



Master's degree thesis

LOG950 Logistics

**Food Supply Chains: A Case Study of Fresh Fruits and Vegetable
Logistics and its impact on Food Loss in Kumasi-Ghana.**

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Preface

This study represents the last stage of my Master of Science in Logistics at Molde University College – Specialized University in Logistics, the Norwegian School of Logistics. In the last three years as a student at Molde University, there have been ups and downs but I am most grateful for the life experience the University through its staff has impacted me. My sincere gratitude goes to my mother's Ms. Eno-Sarpong Matilda and Ms. Harriet Adu Boahen, my father Mr. Paul Okyere Sarpong and my uncle Mr. Sadiq Kwesi Boateng for their constant support and their ever-giving advice throughout my studies. I am exceptionally indebted to you all, may Our Heavenly Father reward you. To the many staff of Molde University College, I say thank you for all the assistance rendered me.

Summary

The primary objective of this study is to examine the fresh fruits and vegetable supply chain and identify the sources of food loss in the supply chain in the greater Kumasi area and its environs. A qualitative single case study was conducted using participants of 50 from the fruits and vegetables supply chain in Kumasi Ghana. Data collection was conducted by one-on-one interviews and personally observing 10 farmers, 10 middlemen/Distributors, 15 market women, and 15 petty traders involve in the onion, tomato, pepper, banana, mango and pineapple cultivation, trade and supply. With the initial sample size of between 80 to 100 participants, the researcher was forced to reduce sample size due to the COVID-19 pandemic.

Two forms of fresh fruits and vegetable supply chain (SC) were observed in this study, the first being a short supply chain due to farmers involved in the direct sale of their yields to the final consumer and the other been long supply chain and looking much more like the normal supply chain whereby the food items goes through multiple chain members. Losses were observed to be significantly high in the fresh fruits and vegetable supply due to the highly perishable nature, but the majority of these losses were attributed to the various supply chain activities at the post-harvest stages at the farm level. The findings indicate that postharvest activities like harvesting, sorting and grading, storage, packaging, transportation, and some poor infrastructures like bad roads, poor market center conditions, and lack of cooling chain are some of the major factors causing losses in the Fresh fruits and Vegetable (FFV) in the Kumasi area. Theft of the FFV's, pest and rodents are also some of the causes of the losses.

Finally, several recommendations are offered. It's highly recommended that some initiatives like improving packaging, improved market facilities, the introduction of a cooling chain when possible, training, and local investment can help mitigate food losses significantly.

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List of Abbreviations

SC	Supply Chain
FSC	Food Supply Chain
FFV	Fresh Fruit & Vegetable
GSS	Ghana Statistical Service
FAO	Food & Agriculture Organization
MoFA	Ministry of Food & Agriculture
MiDA	Millennium Development Authority
GEPA	Ghana Export Promotion Authority
APHLIS	African Postharvest Losses Information System
PHL	Post-Harvest Loss
GDP	Gross Domestic Product
SRID	Statistics, Research and Information Directorate.
VREL	Volta River Limited

CHAPTER 1

1.0 Introduction

1.1 Agriculture in Ghana

The Republic of Ghana exists in scope 4° 44' N and 11° 11' N and 3° 11' and 1° 11' E. Ghana is bordered by the Republic of Togo toward the east, Burkina Faso toward the north, and the Republic of Cote d'Ivoire toward the west. The Gulf of Guinea, a piece of the Atlantic Ocean lies south of the nation, which frames the 550km-long coastline. The nation has a large water body system with the Volta River bowl as the biggest, including the misleadingly Lake Volta. With a populace of about 29.77 million, Ghana has a for every annum development pace of 6.7%, and a mean population density of 121 people/km².

The population distribution is varied across the 16 administrative regions and what is more eco-zones of the nation, with 68% living in the urban and city areas, while 32% live in the rural areas. About 50% of the labor force in Ghana is directly or indirectly involve or engaged in agriculture, 30% makes up the services industry, and 20% in industry. About 40% of the horticultural work power is comprised of women. The agriculture sector contributes to 55% of the country's GDP and this accounts for over 40% of export earnings and at the same time providing about 90% of the nation's food needs. (FAO, 2020)

Ghana has around 136,000 km² of land covering about 60% of the nation's all-out land region of 238,539 km² classified as Farming Land Area or agricultural land, from which about 58,000 km² making up 24.4% is under cultivation and 11,000 hectares under irrigation. Because Ghana's agriculture is predominantly a smallholder type, about 60% of all farms within the nation are fewer than 1.2 hectares per the size, about 25% are between 1.2 to 2.0 hectares, and only about 15% above 2.0 hectares (FAO, 2020). With the mean homestead size under 1.6 hectares, smallholder and medium holder farms are approximately 10.0 hectares accounting for about 95% of the cultivated land.

Ghana's cultivating frameworks shift with agro-environmental zones, however, certain general highlights are obvious throughout the nation. The bush fallow system reigns wherever there is sufficient land to allow a plot to be rested enough to regain its nutrients, after about

three years of farming. Food crops like yams and cassava are often mixed while cash crops are usually monocrop. (FAO, 2020)

In the forest zones of the nation, three harvests are noteworthy with cocoa, oil palm, coffee, and rubber being of specific significance. The food crops in the region are for the most part between edited blends of maize, plantain, cocoyam, and cassava. The center belt is marked by blended or sole editing of maize, vegetables, cocoyam, or sweet potato, with tobacco and cotton being the significant money crop. Cotton and tobacco are likewise significant in the northern part, where the food crops are sorghum, maize, millet, cowpeas, groundnuts, and sweet potato. Rice is significant in all the zones.

The majority of the rural populace keeps some sort of live animals like goat, chickens, or sheep, but farming of livestock is in addition to crop farming. Poultry farming is mainly found in the south of the nation, while cattle farming is done in the savannah regions. Goat and sheep farming is spread out within the nation.

Table 1. Gross Domestic Product (GDP) at Current Market Prices. Agriculture (GH¢ Million)

		2013*	2014*	2015*	2016*	2017*	2018*	2019*
1.	AGRICULTURE	25,290	31,086	36,526	45,116	50,554	54,924	60,482
1.01	Crops	17,062	20,637	24,479	32,210	36,599	40,349	45,069
	<i>o.w. Cocoa</i>	1,980	3,254	3,646	3,834	4,186	4,342	4,417
1.02	Livestock	4,354	5,572	6,052	6,524	7,100	7,528	8,050
1.03	Forestry and Logging	2,048	2,892	3,455	3,542	4,055	4,239	4,329
1.04	Fishing	1,826	1,985	2,539	2,841	2,800	2,808	3,035

Source: Ghana Statistical Service, (2020).

1.2 Background to The Study

Throughout the existence of man, food supply systems are as old as the presence of man on earth. From the gathering of food for personal consumption as a household to the cultivation of food for income generations and sale. A food supply chain is referred to as a collection of food-related businesses, enterprises, or companies and individual farmers through which food produces move from production to the final consumer for consumption. (Osazuwa, 2015)

Food cultivation in Ghana is done on a sustenance scale, about 60% of the farming sector is made up of food farmers who grow mainly to feed themselves and their families. The remaining 40% are mainly income generation farmers who cultivate purposely for exports and

sale. The food supply chain links three main sectors in Ghana, the agricultural, food manufacturing, and the distribution and transport sectors.

Ghana has a vast land field that citizens use for agricultural purposes many of these farms with tomato, onion, pepper, okra, and eggplants. Vegetable plantations are the most common form of farming in the country. This is because they are highly tolerant to the climatic conditions and are sometimes grown as refined crops. These fruits and vegetables uncover a ready market not only in large urban areas but also in the growing communities and rural areas.

The vegetable and fruit industry in Ghana has some diverse components; Gardening on commercial bases are mostly found around major cities such as Accra, Kumasi, and Tamale; The type of farming in which fresh fruit and vegetables are cultivated in rural areas and from where they are purchased by contractors or middlemen, market women, traders and transported by road to the cities; and lastly, a small domestics or backyard gardening which are found in many households. (Sinnadurai, 1971)

Cash crop farming is another type of farming, farm commodities like Cocoa, Palm Tree, Cashew, Mango, Coconuts, and Pineapple plantations. Cocoa is the number one cash crop in Ghana, it is the backbone of Ghana's agricultural sector. It generates millions of dollars for the country every year. Ghana together with the Ivory Coast produces about 70% of the world's cocoa (Smooth, 2013).

1.3 Problem Statement

The food supply chain has assisted farmers, market women, and businesses with moving their items or products and services from farms and production plants to definite customers all the more adequately. Food supply chain affix activity mostly to meeting the ever-expanding buyer interest for modest food items, of high caliber and, manageable.

A food supply chain or supply framework deals with the procedures that clarify how food from various farms end up in our homes and on our food tables. The procedures incorporate creation or production, handling, and processing, transporting, circulation or distributing, ingesting, and removal or disposal.

The foods we eat gets to consumers by methods of viable food supply chain of which food travels deliberately in domino-like movement from producers to purchasers while the cash customers pay in exchange for the food goes to the individuals who work at different phases down the food supply chain the other way.

Every level within the supply chain involves the human factor and some normal assets. Since a food supply chain is linked to each chain member, when one piece of the chain is influenced, the entire chain is influenced, which on many occasions showed through changes in food prices, shortage of food, losses, and wastages of food.

Indeed, many food supply chains get influenced or disrupted. But when they do, members of the chain do not only lose money and distrust between those who depend on the chain, but the final consumer also feels the disruptions through food shortages and high prices as well as the precious cargo much often going waste and being lost due to these disruptions in the supply chain.

Global food losses have been studied widely in high-income countries, however, the factors contributing and causing food losses in low-income countries and sub-Saharan African in particular, has not been extensively looked at, especially in the fresh fruits and vegetable sector.

1.4 Research Objective

The study seeks to describe the fresh fruits and vegetable supply chain and find out the causes or reasons behind food losses in this supply chain using some selected farmers, petty traders, middlemen, and market women in and around Kumasi - Ghana who grows, buy, sells and supply onions, tomato, pepper, pineapple, bananas and mangos as a case study. The objective of the study is the fresh fruit and vegetable supply chain, and the subject of the study will be to find reasons for the losses of the food items.

1.4.1 Specific Research Objective

The specific research objectives which the study shall focus on are as follows:

- To examine the Fresh Fruit and Vegetables supply chain from the farm to the final consumer.
- To determine the sources of food loss in the FFV supply chain.
- To explain how these fresh fruits and vegetables get to consumers in and around Kumasi.

1.5 The Scope of Study

This study covers some selected farmers, petty traders, and market women in and around Kumasi who buy or sell Fresh Fruits and Vegetables as well as farmers, market women who directly or indirectly transport their harvest to the markets. The study also examines the chain's infrastructure and the ways it influenced the supply chain as well as if they contribute to the losses of these food items.

