste exacerbates environmental degradation as wasted food translates to waste of resources such as energy, water and soil invested in their production. Food that was intended for consumption and ended up being wasted results in unnecessary CO₂ emissions, contributing to environmental degradation. Wasted fruits and vegetables like tomatoes that end up in landfills emit methane, a potent greenhouse gas. Improper disposal of tomatoes leads to environmental degradation, emitting gases that negatively impact the climate. Globally, FLW are significant contributors to greenhouse gas emissions, exacerbating climate change and biodiversity loss (Wakene & Sharew 2024).

2.6 Conceptual framework

Food loss and waste in the tomato value chain in Cameroon occurs at multiple stages due to poor harvesting practices, inadequate storage, weak transportation systems, lack of processing facilities, market inefficiencies, and limited farmer knowledge. The conceptual framework illustrated in figure 7 below captures the 3 main objectives of this study and the corresponding research questions, tracing a logical progression, from identifying the problem to understanding the consequences and proposing feasible solutions.

The conceptual framework of food loss and waste explains how targeted interventions across the tomato value chain can reduce losses, improve efficiency, increase farmer income, enhance food security, and strengthen the agricultural economy. The framework assumes that improving farmer capacity, post-harvest infrastructure, storage systems, transportation efficiency, and market coordination will significantly reduce tomato losses throughout the value chain.

The integration of technology, processing, and institutional support strengthens value chain efficiency. As losses decrease, more tomatoes reach consumers in good condition, resulting in higher incomes for farmers and traders, improved food security, reduced environmental waste, and stronger economic performance in Cameroon's agricultural sector.

A.

STUDY AIM

Investigating causes and extent of FLW in the tomatoes value chain in Cameroon and propose evidence-based mitigation strategies

Objective 1 – Quantify FLW at each stage | RQ1: What quantity of waste occurs at each level?

Causes of FLW
-Physical: bruising, rot, moisture loss
Biological: pests, disease, mould
Managerial: poor handling, packaging
Infrastructural: roads, cold chain
Market: price volatility, information
Institutional: policy gaps, credit
Behavioural: actor knowledge, gender
Seasonal & geographic context.

1. Production/ Farm

2. Aggregation/Middlemen

3. Wholesale Market

4. Retail Market

5. Consumer/Household

FLW Measured
-% quantity lost per stage

Quality degradation
(rot, bruising, moisture loss)
Hotspot stage identified (highest loss node)

Data-driven evidence to justify intervention.

B.

Objective 2 – Assess Socio-Economic Impact | RQ 2: What is the impact on the livelihood of the chain actors?

Value chain
actors
Farmers /
producers
Middlemen /
aggregators
Wholesalers
Retailers
Consumers /
household

Burden analysis
Who bears most loss?
Income reduction
(FCFA)
Profit margin erosion
Market price effects
Gender-differentiated
loss burden
Vulnerability of actors

Socio-economic
outcomes
Reduced actor
incomes
Weakened livelihoods
Food insecurity for
low-income
consumers
Reduced tomato
supply & price
inflation
Household wellbeing

C.