1.5.1 Conceptual Scope

The study examines the food supply chain framework and will focus on Fresh Fruit and Vegetables Supply chain i.e. (onions, pepper, tomatoes, mangoes, bananas, and pineapple) from farm to the final consumer, examining the chain linkages, actors, and their activities that contribute to food losses.

1.6 Significance of the Study

The study seeks to add to the knowledge already available on food loss caused by the supply chain, especially by providing literature from Ghana and the sub-region for future suggestions by other research studies and researchers. The findings of this thesis are expected to help farmers, market women, food producers, and sellers, and local authorities to navigate through supply chain best practices that ultimately will save food by reducing or limiting food losses as a result of the supply chain. It will further avail to the managers and actors of the supply chains, the various approaches to enhancing food supply chain efficiency and ways of reducing or eliminating food losses.

1.7 Methodology

In her book (Bell, 2018) asserts that research strategies can be categorized into two major types.

(1) Qualitative research: This is more concerned with descriptive details and explanation: and
(2) Quantitative research which adopts a quantification approach to data gathering and analysis. Qualitative or Subjective research is a request that examines a social or human issue. This process seeks to comprehend based on distinctive methodological behaviors. (Creswell, 1998)

A qualitative researcher fabricates a mind-boggling, all-encompassing picture, investigation words, reports subtleties of witnesses, and directs the examination in a characteristic setting. Subjective or Qualitative research depends on the perceptions and understandings of the impression of individuals concerning various occasions and it takes the preview of the individual's discernment in a characteristic setting. We can never accomplish a total logical comprehension of the human world. All the better we can do is to show up at a reality that has any kind of effect that opens up additional opportunities for comprehension. (McLeod, 2011)

As indicated by (McCaig, 2010) the decision of deductive or inductive research approach does not characterize the utilization of quantitative or subjective research strategy. In any case, Strauss and Corbin (1990) recommended that the inductive research approach is very well known with the Qualitative or Subjective strategy for information examination. This study is a qualitative

An in-depth one-on-one unstructured interview will be conducted with about 80 parties in fresh fruits and vegetable production, trade, and transport. This will be an informal method and will hence invite opportunities to get details in-depth form of the respondents. One-on-one interviews with each farmer, petty trader, market women, and middlemen will provide a huge opening to collect accurate data about their activities, what they believe, and what their incentives are.

Again, this study will adopt the process of observation as a data-gathering method thereby giving the researcher a first-hand experience through the supply chain. An open-ended questionnaire developed by the researcher will be administered and personal observation of the respondent's activities will be adopted. Government agencies and ministries data sources will be used. This will give the researcher an important sight data collection where the researcher can observe respondents experiencing issues and problems within the food supply chain.

1.8 Thesis Organization

The study will be organized into five chapters. The first chapter will be the introductory chapter of the entire study. It will take a critical look at the general background of the study, the problem statement, the objectives of the study, the methodology, justification of the study as well as the scope of the investigation. The second chapter is dedicated to the review of the relevant literature and reports considering the objectives of the thesis. Chapter 3 will describe the study method and approach employed in the investigation while the fourth chapter will be dedicated to findings and discussions. Chapter five will conclude the investigation by stating recommendations to chain members and organizations based on the major findings made in the study.

CHAPTER II

2.0 Literature Review

2.1 Introduction

To contextualize the supply and accessibility of food within the urban locales, a knowledge of food structures as an entire is essential and necessary. This chapter talks about the relevant literature reviewed on agri-food systems, offering the heritage for this research by conceptualizing the global food supply chain and how its activities affect food loss in addition to food security.

2.2 A General Framework of Food Supply Chain.

Prior research on the supply chain in all and food/agriculture supply chains demonstrate the chain's unpredictability system of various multifaceted firms generally cooperating inside explicit mechanical divisions in various procedures and exercises to satisfy the clients' needs and fulfillment (Bryceson, 2008).

A food supply chain (FSC) in Ghana entails all the input supply, production, mediators, processors, retailers, national/worldwide markets together with the bio-geophysical and human surroundings that require activities, and the consequence of those activities. The tasks in this chain get strong administrative support from strategic, monetary, and specialized administrations which are essentially constrained by three streams in supply chain management; Information, money related and material streams to adequately act in an empowering domain. (E. Y. Nyamah, 2014)

This interconnectedness of world food supply chains is currently featured in agri-food contemplates, with specific enthusiasm for the most recent twenty years on food utilization over food production (Niles & Roff, 2008) (Lane, 2010) (Phillips, 2006). Lane (2010) uncovers that "both food supply chain and food security in the 21st century are crucially portrayed by huge development of handling and packaging of food items, corporate fixation in retailing and distribution, and the rising impact of enormous quantities of urban purchasers and consumers."

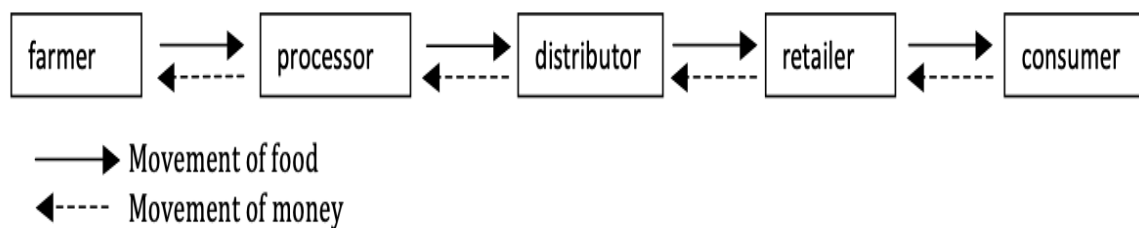
All in all, researchers have begun to ascertain agri-food studies as a social, political, and economic system encompassing numerous worldwide connections and actors (Lane, 2010). Viewing agriculture within a larger more complex agri-food supply chain system has enlivened scholars to connect isolates among production and utilization, just as think about the social, political, and ideological impacts that influence farming activity was the findings of (Niles & Roff, 2008) and at last, food availability, access, and consumption. This thought of several actors and characters around the agri-food supply chain sees agribusiness as being shaped in better places and scales. Further, it considers the impact of retailers and buyers on the manufacturing procedure as indispensable segments in the general chain (Niles & Roff, 2008) (Whatmore & Thorne, 1997). Phillips (2006) attests that "Food production and intake are always sides of the equal kind." For a careful comprehension of food supply chain frameworks, four essential classifications involved are highlighted: (Lane, 2010).

1. Food production includes all exercises associated with the production of uncooked foodstuff; ranges from acquiring inputs (land and work), obtaining domesticated animals, planting crops, collecting and harvesting, and so on. Atmospheric conditions, input costs, agrarian innovation, and government sponsorship all play an important and significant function in food production.
2. Handling and bundling allude to the progressions that uncooked food material experiences before it is sent to be retailed. This may incorporate the changing appearance of the foodstuff, expanding capacity life, dietary benefit, and general substance of the material.
3. Distributing and retailing incorporates all exercises including the development of food starting with one spot then onto the next, just as showcasing nourishments. Dissemination is impacted by transportation foundation and infrastructure, trade guidelines, government projects, and capacity necessities and capabilities. Retailing is affected by the association and area of the business sectors, publicizing and advertisement, specialty markets, and premiums.
4. Expending relates to everything from what food to choose through to planning, eating, and processing the food. Costs, salary levels, social conventions, inclination, social

qualities, education, and wellbeing status, just as globalization, publicizing, and the structure of the supply chain impact these choices and activities (Lane, 2010).

Researchers of the food supply chain, in particular, have turned their attention to the impact globalization has on food security. They assert that with the expansion of the food networks and the many distances food now travels, supply chain activities like processing of the food, handling, and packaging, dissemination, marketing, and selling of food items from cultivation to ending up on the tables of the consumer has become more complex and huger because of how rapid cities and urban areas are getting larger. Lane (2010) who attributed this change of going into the world markets and the capability to move food items over several distances has significantly changed food retailing in many developing nations. Likewise, Weatherspoon and Reardon (2003) in their study concluded that supermarkets are also rising in large numbers in developing cities, while another study by (Lane, 2010) asserts that, restaurants, chop bars, and fast food joints have been rapidly expanding as well. Lane (2010) asserted that this modification in retailing in the city and urban areas is the reason for the changing nature of what food farmers are cultivating and ways foodstuff and items are consumed.

Figure. 1. A simple food supply Chain.



Sources: (Osazuwa, 2015)

The figure above (fig 1.) illustrates a generic food supply chain in Ghana that normally entails all chain actors of all food items. The actors facilitate the movement of food and food items through the chain while money moves the opposite direction of the chain. Farmers are the producers of all agricultural food items in Ghana, they play a key role in feeding the entire country and beyond. Processors are the actors who breakdown food into various food items. They transform agriculture products into food or one form of food into other forms. They do this by either grinding grains to make raw flour or converting plantain into plantain chips.

Distributors are the actors that move food items to wherever they are needed. They are normally involved in the general distribution of food and food items across Ghana and are sometimes referred to as dealers or traders.

Retailers are the actors that sell the food items or goods to the ultimate consumers. They usually sell in small quantities as opposed to wholesalers. They are the storekeepers, exporters, and sellers. Consumers are the people that use a commodity or in our study, the food items. They are the buyers or purchasers, customers, and shoppers of food primarily for feeding themselves or their families.

2.2.1 Vegetable Supply Chain

Vegetables, an eccentric food item in the FSC system. For this study, the researcher must say at this stage of the study that, this thesis is not to look at food supply chains involving all food items or food supply chains as a single entity but to examine fresh fruit and vegetable supply chain systems from the farm fields to the gates of the final consumer. As significant as these fruits and vegetables are in human existence, quite a few studies have been done on food supply in the greater Kumasi area and its environs and it is very important for researchers to know and understand how these agri-foods get to the homes and tables of consumers in Kumasi and what Ghanaian farmers contribute to the fresh fruit and vegetable intake in the country. Farmer's market which is a form of farmers to consumers or much often farmers-to-market women-to-consumers direct marketing has helped vegetable consumers in the Kumasi metropolitan area acquire these vegetables fresh and in high quality and at the right price (Osazuwa, 2015).

Current ongoing events such as the turmoil of the world financial markets and COVID-19 pandemic, the connection between food production and its environmental footpaths, and the impact of the high cost of production on the security and affordability of food items may lead to an overwhelming transformation on food production systems (Osazuwa, 2015). Sudarshan Naidu (2008) in his paper believed that the development of the supply chain is not only beneficial to the private sector but its chain reaction stimulates social, economic, and ecological sustainability development for the sector and the region. i.e. employment added value and reduction in food losses. With gains in reduced food losses in transport and storage, sales increase, supply chain transparency, tracking and tracing the origin, proper control of food items, greater investment, and risk distributed among chain members, improvement in output, comes consumer satisfaction, and timely delivery.