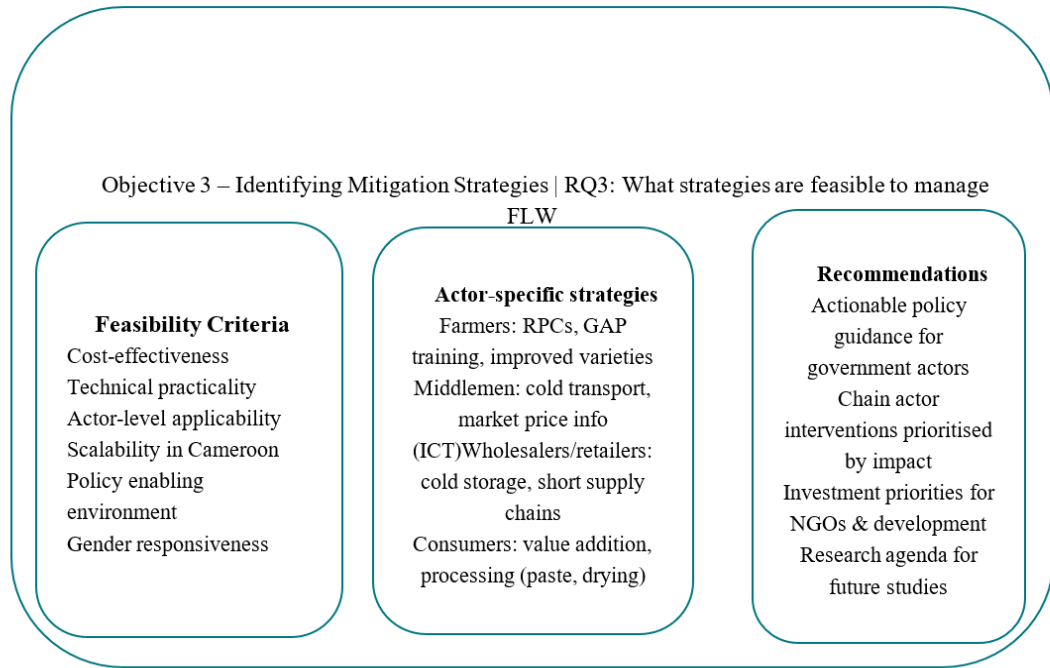


Figure 7. Visual Representation of the Conceptual Framework addressing the 3 main objectives of the study. Fig7.A) Illustration of causes of FLW & different stages at which it occurs in the tomato value chain. Fig 7.B Illustration of Chain Actors & Socio Economic Impact of FLW in the tomato value chain. Fig 7.C Illustration of Feasibility Criteria, Actor Specific Strategies & Recommendations. Adapted from Parfitt et al. (2010)— stage-based FLW definition | Gustavsson et al./FAO (2011) — commodity-region-stage model (Hodges et al. 2011)— value chain loss valuation (Chaboud & Moustier 2021)

3. METHODOLOGY

3.1 Study Area and Context

Cameroon is a country in Central Africa, stretching over an area of 475,000km² with a population of approximately 29.5 Million inhabitants as of 2013 with a density of 39.7 inhabitants per km². Known for its huge agricultural potential and often termed ‘Africa in miniature’, Cameroon is the bread basket for neighbouring countries like Equatorial Guinea, Chad and Gabon (Fambon et al. 2014). For decades, agriculture has been a very important sector that significantly contributes to national poverty reduction and sustainable development as it engages about 75% of Cameroon’s active population and accounts for 50% of total export and with smallholder farmers accounting for most of the food supply (Yerima et al. 2014). In Cameroon, the tomato food supply chain is a vital income source for its chain actors: producers, middlemen, wholesalers, retailers (buyam sellam) and consumers. Cameroon is the 5th largest producer of tomatoes in Africa with a production capacity of 889,800 tons and annual growth rate of 9.4% (Njume et al. 2020). Tomatoes are highly preferred by farmers for their commercial value. They are either sold on the farm or in the market. Demand influences the prices and contrary to popular knowledge, prices are not fixed in advance. For example, in the West region, during high demand seasons, a 20 liters basket is sold at XAF13,000 (€19.82). Generally, tomatoes prices range between XAF250/kg (€0.38) in high production seasons and XAF700/kg (€1.07) in low production seasons (Emile *et al.*, 2012).

FAO reports that in 2012, 150,000 ha of farmland was cultivated for tomatoes production in Cameroon with an average production of 11.3 tons/ha. Despite being the most consumed vegetable nationally, there is a national shortage of tomatoes owing to production constraints and postharvest losses (Njume et al. 2020).

3.2 Research Design

Qualitative analysis was used in this study to understand FLW in the tomato value chain in Cameroon. There are many different research methods but they all serve the same purpose; either in proving or disproving a thesis, answering questions, or expanding on a topic (Oun & Bach 2014). For this study, a qualitative methodology was adopted. Data was collected through interviews with chain actors identified from mapping out the tomato value chain. It was assumed these stakeholders were instrumental in understanding the causes of FLW in the tomato value chain and as well as in the adaption of any proposed mitigation strategies.

Data and information were also gathered by analysing credible documents such as journals, annual reports, websites, and print and online media. For the investigation of the FLW studies along the tomatoes FSC, the databases that were used during the search process were Scopus, Science Direct, Claude AI and Google Scholar. Keyword searches included “food loss and waste”, “food loss”, “food waste”, “postharvest loss”, “tomatoes value chain” and “food supply chain”. Doing a combination of words using AND/OR with the key words, the first search gave 7445 documents. Filtering using year (2006-2025), subject area (agriculture, social science and bioscience) and English being the preferred language, the number of documents was brought down to 20. After extracting and review of the documents 16 documents was chosen. The Google search engine was used to find relevant documents from institutions. Some other documents were obtained by examining reference lists and citations of key articles. The number of articles initially obtained through the database search using the word “food loss” was 127118. “Food loss AND waste” gave a total of 7418 articles. In the end, a total of 41 articles were included in this systematic review.

3.3 Target population and sampling strategy

This study targeted chain actors in the tomato value chain; producers, middlemen, wholesalers, retailers and consumers (hotels and restaurants). I spoke to 3 to 5 persons of each chain actor group to get a picture of their practices and their understanding of FLW and how they were managing some of the challenges they experience.

3.4 Data collection methods

3.4.1 Structured questionnaires

Structured questionnaires were used to collect data from each chain actor: farmers, middlemen, wholesalers, retailers, consumers. 5 persons from each sector was interviewed. The persons were chosen according to their knowledge and experience with tomatoes and availability to respond to the questions. The full questionnaires are found in Appendix 1-4.

4.4.2 Data analysis techniques

The unit of analysis was individual value chain actors (farmers, middlemen, wholesalers, retailers, consumers). Thematic analysis was used to analyse the data where I talked to the various chain actors to understand causes of the food loss and waste reported by each actor. The thematic method of analysis also provided information how the different actors were managing the challenges they faced.

3.5 Ethical considerations

Before each interview, the actor was informed about the purpose of the information gathered; that it was being collected to be used for the purpose of the study only.

4. RESULTS & DISCUSSION

This chapter will talk about what I could find talking to the chain actors following the 3 research questions;

Q1: What quantity of waste occurs at the different level of tomatoes value change?

Q2: What is the impact of tomatoes loss and waste on the livelihood of the different chain actors?

Q3: What mitigation strategies are feasible to manage loss and waste in the tomatoes value chain?

FLW has social, environmental and economic implications and reducing it will greatly impact the chain actors and the environment. Achieving this will require understanding the quantity that is wasted at the different levels of the FSC, the impact of FLW on the livelihood of the chain actors and propose mitigation strategies based on existing knowledge and feasibility given the resources available.

Tomatoes being the 2nd most consumed vegetable globally (after potatoes) and most consumed vegetable in Cameroon was the product of interest in this study. Being the most consumed vegetable, it presents a lucrative income opportunity for chain actors from farm to fork and presents an opportunity to reduce poverty and improve food security. It is therefore imperative that we understand FLW in the tomatoes value chain in a bid to come up with mitigation strategies.

4.1 Farmers

Previous literature suggest that a number of pre-harvest activities impact the fruits quality and its shelf life. Talking to farmers in this study proved this to be true as farmers mentioned activities such as cultivar selection, pest and disease control, irrigation, pruning and time of harvest to play a major role in the life cycle of the tomatoes fruit. Just as literature suggest, the research reported the largest amount of waste being recorded at the level of the farm with diseases being the major cause of this loss. For example, for a harvest of 150 baskets in a season, a farmer lost approximately 20 baskets to disease.

Njume et al. (2020) reported that in Cameroon, the government offered little support to the farmers. This research further confirms this and with little or no support from the government on new, improved and adaptable farm practices, farmers are forced to rely on each other's knowledge on managing challenges at the farm.

Numerous literatures reviewed for this study show that tomato cultivation is rarely done without some form of irrigation owing to the constant need of water by the crop. The replies gotten from the questionnaires showed that farmers cited water availability as another major factor which affected yield. The farmers identified for the study expressed that because they cannot afford the cost of setting up irrigation systems, they tend to have their farms next to a stream and also rely on rainfall. For the farmers, irrigation is usually done in the morning hours and harvesting is done approximately 6 times per season, at different levels of ripeness. The farmers prefer selling at farm gate to avoid bearing the cost of damage during transportation to the market. The farmers considered in this study all had basic knowledge on how to improve yield by pruning but lack additional knowledge on new and improved farm practices. They also indicated that they relied on their network for information sharing especially in managing challenges at the level of the farm; there was no recorded support from the government. With no structured arrangement for information sharing, farmers depend on middlemen for market information. The farmers seldom visit the markets so there is a trust-based relationship between farmers and middlemen.

From an economic point, the farmers made over 100% profit from sales (farmers invested about XAF200,000 - 350,000 (USD 349- 611) and sold at XAF 800,000 (USD1388) making a profit of XAF 450,000 -128.57%) when the market is good. However, the farmers pointed out that when there is abundance in the market, they sell at a loss (selling a basket at XAF2000) and do not end up recovering the cost they invested in the farms.