Osazuwa (2015) argues that a good quality item cannot be produced and delivered without considering the effective food supply chain, particularly when it comes to fresh vegetables. The quality of fresh vegetables is greatly influenced by logistics (Smith, 2006). A significant piece of the vegetable supply chain is coordination. Vegetable supply chain logistics plans execute and control the productive progression of vegetables and warehousing services and applicable data from the different farms to the final destination to meet consumer needs. Vegetables are perishable foods and therefore cannot be stored for longer periods, this makes it very delicate and complex trading of these agricultural items and divulging big challenges to suppliers, processors, traders, and market women. Vegetables due to their nature demand dependable down to earth post-harvest management rehearse for better quality and last price. Post-reap activities encompass cooling, relieving, taking care of, storage, processing, packaging, transport, and the market stage. It likewise implies keeping up quality from production in the enclosure to the vegetables being put on a plate for consumption (Osazuwa, 2015).

Ensuring that vegetables are of value requires great framework and correspondence all through the supply chain as each progression is affected by the past; it is a chain of autonomous activities. In this manner, to adapt to these difficulties of conveying these vegetables new to the purchaser from the farms to the door or tables, a compelling coordination approach is required. This coordination is a piece of the food supply chain that manages the execution of the progression of food (Fresh vegetables and fruits) between the farm fields and the point of consumption to meet the prerequisite of consumers. Coordination or Logistics in this study alludes to the general administration of how these vegetables are gotten, put away or stored, and moved to areas in the greater Kumasi area where they are bought by purchasers.

Food chain logistics is a critical part of the food supply chain system in general. Effective logistical coordination and advances in technologies are basic achievement factors for both farmers and market women (Osazuwa, 2015). Successful logistical coordination requires conveying the correct item, in the correct amount, in the correct condition, to the right place, at the right time, for the correct expense (Aghazadeh, 2014) and it positively affects the accomplishment of the partners in the supply chain (Osazuwa, 2015).

2.2.2 Vegetables in focus

2.2.3 Onions

Allium cepa, the botanical name for onions are fundamental vegetables utilized broadly in Ghana and numerous parts of the world for enhancing flavor, seasoning of foods, drugs, and medication and for cooking. They are of a high in nutrients like vitamin C and a significant amount of fiber source. The food propensities for Ghanaians are such that, at least one bulb of onion is utilized in pretty much every food preparation. Ghanaian ranchers' normal yield of onion is about 17kg/ha (SRID/MoFA, 2012), this is low contrasted with that of onion producing nations in the sub-region (FAO, 2000). Ghana's onion utilization needs surpass its onion production thus around 5 million dollars is spent every year to import dry onions from neighboring nations like Burkina Faso (Ghanaweb, 2012).

Commercial onion farming is done mainly in the northern part of Ghana and some parts of southern Ghana in the basin of the Afram river in the eastern regions of Ghana. Because of the limitation of onion production being seasonal, importers buy them from farmers in our neighbors at the north (Burkina Faso), transport them via road into Ghana. (Akrofi, Kotey, Ahiatsi, & Stephen, 2016) Onions are packaged into wide- meshed rubber and jute sacks and packed into trucks before they make about 700km journey south to Kumasi areas and further south to the greater Accra areas.

2.2.4 Tomato

Tomato, *Solanum Lycopersicum* is among the most significant vegetables on the planet because of expanding commercial and dietary worth, broad production just as a model plant for research. It is used as a fresh crop or processed into different products such as tomato paste, puree, and squeezes or juices. It is plentiful in nutrient vitamins (A and C), minerals (iron, phosphorus) lycopene, Beta-carotene, a high measure of water, and low calories.

Tomato is generally grown in seven out of 16 regions in Ghana. Interest for both fresh tomato and tomato products is all-year-round even though tomato production is seasonal due to the distinction in precipitation patterns just as water accessibility (Leander, et al., 2019). Tomato production is mostly rain-fed except for the upper East Region and some part of the Greater Accra Region where they are produced during the dry season because of furrow irrigation systems. Because of this, tomato is generally in abundance during the rainy season, harvests are abundant and this much often leads to glut and wastage even though there is

scarcity during the dry season. After harvest, farmers, market women, petty traders, and middlemen buy package them into wooden crates and transport them via road to the urban areas where they are sold to purchasers and consumers.

2.2.5 Pepper

Pepper (*Capsicum annuum*) popularly known as chili pepper is a significantly high-value cash-generating vegetable in the country, its cultivation is mainly for its export sales and local consumption by both the metropolitan and rural areas. Farming and consumption of pepper have long been part of Ghana's agriculture and diet (MiDA, 2010). Sometimes called “green gold” by some farmers, it has made a good reputation for itself because of its economic value. In the European markets where it is export too much often, it is famous for its great taste and longer shelf-life. (Asravor, Jacob; Onumah, Edward E; Osei-Asare, Yaw B., 2016).

Chili pepper is arguably is the most popular horticulture crop grown by smallholder farmers in Ghana, this is because they are quite easy to cultivate, and tolerant to a wide range of climatic conditions (Saavedra et al., 2014), with around 31 million tons produced on approximately 1.9 million hectares of land. Mohammed et al., (2016) in their study assets that, smallholder farmers production in the country is very much profiting, this is because the request for pepper is rising strongly domestically and on the international markets too. This rise has offered a great opportunity for growers to expand pepper production in the country, thereby maximizing their profit margins and ultimately improve their economic situation.

After harvesting, Chili pepper is package into wooden baskets and transported using road networks into the various city and urban markets across the country. The produce heading for the international markets are further processed and packaged then shipped to mainly the European markets.













































































































































2.3 Fruit Supply Chain

Horticulture despite everything remains and rules the economy of Ghana, household farmers, smallholder farmers, ranchers, and gardeners constitute about 95% of the cultivating populace and produce 80% of the fresh fruits and vegetables yearly yield (Abatania et al., 2012). Fruit producers, for the most part, are found in the Volta, Central, Ashanti, Eastern and Western Regions of Ghana.

Marketing and selling channels are regularly short for urban and city producers and become increasingly unpredictable and exorbitant the more extended the separation of food supply areas from Accra and Kumasi, because of fruits been perishable. Ghana has progressively positioned accentuation on private sector food supply and distribution systems. Such dispersion framework has shown the capacity to adjust to changing urban food demands and to initiate, when appropriately working, changes in farming frameworks.

Two significant cultivation systems apparent in Ghana are the export-centered and household-centered production. Export-oriented farmers just sell overflow or un-exported fruits to the local market. Household centered farmers regularly sell at farm fields or by their spouses directly to consumers and purchasers or through petty traders such as wholesalers and fruit vendors to consumers. Figure 2. illustrates some fruits produced in Ghana and their seasonality.

Figure 2. Fruits in Ghana per Season.

<i>Fruits</i>	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul</i>	<i>Aug</i>	<i>Sep</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>
Banana												
Pineapple												
Papaya												
Avocado												
Orange												
African star fruit												
Water melon												
Pears												
Guava												
Mango												
Jack fruit												
Graviola												
Apple												
Atemoya												
Cashew												

Source: (Banson, Sun, & Banson, 2016).

Fruits like banana, pineapple, and papaya are all-season fruits while others like mangoes, oranges, and cashew are not.

The fruit supply chain cannot function properly without the transport sector. Transportation is a significant cost factor in the sale and marketing of fresh fruits devoured in the Kumasi and its environs. Arrangement of transportation infrastructure can initiate market improvement and simple openness to transportation consequently instigated versatility or supply of goods and services. Wholesalers and Market women control the majority of tasks along the more drawn out market channels. They typically have systems of fruit vendors who rely on them for their fruits supplies. Retailers and petty traders thus depend on wholesalers for fruit sales inside and between local markets (Banson, Sun, & Banson, 2016).

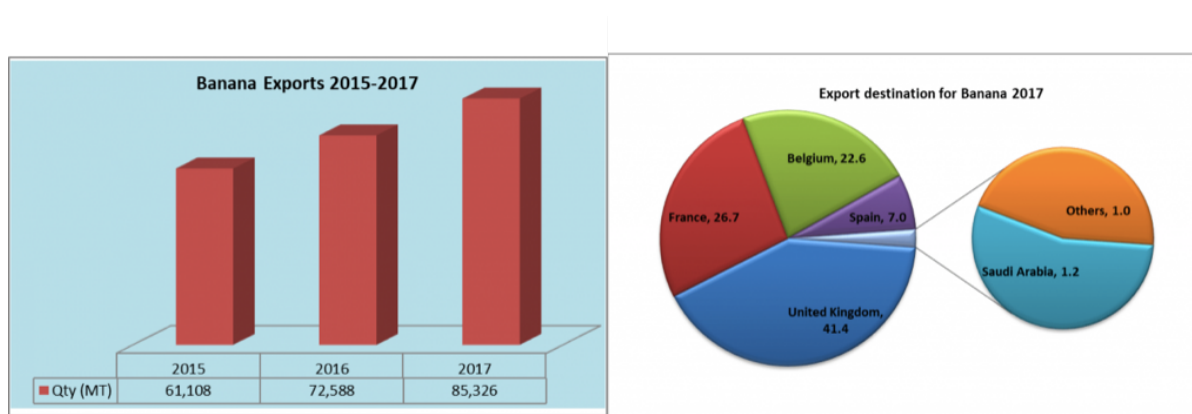
2.3.1 Fruits in Focus

2.3.2 Banana

Banana (*Musa sapientum*) as per (Kilimo, 2012) is a solitary most vital tropical fruit, with an overall yearly output of about 102 million metric tonnes. Ghana stays perhaps the most noteworthy producers of banana in Africa, this is because banana develops normally in the timberland and transitional zones of the Brong Ahafo, Western, Ashanti, Volta, and Central areas of Ghana. A couple of farmers likewise interplant it in plantain farms around these regions (Anyindana, 2016).

The Volta River Limited (VREL) is perhaps the biggest producer and exporter of banana in Ghana. The organization's homesteads are principally situated along the Volta Lake in the Asuogyaman District of the Eastern Region (FAO, Food and Agriculture Organization, 2020). Throughout the years, the degree of yield and cultivation regions for banana has risen impressively.

Figure 3. Ghana Banana Exports Destination and Quantity.



Source: (GEPA, 2017)

The United Kingdom is the biggest buyer of banana from Ghana, with France and Belgium coming second and third respectively. According to the Ghana Statistical Service, Ghana's banana production quantity was about 88,276 tons in 2017.