At the level of transportation, sometimes bad roads cause damages in trucks, obstructing estimated time for the trucks to reach the market. Sometimes the trucks will be on the road for multiple days. This will cause damages to the tomatoes, and this loss is borne by the farmer.

4.2 Middlemen

Another interesting piece of information gathered from this study showed that for most farmers in Cameroon, from the moment harvest begins farmers begin sending out 300 to 350 baskets of tomatoes 3 times a week till the harvest is over; this usually last for about 3 months. Middlemen could decide to buy from the farm gates in which case he bears the cost of all the waste which occurs during transportation from the farm to the market. For those who decide to wait for the produce in the markets in the urban cities, the farmers make the necessary arrangements for the produce to reach the market. Once the tomatoes get into the market, the market decides the price each basket should be sold out. Prices usually range from XAF 2500- XAF11000. Once the middleman finish selling, he deducts

all the cost that was incurred while moving the goods from the farm to the market and offloading and gives a report to the farmer. This relationship is based on trust with no formal contract. In this case, all the waste that happens while moving the tomatoes from the farm to the market is borne by the farmer. Wholesaler and retailers prefer tomatoes from the West Region because it is low in water content hence longer shelf life. For example, tomatoes from the Dchang can last for over a week hence ideal for the international market. That from Mbouda, Bafoussam and Bamenda have a shelf life of 3-4 days and usually reserved for the local market. The ones from the Southwest region are consumers less preferred tomatoes because of its high-water content.

When inquired if they provide any support to the farmers, middlemen were found to sometimes prefinance farmers and deduct the money when farmers send their tomatoes to be sold; they could deduct all at once or in different instalments, depending on their agreement with the farmers.

4.3 Wholesalers

This study showed that wholesalers, sometimes called “buyam sellam,” have the capacity to buy from the middlemen and sell to the retailers. They do not retail and only sell in baskets. Waste at this level is incurred by them reason why they are often very careful when buying from the middlemen.

4.4 Retailers

The retailers are people who sell in smaller quantities to consumers. They could sell in baskets or retail in hips of XAF500, 1000 or 2000 as seen in figure 8 below. They must attempt to sell the tomatoes within its given shelf life because any waste at this level is their loss. They too are usually extra careful when buying from wholesalers to avoid carry the burden of damaged or spoiled tomatoes.



Figure 8 Illustration of fresh tomato on retails displayed on jute sacking at a Cameroonian market (Photo: Atim Mbah, 2026).

4.5 Consumers

Consumers bought tomatoes as needed hence recording very little waste. Sometimes due to price fluctuations, they buy in large quantities when it is cheap and freeze; they could freeze whole or blended. Hotels and restaurants preferred tomatoes from the West region because it has little water content and hence a longer shelf life whereas consumers at the household level did not care where the tomatoes came from. Consumers in a way have mastered the art of no waste at their level.

5. RECOMMENDATIONS

Given that packaging plays a vital role in preserving fruit quality by reducing mechanical damage, it is recommended that tomato handlers in Cameroon move away from the traditional use of raffia baskets as shown in figure 9, which offer limited protection during transport and marketing. Clean plastic crates fitted with liners should instead be adopted, as Sibomana et al. (2016) found that liners prevent the damage caused by rough internal surfaces. Where such crates are unavailable, perforated plastic crates fitted with inner shock absorbers and only moderately packed with fruit, as proposed by Njume et al. (2020), would similarly help reduce postharvest losses during packaging and transportation.

Strengthening preharvest management is equally important, since Shezi (2016) shows that well-managed preharvest practices produce healthier fruit with balanced antioxidant, sugar, mineral, and water content, thereby extending shelf life. Building on this, the early-morning and post-harvest watering already practiced by Cameroonian farmers should be refined: rather than irrigating daily, farmers are encouraged to adopt the schedule recommended by Arah et al. (2015), who found that early-morning irrigation every three days resulted in higher yields than daily irrigation.



Figure 9 Overfilled raffia baskets of tomatoes at a Cameroonian market — a packaging practice that contributes to mechanical damage and post-harvest losses (Atim Mbah, 2026)

At the retail level, small retailers should consider forming unions or cooperatives through which to purchase from wholesalers in bulk. Beyond the cost advantages of bulk buying, such unions would give retailers a collective voice to raise concerns when challenges arise.

Finally, given that farmers report receiving little to no support from the government, it is recommended that government institutions design and implement targeted programs that extend the necessary technical support, resources, and interventions to farmers across the value chain.

6. CONCLUSION

The aim of this study is to understand areas where food loss and waste occur along the tomatoes value chain and to propose various mitigation recommendations.

Research Questions

Q1: What quantity of waste occurs at the different level of tomatoes value change?

Q2: What is the impact of tomatoes loss and waste on the livelihood of the different chain actors?

Q3: What mitigation strategies are feasible to manage loss and waste in the tomatoes value chain?

This study demonstrated that FLW occurs at all stages of the tomato value chain and that tomatoes have the potential to improve the livelihood of its chain actors and improve food security in Cameroon. However, pre- and post-harvest loss and waste pose major challenges which require improvements to mitigate the loss and waste.

Pre-harvest practices such as cultivar type, pruning, irrigation and fertilizer use are vital in tomatoes yield and should be looked into more seriously. Postharvest activities such as harvesting, packaging, transportation to markets also contribute to loss and waste through crushing in the cause of transportations and delays as a result of poor road infrastructure. These affect the quality and the quantity which reaches the market.

Being the 2nd most consumed vegetable globally and most grown vegetable in Cameroon, managing FLW in the tomatoes value chain presents an opportunity to contribute to chain actors livelihood and manage FLW for social, environmental and economic gain.

This study suggests that FLW interventions preharvest and postharvest management practices in the tomatoes value chain should be multi-level and context-sensitive, integrating economic insights.

In conclusion, it is worth noting that “Tomatoes” was used in my literature search instead of tomato which I believed might have impacted the results I got in a way.

References

- Ambuko, J.L., Masakhwe, S.M., Amwoka, E., Mujuka, E. & Fabi, C. (2025a). Food loss and waste data gaps in fruit and vegetable value chains: a review of the literature. *Frontiers in Horticulture*, 4. <https://doi.org/10.3389/fhort.2025.1529040>
- Ambuko, J.L.L., Tokala, V.Y., Essilfie, G.L.L. & McGuire, E. (2025b). Editorial: Sustainable approaches to food loss and waste reduction in smallholder horticulture: from proof of concept to scale. *Frontiers in Horticulture*, 4. <https://doi.org/10.3389/fhort.2025.1702011>
- Aragie, E., Balié, J. & MoralesOpazo, C. (2018). Does reducing food losses and wastes in sub-Saharan Africa make economic sense? *Waste Management & Research*, 36 (6), 483–494. <https://doi.org/10.1177/0734242X18770247>
- Arah, I.K., Amaglo, H., Kumah, E.K. & Ofori, H. (2015). Preharvest and Postharvest Factors Affecting the Quality and Shelf Life of Harvested Tomatoes: A Mini Review. *International Journal of Agronomy*, 2015 (1), 478041. <https://doi.org/10.1155/2015/478041>
- Cederberg, C. & Sonesson, U. (2011). *Global food losses and food waste: extent, causes and prevention; study conducted for the International Congress Save Food! at Interpack 2011, [16 - 17 May], Düsseldorf, Germany*. Gustavsson, J. (ed.) (Gustavsson, J., ed.). Food and Agriculture Organization of the United Nations.
- Chaboud, G. & Moustier, P. (2021). The role of diverse distribution channels in reducing food loss and waste: The case of the Cali tomato supply chain in Colombia. *Food Policy*, 98, 101881. <https://doi.org/10.1016/j.foodpol.2020.101881>
- Delgado, L., Schuster, M. & Torero, M. (2014). The Reality of Food Losses A New Measurement Methodology.
- Dube, J., Ddamulira, G. & Maphosa, M. (n.d.). TOMATO BREEDING IN SUB-SAHARAN AFRICA - CHALLENGES AND OPPORTUNITIES: A REVIEW.
- Emile, T., Honorine, N.T., Thomas, N. & Marie-Anne, S. (n.d.). Vegetable Production Systems of Swamp Zone in Urban Environment in West Cameroon: Case of Dschang City.
- Fambon, S., McKay, A., Timnou, J.-P., Kouakep, O.S., Dzossa, A., Tchakoute, R., & UNU-WIDER (2014). *Growth, poverty, and inequality: The case study of Cameroon*. 154. ed UNU-WIDER. <https://doi.org/10.35188/UNU-WIDER/2014/875-9>
- FAO (ed.) (2019). *Moving forward on food loss and waste reduction*. Food and Agriculture Organization of the United Nations. (The state of food and agriculture; 2019)
- Fernqvist, F. (2021). – A consumer perspective .
- Garcia-Garcia, G., Woolley, E., Rahimifard, S., Colwill, J., White, R. & Needham, L. (2017). A Methodology for Sustainable Management of Food Waste. *Waste and Biomass Valorization*, 8 (6), 2209–2227. <https://doi.org/10.1007/s12649-016-9720-0>
- Gustavsson, J., Cederberg, C. & Sonesson, U. (n.d.). Global food losses and food waste.
- Hodges, R.J., Buzby, J.C. & Bennett, B. (2011). Postharvest losses and waste in developed and less developed countries: opportunities to improve resource use. *The Journal of Agricultural Science*, 149 (S1), 37–45. <https://doi.org/10.1017/S0021859610000936>