2.3.3 Pineapple

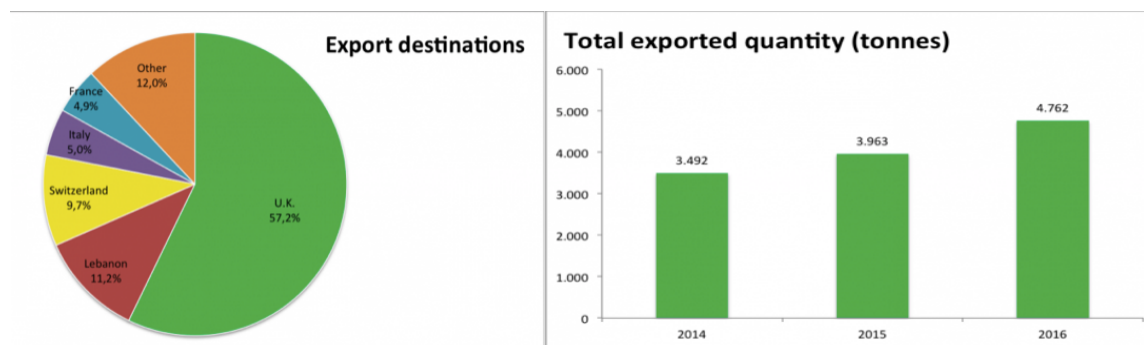
Pineapple, *Ananas comosus* a tropical plant with eatable fruit products and the most financially noteworthy plant in the family Bromeliaceae. The production of vegetable and tropical organic products for trade in Ghana is growing with customary yields, for example, cocoa continually coming under pressure. Growers have started to understand that the cultivation of pineapple for the export market is an entirely gainful business and produces a quick return of money inside a 12 to 15 months production cycle. Pineapple ranks first as Ghana's most significant non-customary horticulture export product, contributing around 24% of absolute agriculture trade. According to (GEPA, 2017), banana brought in 18,055,860 US dollars in 2017, and the top importing country of Ghana's pineapple is Belgium.

2.3.4 Mango

Mango, *Mangifera indica* is overall considered as perhaps the best fruits and significant crop in tropical and subtropical areas (Krishnan, A. G.; Nailwal, T. K.; Shukla, A.; Pant, C. R., 2009). Mango production in Ghana is a significant cultivating movement and Ghana has been recognized as one of the nations with a relatively favorable position of having a bimodal mango cultivation system. As per Ghana statistical service, mango as an organic food item has huge potential that could change Ghana's economy more so than cocoa and other conventional export commodities (Micah & Inkoom, 2016).

Mango is for the most part cultivated in the Coastal Savannah, Northern Ashanti, transitional zones of Ashanti and Brong Ahafo districts, Northern Volta Regions, and the entire of the three Northern locales are very conducive for mango production (GEPA, 2017). Notwithstanding the possibility of mangos commitment to Ghana's economy, observational proof demonstrates that farmers are not delivering the ideal yield level of about 12000kg/hectare of mango fruit (MoFA, 2014). This in my view are connected to the numerous supply chain activities that contribute to even more reduction in the overall yield output during harvesting and handling of the fruit early in the supply chain. The figure below illustrates the mango export destination in Ghana and quantities.

Figure 4. Ghana Mango Export Destination and Quantity



Source: (GEPA, 2017)

The biggest buyer of mangos from Ghana is the United Kingdom with 57.2% of the total exported quantity in 2017. By the FAO estimate, the global production of mango is nearly 35 million tonnes. Africa's contribution to this is only about 2.5 million tonnes, representing just 10% of the fresh mango and 11% of the processed.

In Ghana, it has been assessed that the average loss following harvest is between 20 to 50 percent (Zakari, 2012). The principle explanation behind losses concerning Ghanaian mangos has been attributed to the fruit fly presence and a number of ailments just as the absence of cold chain facilities, and long travel time. Related difficulties incorporate poor fruit handling practice, restricted access to on-farm power, and lacking transportation. At long last, supply chain actors have constrained information on production potential, accessible assortments, and post-harvest rehearse (Ridolfi, Hoffmann, & Baral, 2018).

2.4 Food Retailing Environment and Distribution in Ghana

Food retail settings in Ghana encompass all exercises and procedures by way of which individuals, society and subculture procure and uses food items and the food conveyance framework in the transportation, stockpiling, and advertising of food items to costumers (Unger & Wooten, 2006). A few providers, retailers, and merchants are associated with the supply and retail of food items in the nation. Women are the bulk of these actors and incorporate producers, ranchers, voyagers, advertisers, wholesalers, petty traders, and hawkers. Farmers produce food items and, at times, single farmers or groups of farmers likewise carry their harvest to the markets and urban zones to sell and promote.

Voyagers because of being on the move often, invest most of their energy and time on the street and bring food from farmers' doors or regional markets and territories to neighborhood markets in the urban and city areas (Oltmans, 2013). When the travelers and farmers arrive at the market, normally wholesaler sells the items on a commission or by profit basis where she adds a certain amount onto the amount the farmer sold to her in order to make some profit on it. As time passes on and the trade arrangement works for both parties, the wholesaler will receive one truckload of food items after another to sell to consumers. Clark (1994) in his investigation expressed that, on a rare occasion, you may see petty traders who grow or sell small quantities of food items that are meant for single household consumption in the local markets and throughout the city environment to travel to farmers to buy their goods. This attitude of petty traders in my view is triggered by the need for other material things by the traders. These individuals are mainly rural dwellers who are farmers who grow food mainly to feed themselves and their families, but when the family's needs go beyond what their daily lives activity can provide, they find other means to provide such needs. Hence, they either sell their excess yields or prepare it and fast meals and sell them to consumers themselves. Petty or small traders purchase their food items from traders in the wholesale markets. Marketers are normally exceptions.

They head out every day or once in a while to town markets or to the farms to purchase the food items and come back to markets in the urban regions to sell the items they procured (Clark, 1994). Distinctive food types like grains that are simpler to store and have fewer middlemen in comparison to fresh produce like fruits and veggies that necessitates to arrive at the market as fast as conceivable to maintain a strategic distance from decay (Lyon, 2003). Conventional food markets are assigned areas for the retail as well as wholesale of foods by traders and farmers.

The retail zone serves customers and is sorted out in ware or commodity-specific zones where countless frivolous petty traders are concentrated who sell a moderately little amount of comparable food items (Lyon, 2003). The wholesale zone serves the customer who makes huge buys, for example, establishments and eateries. The wholesale yard has an alternate sort of set-up, with few numbers of traders, merchants, and farmers and massive quantities of food items situated on the external edge of the market in bigger areas where trucks can enter and empty their load. These spaces are set up to move large quantities of food rapidly (Oltmans, 2013).

There are a few different retailers in the urban and city location from whom shoppers can purchase food for in-home readiness and utilization. The expansion in the casual labor force and urbanization brought about new structures and places for manufacturing and service

in which these petty traders sell their food items (Owusu, 2007). Minimarkets are known as the side of the road stands additionally situated along significant streets, highways, and in street privileges of-way (Pellow, 2002). A few smaller than usual markets stay little and work in selling just scarcely any items, while others venture into full-administration supermarkets that give everything from processed foods to fresh produce and frozen meat and fish.

These mini markets regularly get their items from indistinguishable wholesalers from conventional markets petty traders. Be that as it may, the cost at smaller markets is marginally higher than conventional markets because of the cost of transportation, stocking, and convenience (Oltmans, 2013).

Peddlers, known as hawkers in Ghana offer food and products available to be purchased to the general society without having a perpetual developed structure from which to sell. They purchase their items from close by traditional markets and retailers using a loan or through direct buy. Hawking is illicit, hard to deny in Ghana however it equally undertakes a necessary job in the food retailing and distribution in the country (Asiedu & Aggyei-Mensah, 2008). The roadside food stand is an extra wellspring of food dissemination in urban regions. It is a wide assortment of regularly cooked, prepared-to-eat foods and drinks just as fruits sold and now and then arranged out in the open spaces (Oltmans, 2013). Hawkers are petty traders contribute significantly to the food retailing and distribution environment. They are the providers of cooked and uncooked meals for many people in Ghana and Kumasi in particular. Their activities are considered illegal, but they disseminate and contribute greatly to the food systems in Ghana.

Although this study does not include in-depth consumer behavior in relation to street food, it is critical to mention that, about 32% of all food budget in Ghanaian homes is spent on prepared foods. But the poor and vulnerable spends almost 40% of their budget on street foods. Ghana's retail market compared to other African countries has relatively advanced in the last 10 years, retail sector analysts forecast retail spending to increase from \$ 8 billion in 2015 to \$11billion by 2019. This is thanks to the large growing number of the middle class. Market share wise in-terms of the retail food subsector, supermarkets in Ghana account for about 4% of the total retail sales, small grocery stores and convenience stores also account for 36% while the remaining 60% is the traditional open-air market (Taylor, 2017).

2.5 Supply Chain Disruptions

Supply chains are progressively getting perplexing and defenseless against disruptions. Supply chains exist in different geographic districts, and subsequently, nearby firms are inclined to operational hazard and unusual disruptions or disturbances to the chain (Tse, 2016). Disruptions in supply chains happen all the more habitually and are turning into an issue in the worldwide marketplace (Hurn, 2013). As per Business Continuity Institute (2013), 75% of the respondents from 71 nations experienced in any event one significant supply chain disturbance in 1 year. In the United States, around 600 organizations endured a supply chain disruption prompting, in any event, a 9% decrease in stock cost somewhere in the range of 1998 and 2007 (Wildgoose, Brennan, & Thompson, 2012).

On account of the incessant event of supply chain interruptions, supervisors need to think about different systems to forestall and limit their impacts (Hurn, 2013). Supply chain disruptions may happen because of drought, tremors and earthquakes, typhoons and hurricanes, and civil wars (Iakovou, Vlachos, Keramydas, & Partsch, 2014). Supply chain disruptions may likewise be because of different elements including (1) poor correspondence among providers and producers, (2) Labor strikes, (3) government guidelines (4) demonstrations of psychological oppression, (5) data innovation glitches, (6) quality issues, (7) operational issues, and (8) modern mishaps (Macdonald & Corsi, 2013). Disruptions in the food supply chain are even worse and cause greater harm to nations and people. Like many other African countries, farming in Ghana is about 90% reliance on rainwater for irrigation, so when disruptions like drought happen during the farming season, it becomes a problem. Yields are lost when drought strikes, people die from hunger and starvation. Bush fire is by far the single contributor to supply chain disruption in Ghana. (Researchers own assertion). Bush burning is a common practice in Ghana and many sub-Saharan countries, farmers burn their lands when beginning cultivation, hunters tend to start fires in the bushes during their hunt for cooking purposes. But much often this causes much harm than good when left unchecked. The fire spread quickly and burn down farms and yields when not controlled and this lead to a disruption in the food supply chain and creates food shortage in the process.