- Hussein, Z., Fawole, O.A. & Opara, U.L. (2020). Harvest and Postharvest Factors Affecting Bruise Damage of Fresh Fruits. *Horticultural Plant Journal*, 6 (1), 1–13. <https://doi.org/10.1016/j.hpj.2019.07.006>
- Ishangulyyev, R., Kim, S. & Lee, S.H. (2019). Understanding Food Loss and Waste—Why Are We Losing and Wasting Food? *Foods*, 8 (8). <https://doi.org/10.3390/foods8080297>
- Kayikci, Y., Demir, S., Mangla, S.K., Subramanian, N. & Koc, B. (2022). Data-driven optimal dynamic pricing strategy for reducing perishable food waste at retailers. *JOURNAL OF CLEANER PRODUCTION*, 344. <https://doi.org/10.1016/j.jclepro.2022.131068>
- Khan, A.A., Siddiqui, Y., Siddique, K.H.M., Bobo, J.A. & Ali, A. (2024). Minimizing postharvest food losses: a vital strategy to alleviate food insecurity and malnutrition in developing nations: a review. *Discover Food*, 4 (1), 145. <https://doi.org/10.1007/s44187-024-00129-0>
- Khandaker, M., Hossain, A.B.M.S., Sani, W., Saifuddin, M. & Alenazi, M. (2009). Effect of harvesting and storage conditions on the post harvest quality of tomato (*Lycopersicon esculentum* Mill) cv. Roma VF. *Australian Journal of Crop Science Southern Cross Journals*©2009, 3, 113–121
- Magalhaes, V.S.M., Ferreira, L.M.D.F. & Silva, C. (2021). Causes and mitigation strategies of food loss and waste: A systematic literature review and framework development. *SUSTAINABLE PRODUCTION AND CONSUMPTION*, 28, 1580–1599. <https://doi.org/10.1016/j.spc.2021.08.004>
- Mattsson, L., Williams, H. & Berghel, J. (2018). Waste of fresh fruit and vegetables at retailers in Sweden - Measuring and calculation of mass, economic cost and climate impact. *RESOURCES CONSERVATION AND RECYCLING*, 130, 118–126. <https://doi.org/10.1016/j.resconrec.2017.10.037>
- McGuire, S. (2013). WHO, World Food Programme, and International Fund for Agricultural Development. 2012. The State of Food Insecurity in the World 2012. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. Rome, FAO. *Advances in Nutrition*, 4 (1), 126–127. <https://doi.org/10.3945/an.112.003343>
- Nahman, A. & de Lange, W. (2013). Costs of food waste along the value chain: Evidence from South Africa. *Waste Management*, 33 (11), 2493–2500. <https://doi.org/10.1016/j.wasman.2013.07.012>
- Nicastro, R. & Carillo, P. (2021). Food Loss and Waste Prevention Strategies from Farm to Fork. *Sustainability*, 13 (10). <https://doi.org/10.3390/su13105443>
- Njume, C.A., Ngosong, C., Krah, C.Y. & Mardjan, S. (2020). Tomato food value chain: managing postharvest losses in Cameroon. *IOP Conference Series: Earth and Environmental Science*, 542 (1), 012021. <https://doi.org/10.1088/1755-1315/542/1/012021>
- Oun, M.A. & Bach, C. (2014). Qualitative Research Method Summary. 1 (5)
- Owino, W., Kahenya, P., Wafula, E. & Otieno, G. (2025). Food Loss and Waste Reduction in Specific Fruit and Vegetable Value Chains in Eastern Africa. *Foods*, 14 (22). <https://doi.org/10.3390/foods14223938>
- Parfitt, J., Barthel, M. & Macnaughton, S. (2010). Food waste within food supply chains: quantification and potential for change to 2050. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365 (1554), 3065–3081. <https://doi.org/10.1098/rstb.2010.0126>
- Plaisier, C., Sibomana, M., Waal, J.V. der, Clercx, L., Wagenberg, C.P.A.V. & Dijkshoorn, Y. (2019). Approach for Designing Context-Specific, Locally Owned Interventions to Reduce Postharvest Losses: Case Study on

- Tomato Value Chains in Nigeria. *Sustainability*, 11 (1).
<https://doi.org/10.3390/su11010247>
- Porat, R., Lichter, A., Terry, L.A., Harker, R. & Buzby, J. (2018). Postharvest losses of fruit and vegetables during retail and in consumers' homes: Quantifications, causes, and means of prevention. *POSTHARVEST BIOLOGY AND TECHNOLOGY*, 139, 135–149.
<https://doi.org/10.1016/j.postharvbio.2017.11.019>
- Salume, P.K., Barbosa, M.W. & Pinto, M. de R. (2026). Food Waste and Consumer Behavior: A Bibliometric and Review Study and Future Research Directions. *Foods*, 15 (2), 380.
<https://doi.org/10.3390/foods15020380>
- Sawaya, W.N. (2017). Impact of Food Losses and Waste on Food Security. In: Murad, S., Baydoun, E., Daghir, N., & Badran, A. (eds) *Water, Energy & Food Sustainability in the Middle East: The Sustainability Triangle*. Springer International Publishing. 361–388. https://doi.org/10.1007/978-3-319-48920-9_16
- Schanes, K., Dobernig, K. & Gözet, B. (2018). Food waste matters - A systematic review of household food waste practices and their policy implications. *Journal of Cleaner Production*, 182, 978–991.
<https://doi.org/10.1016/j.jclepro.2018.02.030>
- Scholz, K., Eriksson, M. & Strid, I. (2015). Carbon footprint of supermarket food waste. *RESOURCES CONSERVATION AND RECYCLING*, 94, 56–65.
<https://doi.org/10.1016/j.resconrec.2014.11.016>
- Shezi, S. (2016). EVALUATION OF THE EFFECTS OF SUPPLY CHAIN ROUTES AND PRE-STORAGE TREATMENTS ON THE POSTHARVEST QUALITY OF TOMATOES.
- Sibomana, M.S., Workneh, T.S. & Audain, K. (2016). A review of postharvest handling and losses in the fresh tomato supply chain: a focus on Sub-Saharan Africa. *Food Security*, 8 (2), 389–404.
<https://doi.org/10.1007/s12571-016-0562-1>
- Spang, E.S., Moreno, L.C., Pace, S.A., Achmon, Y., Donis-Gonzalez, I., Gosliner, W.A., Jablonski-Sheffield, M.P., Momin, M.A., Quested, T.E., Winans, K.S. & Tomich, T.P. (2019). Food Loss and Waste: Measurement, Drivers, and Solutions. *Annual Review of Environment and Resources*, 44 (Volume 44, 2019), 117–156. <https://doi.org/10.1146/annurev-environ-101718-033228>
- Stathers, T., Holcroft, D., Engelbert, M., Ravat, Z. & Marion, P. (2025). The evidence on crop postharvest loss reduction interventions for sub-Saharan African and South Asian food systems: a systematic scoping review update 2024. *Journal of Stored Products Research*, 114, 102727.
<https://doi.org/10.1016/j.jspr.2025.102727>
- Wakene, D.M. & Sharew, T. (2024). A Comprehensive Review of Tomato Post-Harvest Losses: Understanding Impacts and Contributing Factors in Ethiopia. *Asian Science Bulletin*, 2 (4), 525–535.
<https://doi.org/10.3923/asb.2024.525.535>
- Wani, N.R., Rather, R.A., Farooq, A., Padder, S.A., Baba, T.R., Sharma, S., Mubarak, N.M., Khan, A.H., Singh, P. & Ara, S. (2024). New insights in food security and environmental sustainability through waste food management. *Environmental Science and Pollution Research*, 31 (12), 17835–17857. <https://doi.org/10.1007/s11356-023-26462-y>
- Yerima, B., Asongwe, G.A., Yerima, B.P. & Tening, A. (2014). Vegetable production and the livelihood of farmers in Bamenda municipality, Cameroon. *Int. J. Curr. Microbiol. Appl. Sc.*, 3(12): 682-700

Zewdie, T., Desaiegn, A., Olijira, G., Amare, H., Fetene, K. & Gebrie, L. (2021).
Review on effects of pre and post-harvest factors affecting the quality and
shelf life of tomato (*Lycopersicon esculentum* Mill.).