2.5.1 Supply chain Risk

Management risk in the supply chain is connected with cost, consequently, before companies have interaction in such a costly venture, there's the necessity to specify the sort of industries to control the risk and to become aware of the sources risks that cause the chains disruptions. By figuring out the danger and risk, actors in the supply chain may want to efficiently control the risks to limit its general value which incorporates decreasing forthcoming loss and damage (E. Y. Nyamah, 2014).

Sources of risk and the mitigation of it are specific to geographical location and the business type. It will therefore be very important to identify risks based on the area and specific industrial supply chain. To my knowledge, many researchers focusing on the identification of risk in sub-Saharan Africa and in Ghana's agricultural supply chain are lacking. Researchers can only try to unearth the reality of risk in Ghana's agricultural supply chain by identifying risk to obtain its severity and the capabilities of the SC participant to control/mitigate risks.

In an agro-food supply chain, risk can arise either within or from the external environment of the SC. The most common among them are risk sources associated with weather or natural disasters and biological and environmental related. The most identifiable risk in Ghana is market-related risks, infrastructure, and logistical related risk, institutional and policy-related risks as well as financial and operational managerial related risks.

a) Weather/Natural Disaster-Related Risk

One may argue that weather influence sales primarily through its effect on economic activity, but broader and systematic research by (Starr-McCluer, 2000) records a substantial effect of climate and weather on retail income and sales at a combination level, even though the number one impact can be that of moving demand in advance or later. In Ghana, weather-related risks like lack of rainfall or excess rainfall, strong winds often affect the agricultural supply chain. In the northern regions of the country, lack of rainfall during the dry season causes devastating damages to crops and livestock. It is similar in the rainy seasons where excessive rainfall also brings about floods in many farm fields as well as causing damages to people and properties. All these weather-related risks are always associated with a reduction in yields, but also affect the quality of food items and disrupt the flow of goods and services in the greater Kumasi area for example. The disruptions do not only affect the food but they also impact logistics along the supply chain by disrupting transport, energy, and communications. Weather-related risk like drought does not only have an impact on farmers or raw material producers in Ghana in a

particular area but also traders, processors, and upstream buyers which in turn affect the whole supply chain performance.

b) Market-Related Risks

Like many other supply chains, the agricultural supply chain is associated with market-related risk. Many of these risks basically reside in demand and supply variations. Disruptions of Operations in the downstream supply chain can result in demand related risks. Demand related risks or volatility in the agricultural supply chain emerges from a number of factors, the main ones are (i) fluctuation in demand that affect domestic or international prices of input and or output, (ii) Food safety requirement changes, (iii) market demand changes for quantity and or quality attributes. (iv) supply chain dependability and reputation changes as well as (v) market demand changes with respect to timing and product delivery. All the listed demand related risk causes disruption in the agricultural supply chain.

Supply related risks are the numerous events that affect the continuity of the supplier and result in temporary or permanent termination of the buyer-supplier relationship. For example, financial instability or a supplier or a threat to it may lead to supplier default, insolvency, or even bankruptcy (Wagner & Johnson, 2004). This type of risk may include, changes in technology, problems relating to quality, production capacity constraints, and changes in product design.

c) Infrastructure and Logistical Related Risk

Effective logistics and technologies are critical to the success of both producers and retailers. Agro- supply chain progressively faces risks related to logistics and infrastructure that can have an effect on the timing of goods and services as well as its availability. To logistically be effective, one needs to deliver the right product in the right quality and quantity, to the right place at the right time and for the right amount. Future production, processing, and marketing decision are closely related to infrastructure and logistics-related risks. The complexity of agricultural supply chain networks demands a careful and well plan logistics to allow an effective and efficient operation to interconnect the various nodes. Infrastructure related risks in Ghana may come in the shape of transportation risk as a result of high energy cost, shortages in labour, and or congestion at the port in relation to capacity constraints.

Another problem included in logistics and infrastructure risk is Information Technology (IT)- related problems. This is relevant to supply chain management because SC management functions are built on information sharing and processing. Each and every one of the risks

identified can cause supply chain disruptions. From over-dependency on the rains and the possibility of it not coming or being excess causing floods to poor infrastructure and logistical equipment and strategies are some of the many disruptions faced by actors in the food supply chain and agriculture supply chain in Ghana.

2.6 Food Loss in Food Supply Chains.

Food loss in the large scale of the food supply chain is evaluated corresponding to the possibility of taking care of a populace of nine billion by 2050. During the time the Food and Agriculture Organization of the United Nations (FAO) was established in 1945, the reduction of food losses of its was part of its mandate. By 1974, the primary World Food Conference recognized a decrease of post-gather losses as a feature of the arrangements intending to and solving world hunger. As of now, a general estimate for post-harvest losses of 15% had been proposed, and it was set out of about a 50% decrease by 1985. Subsequently, the FAO built up the Special Action Program for the reduction and avoidance of food losses.

The principle center was at first on diminishing losses of tough grain; by the mid-1990s, the extent of the work had been expanded to cover roots and tubers foods like yams for example, and fresh fruits and vegetables (FFVs). Poor selection rates for mediation prompted the acknowledgment that a specialized center was deficient for taking care of issues inside the sector and increasingly all-encompassing methodology was needed (Grolleaud, 2002). There are no accounts of advancement towards the post-harvest loss decrease target of 1985, and as of late Lundqvist et al. (2008) in their study called for an activity to lessen food loss supporting a 50% decrease in post-harvest losses to be achieved by the year 2025.

Efforts have been made to measure worldwide food loss more than a very long while, spurred halfway by the need to feature the size of “waste” according to worldwide lack of healthy sustenance (Parfitt, Barthel, & Macnaughton, 2010). Such appraisal is dependent on constrained datasets gathered over the food supply chain at various occasions and extrapolated to the bigger picture. The frequently estimated figures show that ‘as much as half of all food items produces is lost or squandered before it gets to the purchaser and or the final consumer (Lundqvist, J.; de Fraiture, C.; Molden, D., 2008)

Table 2. Examples of Food loss in a Common Food Supply Chain

Phase	Examples of food loss traces
1) harvesting-Handling at harvest	eatable yields left in the field, plowed through the soil, eaten by birds, rat, the timing of harvest not ideal: misfortune in food quality, crops harmed during reaping/poor harvesting strategy.
(2) storage	Pests, bugs, spill, blemished, natural ventilation out of food
(3) packaging – weighing, labeling, sealing	improper packaging and bunding harms produce grain spillage from sacks, assault by rodents
(4) drying – transport, and distribution	Poor transportation infrastructure, losses due to spoiling/bruising.
(5) marketing-publicity, selling, distribution	damages during and in transport: spoilage, poor handling in the wet market, poor market infrastructure.

Source: (Parfitt, Barthel, & Macnaughton, 2010)

2.7 Drivers and Trends of supply chain losses in Developing Countries.

The majority of the rural communities in countries like Ghana rely on short food supply chains (FSCs) with limited or no after-harvest infrastructures nor technologies. Progressively broadened FSCs taking care of the urban populace include numerous mediators among farmers and consumers, which may restrict the potential for farmers to get more significant expenses for quality. With cultivating for the most part on a little scope with differing degrees of association in nearby markets and a quickly reducing extent of resource, farmers who neither purchase nor sell food staples (Jayne, Zulu, & Nijhoff, 2006).

Mediation inside these frameworks centers around preparing and updating specialized ability to lessen losses, increment productivity, and diminish the workforce of the advance utilized. Be that as it may, efforts to cutback post-harvest losses must assess social ramifications. (Parfitt, Barthel, & Macnaughton, 2010)

2.7.1 Estimates of Food Losses in the Supply Chain

Parfitt et al, (2010) found that the difference between short-lived or perishable products like fruit and vegetables and durable or non-perishable foodstuffs like grains and tubers is a significant thought in post-harvest losses and misfortunes and the sufficiency of food supply chain infrastructure. With the objective of this investigation, the focus will be on post-harvest losses/misfortunes for transient crops.

The causes and paces of post-harvest losses for transient or perishable vegetation like tomatoes, onions, pepper, mangoes, banana's and oranges are significantly not quite the same as those for grains. Horticultural or green products, for the most part, endure higher loss rates inside industrialized and developing countries like Ghana, even though at various points in the FSC and for a different explanation. Kader (2005) assessed that roughly 33% of all FFV's delivered overall is lost before it arrives at purchasers. Losses in the USA are evaluated from 2 to 23%, contingent upon the item, with a general normal of 12%.

A provisional estimate from the United Kingdom recommend losses of 9% (Garnett, 2006), yet this disregard produce that may be left in the field in the wake of neglecting to meet restorative or quality models. Even though not a post-harvest loss, out-evaluating speaks to a noteworthy part of the waste that is hard to measure and to a great extent narrative with some produce liable to enter the food processing sector on the off chance that it does not meet standards (Stuart, 2009).

The general contrast among developed and developing nations is that FFV framework losses are prominent in developing than in developed nations. (Parfitt, Barthel, & Macnaughton, 2010). Lundquist et al., (2008) in their study estimate 1.7% in Zambia, 3.5% in Kenya, and 3.2% in Malawi of post-harvest losses in farm-level storage of grains for a storage period of 6 to 9 months and attributes the cause of loss to insects, rodents and molds. With a post-harvest loss for fresh fruit and vegetables, Parfitt et al., (2010) estimate 20% for all fruits and 30% for all vegetables with as high as 43% for products like a tomato in Egypt.

Table 3. Food loss data for Sub-Saharan Africa (%)

Commodity\ Stage of Food Supply Chain	Agriculture Production	Post-Harvest Handling & Storage	Packaging and Processing	Distribution
Cereals	6	8	3.5	2
Roots and Tubers	14	18	15	5
Oilseeds and pulses	12	8	8	2
Fruits and Vegetables	10	9	25	17
Meat	15	0.7	5	7
Fish and Seafood	5.7	6	9	15

(FAO, 2011)

Dependable proof of food losses is commonly rare. The most often utilized source of international data is (FAO, 2011), containing overall worldwide food loss estimates by localities and regions, commodity groups, and phase of the food supply chain. These local food loss information for Sub-Saharan Africa was checked on to be moderately high in farming production, post-harvest handling and storage, and preparing and packaging stages. In terms of crops, roots, tubers and, fruit and vegetables face excessively larger losses (Table 3, 2nd, and 4th row). The emphasis is on fresh fruits and vegetables as it is the focus of this investigation.