Popular Science Summary

For months, smallholder farmers and chain actors invest in growing tomato and moving it till it reaches our plates only for a chunk of it to end up as food loss. This study sets out to understanding where, why & how much tomato is lost and wasted in Cameroon – what can be realistically done about it.

Tomato are the 2nd most cultivated vegetables globally and the most cultivated in Cameroon. Cameroon is the 5th largest producers in SSA; 1.3 Million tons. Tomato are a major source of income for its chain actors. To understand the full picture, this study followed tomato throughout the ‘value chain’ - farmers, middlemen, wholesalers, retailers, consumers.

Tomato are too valuable — nutritionally, economically, and culturally — to be lost at the rate they currently are in Cameroon. This study shows clearly that the biggest losses happen closest to the farm, and that relatively simple, affordable interventions targeted at farmers, middlemen, and market infrastructure can go a long way toward reducing waste.

Appendix 1

DATA COLLECTION SHEET FOR FARMERS

Reference number:

Farmer's name:

Farmer's age range:

Farmer's gender: male

Farm size: half an hectare

Household size:

Annual sales

Investment per season:

Variety cultivated:

Reason for cultivating selected variety: s

Reasons for cultivation and quantity

- ☐ for export:
- ☐ for local consumption-
- ☐ both

Who do you sell to? all

- ☐ middle men,
- ☐ retailers,
- ☐ consumers,

What determines who you sell to? no

Do you belong to any farmers group/association?

Expected yield from above farm size at the time of planting

Quantity harvested at the end of season

Quantity loss/wasted

Is wasted quantity edible or sellable

What quantity is edible not sellable?

At what point does the most waste occur:

At what point does the least waste occur:

How is harvest done?

Any particular time or day:

Number of workers at the farm

Number of hours of work/day/week

Age range of farmers

Number of men:

Number of women:

Are they full time or part time?

Any seasonal employees?

What is the reason for waste?

Any crop specific diseases?

Any climate related challenges?

Any strategy to manage the diseases?

Any biological factors impacting yield and productivity?

Do you sort?

Criteria for sorting. why? how? what parameters? color, size, firmness, ripeness.

Appendix 2

DATA COLLECTION SHEET FOR MIDDLEMEN

1. How do you get your tomatoes from farmers?
2. Do you have particular farmers you work with?
3. How do they reach out to you? Do you go towards them or do they come towards you?
4. Do you have a minimum/maximum number of baskets you take?
5. Do they fill the baskets in front of you or is it based on trust?
6. How often do you source from the farmers?
7. Where do you sell?
8. What determines what market you take your tomatoes to?
9. How long have you been a middleman?
10. Do you retail or only sell whole sale too?
11. Do you support the farmers in anyway?
12. Do the farmers or buyers have complaints they bring to you?
13. How do you transport to the main market?
14. Do you experience waste by the time you get to the market? What do you do with the waste?
15. What quantity of waste is usually recorded?
16. what are the possible causes of the waste?
17. Any recommendations on reducing waste from your perspective?

Appendix 3

DATA COLLECTION SHEET FOR RETAILERS

Reference number:

Retailer's name:

Retailer's age range:

Retailers's gender:

Purchasing power:

Household size:

Annual sales:

Investment per season:

A preferred variety when purchasing?

What determines what variety you purchase?

Do you sell locally or internationally

- What criteria do you use for buying for the different market
- What is the minimum quantity bought for each market
- Do you sort when buying?
- What are the criteria for sorting?
- Do you sort when selling?
- What are the criteria for sorting?

What amount goes to waste?

Is it edible but not sellable?

At what point does the most waste occur

At what point does the least waste occur

Appendix 4

DATA COLLECTION SHEET FOR CONSUMERS

1. Where do you buy tomatoes?
2. Is there a reason for buying from this particular place?
3. How often do you buy?
4. What quantity do you buy for each purchase?
5. How do you measure?

6. What determines the quantity of each purchase?
7. Is there a preferred variety when buying?
8. Do you incur waste?
9. At what point?
10. What quantity is being wasted?

11. Reason for the waste

12. What do you do with the waste?

13. Do you measure the waste before discarding?

14. If yes, how?

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