Table 4. Food loss data for Ghana (%)

Commodity\Stage of Food Supply Chain	Agricultural Production	Post-harvest handling and storage	Processing and packaging	Distribution
Maize	4.3	6.2	1.2	4.8
Rice	2.4	5.2	43.0	1.5
Cowpea	0.0	2.9	0.0	15.0
Cassava	5.4	2.5	5.8	13.0
Yam	4.9	12.8	0.1	12.9
Mango	4.5	8.7	3.5	23.8
Oranges	1.1	2.2	0.0	2.8
Tomato	5.7	28.6	0.0	32.1
Okra	16.6	30.0	0.0	4.7
Fish	2.8	2.5	65.2	15.6
Groundnuts	1.1	1.9	1.5	2.2

Source: (Rutten & Verma, 2014)

Table 4. illustrates the numerous types of food lost due to various reasons in the food supply chain system. Vegetables like tomato and okra are lost at high numbers at the post-harvest, handling, and storage stage of the supply chain, 28.6%, and 30% respectively as reported by (Rutten & Verma, 2014) in their study.

Reported food loss information, for the most part, covers a range. Horticulture production covers the classification of collecting and non-farm assembling; post-harvest handling and storage cover fundamental, grading and sorting and storage classes; processing and packaging cover bundling and sacking and processing categories; conveying covers transport to storage, market and advertising/on-market storage stages; food waste in conclusive utilization was not detailed.

The World Bank (2011) centers around post-harvest loss in grains. The African Postharvest Losses Information System (APHLIS) information framework that underlies this investigation, and draws its information from national researchers, regularly discovers food loss estimates well under 40 to 50%. They are anyway still noteworthy, estimated at around USD 4billion every year, or about 15% of the all-out estimation of Ghanaian yield of grains (USD 27 bn).

Table 5. Physical losses and a key loss hotspot for selected commodities in Ghana.

Commodity	Total losses (%)	Key loss hotspots
Maize	14	Harvesting operations (3.9%); on-farm storage (2%); transportation operations (3.4%)
Rice	13.5	Preliminary processing (5.9%); on-farm storage (4.3%)
Cowpea	10	
Yam	31.4	On-farm storage (9.8%); transportation (10.2%)
Cassava	33.6	Harvesting (4.6%); on-farm assembling (4%); transportation (7.4%); processing (8.5%); storage of dried product (5%)
Groundnuts	6.6	Packaging & bagging (1.5%); transportation (2%)
Fish	21.5	Capture (2.1%); transportation (15.5%); sorting (2.5%)
Tomato	37.5	Harvesting (4%); sorting (13.8%); transportation (14.4%)
Okra	24.2	Harvesting (16.6%); retailing (5.1%)
Mango	45.6	Sorting (5.4%); transport (13.4%); marketing (16.2%)
Orange	5	Sorting (2.2%)

source: (Mutungi & Affognon, 2015) (Ridolfi, Hoffmann, & Baral, 2018)

2.8 Losses are observed to be largest for Fruit and Vegetable

The Swedish Institute for Food and Biotechnology in their report concluded that indeed global food losses and food waste occurs in many continents around the world, however, FFV losses and waste are the largest among all in terms of the percentages, volume, financial and energy. Hence, the need to reduce food losses is an important option to increase food availability especially in low-income countries with emphasis on early in the supply chain. (Gustavsson, Cederberg, & Sonesson, 2011)

Again, a report authored by (Rutten & Verma, 2014) also concluded that FFV losses and waste are highest in terms of its production quantity, however, it is second to roots and tubers in Ghana. The researchers found that fruits and vegetable production accounts for about 10% of the value of total output in Ghana and 23% of consumption expenditure. It is, therefore, the most important food category for both producers and consumers in Ghana (Carl, 2016).

Finally, (Anaba, 2018) in his study concluded that losses in FFV's like tomato could be as high as 13% for the farmers in both the minor and the major farming seasons. Middlemen and market women can experience postharvest losses of about 26% and 20% respectively and attribute the cause for these huge losses to heat and bruises. This investigation is in agreement with all the above literature review and also find compelling evidence that indeed food losses the FFV industry is the highest in the agriculture sector in Ghana and most of these losses happen early in the FFV supply chain.

2.9 Conclusion

FFV's are crucial in every Ghanaian recipe and contributes greatly to the economy of Ghana. Ghana can fulfill the nation's FFV need, notwithstanding, low yield, inaccessibility of value food items, pests, and illnesses, Post-harvest losses, absence of market foundation, infrastructure, and poor storage and transport frameworks has upset this potential. This review introduced FFV production patterns in Ghana and Kumasi specifically, and supply chain activities that keep on affecting the loss of FFV's before they get to the last consumer.

A few investigations and analysts have set up the commitments of food supply chains in food losses. It must be observed that the immense margin of the built-up connections has been centered around developed countries. Therefore, an investigation endeavoring to set up this relationship in less developed countries is vital for a sensible and universal conclusion. Ghanaian FFV small and medium holder farmers, middlemen, market women, and petty traders will achieve self-sufficiency in the FFV cultivation and trade as its supply chain members if the government and local government invest and educate chain members.

CHAPTER III

3.0 Research Method and Approach

3.1 Introduction

Chapter three discusses how this research was undertaken, it provides information on the research design, the sampling procedure, data collection methods, and instruments. This chapter explains the research method and how this study was conducted.

3.2 Approach

The focus and target of the study were by looking at agricultural produce like onions, tomato, pepper as well as pineapple, bananas mangos, and its supply chain in and around the Kumasi area. This investigation is a subjective (qualitative) case study. Data was collected by interviewing several parties involved with the production, sale, and retail supply of these fruits and vegetables in the Kumasi area. Secondary Data was retrieved from various information database, research, and reports, publication sources, Government of Ghana Ministries websites (GSS) as well as internet sources.

To conduct this research work and to gather the primary data, a field survey was carried out by visiting fruit and vegetable farmers, petty traders, market women at farmers markets, city and urban markets, and local markets to conduct one-on-one interviews and observe in person their daily activities in their farms and the marketplace over some time.

3.3 Sampling and Data Collection

This investigation embraced a mixture of data collection methods to ensure that the data collected was valid and was rigorously used. The two main techniques used were in-depth one-on-one interviews for primary or first-hand data as well as individual observation and secondary data from different sources such as government agencies reports, Ministry of Agriculture (MoFA) Ghana partner websites, and some industrial websites. The data was collected from the interviews conducted with several parties in fresh fruit and vegetable

cultivation, trade, transport, and supply. Interviewing chain members in the supply chain I believe is the central method of data collection. The respondents were selected considering numerous factors, this was done based on their location and the fruit or vegetable they cultivate or trade-in. The study population was originally going to consist of about 80 to 100 farmers, petty traders, market women, distributors, and market women. This was later reduced to 50 participants. An unstructured open-ended questionnaire whose wording could easily change if needed was used to interview 15 petty traders selling fruits and vegetables, 10 farmers, 15 market women selling fruits and vegetables, and 10 middlemen or distributors. This was to make the interviews flexible and grant me the chance to ask further on each question where clarification was needed. The length of the interview fluctuates dependent on the conditions on the ground; however, the research was able to conduct an interview in 25 to 30 mins. The location of the interview was for the most part at the participant's workplaces which likewise supported the researcher to watch the reality on the ground about the area of studies. During the field interview, respondents were asked to give information about the farm location, fruit or vegetables they grow, the distance they traveled in bringing these items to the markets, mode of transport, packaging mode, and storage.

3.4 Study Location

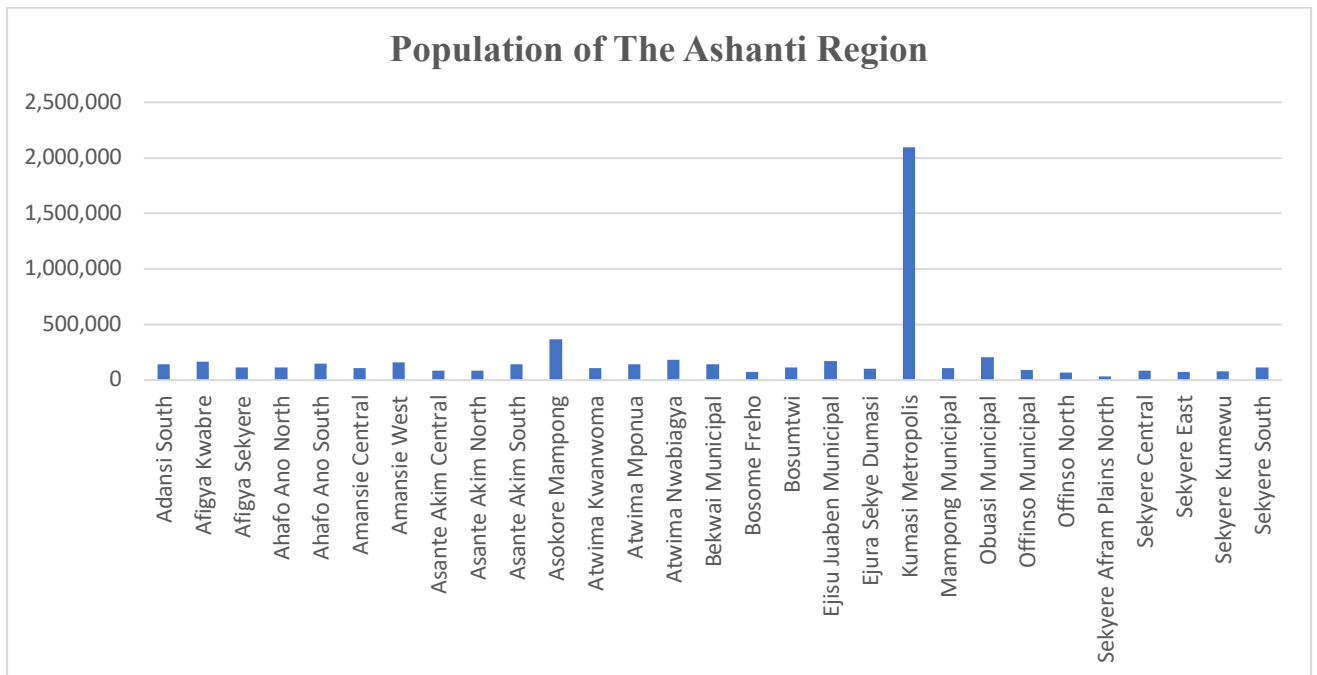
Kumasi, Ghana (see figure 3.) presented an excellent location for the investigation on the FFV food supply chain and its impact on food loss, as the city is undergoing the trend of rapid urbanization. According to the Ghana Statistical Service, the population of the Ashanti region is estimated to be around 5.8 million, with Kumasi metropolis a little over 2 million people living in the city. Furthermore, the city is situated in the middle of the country where every and all major highways pass through the city. The rapidly growing population means high quantities of food is needed to feed the city.

Figure 5. A map of Kumasi Metropolis.



Source: Google Map, (2020)

Figure 6. The Population of the Ashanti Region.



Source: (GSS, 2019)

3.4.1 Data Analysis

Transcription of interviews occurred on a continuous premise, to recognize introductory ideas and developing connections within the interviews and after getting back home. Descriptive statistics were used to describe some social demographics of the respondents.

3.5 Justification of Methodology

A qualitative singles case study research procedure was applied for this thesis. Case study research in an inexorably mainstream approach among qualitative researchers (Thomas & Magily, 2011). Case study research is an examination and investigation of a solitary or aggregate case planned to catch the unpredictability of the object of study (Stake, 2010). Several conspicuous authors have added to methodological turns of events, which has expanded the prevalence of case study approaches across disciplines (Creswell, 1998) (Osazuwa, 2015). The contextual investigation is worried about transmitting true experience rather than progressing standardized decision models.

Since this investigation will be dealing with the supply chain of three fruits (Bananas, Mangoes, and Pineapples) and three vegetable (Onions, Tomatoes, and Peppers) which includes contemporary (Present-day) events that we cannot control and we will look to discover answers to 'how' and 'where' these FFV's are cultivated, packaged, transported and stored, case study research approach is the exceptionally appropriate strategy for conducting this research.

CHAPTER IV

4.0 Findings and Discussions

The in-depth one-on-one interview was conducted by talking and having a conversation with household farmers and medium holder farmers, petty traders, market women, and middlemen in and around Kumasi and its environs in the FFV production and trade. Onions, Tomatoes, Chili Pepper, Bananas, Pineapple, and Mangoes were selected to be used as a contextual analysis because of its largely utilize and consumption of these foods ground from the ground Ghana and to comprehend the difficulties looked by these chain members in the supply chain.

At the beginning phases of this investigation, the food supply chain link channel was thought to be food moving from the gate of farmers or ranchers, and makers through the processor for preparing, at that point to the wholesaler where food is disseminated to the different retail outlets from which purchasers and consumers get their food with cash moving the opposite direction which was illustrated to in figure 1. A different type of supply chain was observed for these three fruits and three vegetables which this investigation was based on after data collection and information assembling. The instantaneous dealings by the farmers themselves were observed to have a short chain than the petty traders and market women.

4.1 FFV Supply Chain in Kumasi.

Figures 7 and 8 below illustrate the FFV's supply chain of the studied foods for farmers was very short than that of petty traders in the Kumasi and its environs. Some growers and cultivators of FFV's in the Ashanti and Kumasi were observed to be often selling their yields within their farm location area, but sometimes they carry their yields to the nearby farmers market where they sell them to the consumers. These types of farmers mainly cultivate household consumption but when the yields are plentiful, they sell the leftovers to consumers. The farmers hardly travel more than 10 kilometers outside their farm location and they package their items in rubbers sacks and in their farm baskets of wooden straps to the nearest farmers market to sell.

Figure 7 shows how fruits and vegetables get to consumers in the Kumasi area from the farms. The fresh fruits and vegetable supply is unique from other foods because of its perishability kind. Figure 7 illustrates the supply chain of peppers, tomatoes, onions, bananas, pineapple, and mangos for the farmers market. This is a result of information gathered from the one-on-one interview and conversation conducted with respondents.

Figure 7. The supply chain of Farmers who directly sell to consumers in the Kumasi area.

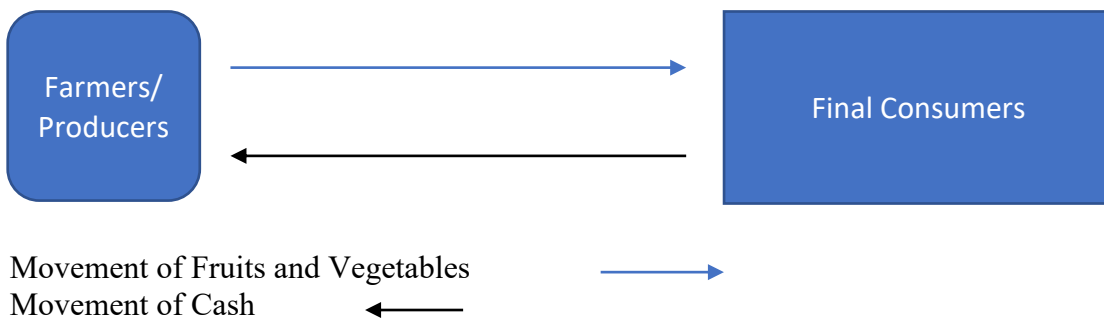
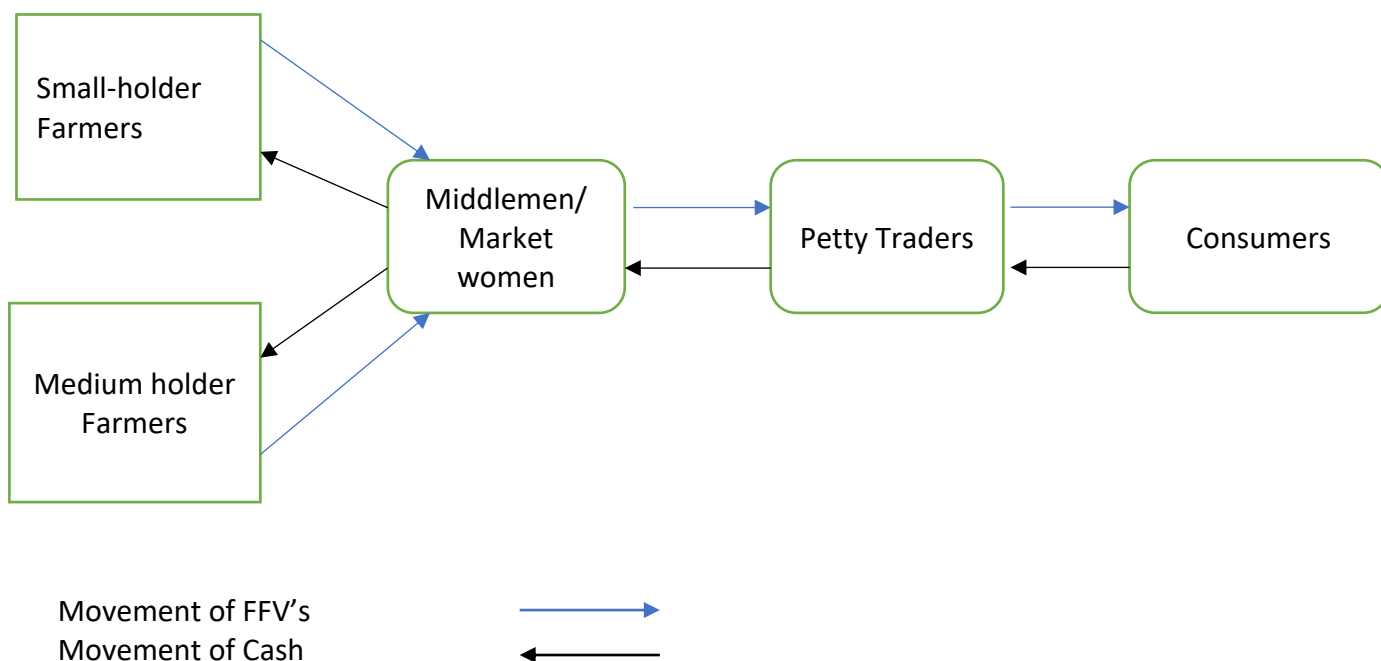


Figure 8 below illustrates the other form of FFV supply chain observed in the investigation, this supply chain has a longer chain since these fruits and vegetables originate from outside of the Kumasi area and even the Ashanti region. They are mainly from the Brong Ahafo, Western, and the northern regions of Ghana. Farmers and producers in this channel sell their yields to wholesalers, middlemen, and markets women. They are then conveyed by roads to the numerous market centers within the Kumasi metropolis where they also have petty traders who rely on them for their supplies. At the hands of the petty traders, they are placed on shelves in smaller quantities where consumers come to buy and money move in opposite directions as represented in figure 8.

Figure 8. Movement of FFV and Cash in the Greater Kumasi Area and its environs.



4.2 Characteristics of Respondents

The participants interviewed consisted of 50 Ghanaians, 14 (or 28%) men, and 36 (72%) women. Their ages varied from 20 to 69 years old with an average of 39.2. Table 5 below illustrates the sample size of the various chain members selected for this study.

Table 6. Number of Respondents (Total 50)

	Farmers	Middlemen/Distributors	Market Women	Petty Traders
Sample size.	10	10	15	15
Percent-age.	20.0	20.0	30.0	30.0

Locations of Farms

In the course of the interview, the farmers were asked where their plantations are located. This specific inquiry was to assist me in identifying the origin or source of these fruits and vegetables. I asked the farmers if their yields come from within the greater Kumasi area of the Ashanti region. The vegetable farmers acknowledged that indeed most of their yields comes from the Kumasi area with the exception the tomato farmers who said their produce comes

from the transitional zone in-between the Ashanti region and the Brong Ahafo regions of Ghana with the greater portions of the tomato yields coming from the town of “Akumadan”.

Akumadan, the capital of Offinso North a locality in the Ashanti region of Ghana. The township is notable for its farming activities. A wide range of food crops can be planted on its soil however tomatoes are the biggest yield. A dive into the town after the interview reveals that about 90% of the locales around 18 years are tomato farmers. They produce tomatoes than any other town in Ghana. This is because the town has a dam that helps to irrigate some farmlands within its reach during the dry seasons when the rains have stopped in the country. The farmers answered that the longest in terms of farm distance to Kumasi is the Farm in Akumadan, which is about 105 Km from Kumasi. The remaining are within a 60 Km radius of Kumasi metropolis. The Fruits on the other comes from different parts of the region.

Packaging of FFV's

The respondents were also asked how they package their items during transport to the various markets and marketing and sales of the food items to final consumers. The farmers package their yields in larger sacks and wooden crates concerning vegetables. Peppers were observed to be in a woven wood basket while tomatoes were in wooden rectangular crates and the onions were in sacks. Middlemen and Market women both receive their products after purchase in the same packaging the farmers brought to the market.

They then repackage the items in smaller rubber buckets and tins to advertise and sell to petty traders. The traders during the sale of the items with regards to vegetables are grouped into small quantities on tables and even small bowls and buckets where purchase then buy them and they are put into small polyethylene bags and handed over to the final consumers after the transaction.

Fruits, on the other hand, was observed to be packed into semi-trucks in numerous quantities and different bags and containers by the farmers and transported to the market centers. Among three studied fruits i.e. Banana, Mangoes, and Pineapples, bananas were observed to be packaged in woven wooden buckets cushion by banana tree leaves to minimize damage during transport. The wooden buckets are laid with dry banana leaves first before packing the bananas into the bucket. This prevents the bananas from having direct contact with the hard surface of the bucket which can damage it by crashing the bananas from excessive shaking during transport due to the bad nature of the roads. Mangoes and pineapples were packaged into semi-trucks cushion with palm tree leave to minimize damage during transport.

(image 1 in appendix C illustrates how mangoes are packaged for transport). At the market centers, they are sold in small quantities to middlemen and market women who also transport them in a similar model as the farmers but mostly without any cushion against damage during transport.

Petty traders purchase the fruits from market women and middlemen and transport them in silver pans for all three fruits where they are then advertised on flat surface tables where final consumers come to buy the fruits. In general, FFV's in Ghana are all transported by roads and in trucks to the numerous marketplaces in the greater Kumasi areas and its environs.

Figure 9. Banana Packaging for Transport.



Source: Field survey 2020

FFV Transportation

At the time of the interview, respondents were asked the question “How do you transport your food items to your various market centers?”. They all indicated that they transport the yields and food items to the market by road. All the respondents indicated that they sometimes share trucks when the yields are not able to fill the entire truck space. Road transportation is the main mode of transport in Ghana. The road networks in the country are vast reaching almost 98% of established cities, townships, villages, and cottages.

It is important to state that, about 50% or more are untarred road, therefore, making transporting goods and passengers stressful and long hours on the roads and contribute significantly to food loss with its bumpiness causing the fruit and vegetable bruises while in transport.

FFV Storage

Respondents were asked the storage approaches and methods for these FFV. Their reaction focuses on the path that, there are no genuine strategies regarding safeguarding the quality and period of the considered fruits and vegetables. All the respondents do not store their food items. FFV's are highly perishable items so you will think that all members of its supply chain would take precaution in maintaining the quality of the items until they get to the final consumer.

Farmers, middlemen, market women, and petty traders all do not have coolers or any cold chain facility where they store their yields and items. Rather, farmers after harvesting their products try to offload the yields of their hand as fast as possible by taking them to the market. During the transport and while the items are in their custody, they try are much as possible to keep the yields as fresh by controlling the temperature to prevent spoilage.

Fruits like Mangos, Bananas, and Pineapples are provided shades or cool temperatures by transporting them overnight to prevent overheating from the sun during the day. Once they reach the market early hours of the morning, the farmers aim to sell off their yields before the sun gets hotter in the day. Many of the respondents indicated that indeed they achieve that aim mostly. The vegetables are transported by farmers in a similar fashion per response from the interview.

Middlemen much often take the same trend as the farmers and market women. Petty traders spend more time with their products compared to the farmers and the middlemen. They display their product at the market and tries to make them fresh and possible as they can. Onions bulbs are preserved by the sunlight so they are mostly left to the mercy on the sunshine and that impacts minimal damage to the onions. Tomatoes and Peppers on the other hand, when exposed to too much sunshine, will impact its quality greatly so they are provided shades by the stands in the market center are occasionally gets a cold-water bath or water are sprinkled on it to keep them fresh. The FFV's that are not sold during the day are left in their packages, stored in cabinets and rooms at approximately room temperature for the next day.

4.3 Causes of Food losses in the FFV Supply Chain.

All respondents were asked if at any stage of their activities they lose some if any of their yields or food items. All of them agree that, at one point in the FFV supply chain, they lose some of their product due to different reasons or factors. The farmers indicated that FFVs are highly perishable hence the need for proper management in order to keep them fresh and of high quality.

The farmers point it out that, during harvesting of the yields is indeed one activity when not done properly leads to food loss in the supply chain. Fruits are harvested when they are just at the right time to be eating. The techniques used in harvesting fruits like mangos are not the best hence damages caused during harvesting. Mangos tend to fall from the trees during harvest thereby hitting the hard ground surface causing damage to the fruits. This eventually will decrease the shelf life of the fruits in total. This was the same for pineapples, they are harvested by cutting the trunk of the fruit and placing it in a wooden basket. During this process, when not done with greater care the fruits get cut and pieced with the harvesting knives causing damage to the fruit.

None of the respondents made any indication of having any proper storage facility other than leaving it to its natural course and the mercy of the elements. The poor storage facility was identified as one of the major causes of food loss in the FFV supply chain. Chain members do not have any storage facility so they store their products and items by what they called "The natural way". All the respondents in their own words try to avoid direct sunshine during their activities, they try to provide shade for their items as possible as they can. Food items are kept under room temperature in the packaging, but even with that, they face another challenge.

The storage room is not full proof to pest, rodents, parasite, and fungus. Warm and humid climate affect the fruits and vegetables if not controlled. The following were cited as the major causes of food loss in their supply chain activities;

- **Poor Storage facilities;** Citing Heat, Rodents, Parasites, fungus, and much often at the mercy of thieves as the major cause of losses to their yields and food items.
- **Poor road infrastructure;** Bad roads cause enormous damage to fruits and vegetables during transport.

- **Lack of Refrigeration;** Coolers and refrigeration are ways of extending the shelf life of FFV's, this investigation observed that chain members in the supply chain do not have access to any means of keeping their food items fresh and from going waste due to spoilage.
- **Inadequate Market Facilities;** Many of the market centers I visited were not well-established market place as found in many places in Ghana. Those that have some sort of structure are not adequate. Middlemen, Market women, and Petty Traders are challenged with unsanitary conditions and overcrowded market centers.
- **Poor Packaging;** Poor packaging was observed to be another cause of food loss in the FFV supply chain. The fruits and vegetables were observed to be sometimes not properly ventilated.
- **Poor Handling;** Sorting and grading were observed to be another factor contributing to losses in the supply chain. FFV's are highly susceptible to bruising so when sorting is not done with care, it ends up damaging the fruits and vegetables.

4.4 Major FFV Supply Chain Activities Contributing to Losses.

Harvesting

Picking was identified as one of the pre-harvesting activities that were contributing significantly to FFV losses in the study area. Vegetables like tomato's cultivating cycle end at the collecting/harvesting stages, however, starts a chain of significant activities that guarantee that consumer obtains vegetables in the favored state. FFV harvesting is work serious and ought to be reaped in a manner to maintain a strategic distance from fruits products from getting overripe during transportation to long distanced market centers and areas. Vegetables like tomatoes are profoundly vulnerable to bruising, so they ought to be picked cautiously and easily to stay away from losses during harvesting. I concur with (Anaba, 2018) suggestion in his investigation that, farmers during harvesting of FFV's ought not to drop new tomatoes into picking baskets or containers at stature, not above 6 inches since it causes bury bruising.

The same was found in mango harvesting where the fruits are picked from the mango tree but are dropped from the tree thereby hurting the hard farm surface. This causes bruises to the fruits. Harvesting of pepper and onions are slightly different from tomato. Onions are root vegetables so they hardly get damaged during harvesting. The many causes of damage leading

to losses in onions and peppers are insects even before they are harvest and rodents when they are been stored.

Handling

Sorting and grading in the FFV supply chain is another major contributing factor to losses. These losses were observed to come about because of rough handling in this process. Sorting and grading are done in preparation for the fresh fruits and vegetables for the markets and this when not done correctly will increase bruising and mechanical damage to the food. At the farms and by all the participants, sorting and grading are done to group the fruits, in particular, to prepare them for sale. This is done to ensure the quality of the food items and even distribution of items for the right pricing strategies. At the hands of any of the participants, sorting and grading are done furthering the damage been done to the food items before it gets to the final consumer. Mangoes and tomatoes are the most sorted and graded food items among the studied food items. All the actors of the supply chain at every stage handle these items by sorting and grading them in terms of quality, shape, and size. This process at most of the time causes bruising to the fruit and vegetable.

Onions are handled in a different manner compared to the rest of the vegetables and fruits. Onions, when harvested, has to be dry before it can be sold out. This drying process was observed to be the major source of losses at the stage in the supply chain. Drying is done by placing the onion bulbs on a flat surface and place in the sun to begin the drying process. This may take 3 to 4 weeks for the process to complete. During this period, farmers and producers place and collect them as the sun comes up and goes down. This process goes on throughout the drying process and about 3% percent of the onion bulbs are lost due to damages.

Bananas, on the other hand, were observed to be most vulnerable at the harvesting stage during the ripening process. They are main harvested unripe and then stored until they are ripe. The process is delicate and when not done properly may lead to losses of the fruit. Traditional farmers turn to perform this process by packaging the fruits in a woven basket cushion with banana tree dry leaves and left at room temperature for the ripening process to complete. During this stage, they are left at the mercy of rodents who fest of them thereby causing damages and losses to the fruits.

4.5 Food loss in FFV supply Chain in the Studied food items observed at the farm level.

Studied FFV's	Sources of Food Loss (Emphasis on early in the supply chain)
Onions	<ul style="list-style-type: none"> • Drying process • Poor packaging during transportation • Poor storage facilities living the vegetables exposed to rodents and bugs
Pepper	<ul style="list-style-type: none"> • Pre-harvesting (birds start to consumer the vegetable when even before the harvest.) • Poor storage facility. • Poor handling leading to bruising of the vegetables. • Excessive use of chemical pesticides to control the pest.
Tomato	<ul style="list-style-type: none"> • Poor harvesting strategy. • Excessive handling at all stages of the SC. (Sorting and Grading) • Poor packaging during transport which leads to bruising of the vegetable • Lack of Cool Chains (Overheating)
Banana	<ul style="list-style-type: none"> • Poor post-harvest Ripening Technique among some farmers. • Lack of proper storage facility leading to the theft of the fruits.
Mango	<ul style="list-style-type: none"> • During Harvesting mangoes are dropped from tree to the hard farm surface causing bruising. • Pest, diseases, and rodents • Uneven ripening
Pineapple	<ul style="list-style-type: none"> • Rough handling • Inadequate temperature regulation • Lack of cool chain and poor pre-cooling

The table above illustrates the sources of FFV losses in this study. Many of all the sources for the losses were at the farm level, primarily at the post-harvest level. Other sources of the losses are at the wholesale and retailing level and many of them are attributed to poor storage strategy and facility, poor packaging, and bad road and infrastructure network.

4.6 Known limitation of the study

Limitations are the shortcoming of a study that adversely influence the investigation's generalizability, dependability, and legitimacy (Marshall & Rossman, 2016). The major limitation of this investigation was that the study population was initially going to consist of about 80 to 100 participants in the FFV supply chain in the Kumasi area and its environs including Farmers, Intermediaries/Distributors, Food Processor, Market Women, Petty Traders, and final consumers. However, the COVID 19 pandemic made it impossible to involve this high number of people especially the processing companies and the consumers because of social distancing rules, restrictions, and lockdown rules. According to (Meyvis & Van Osselaer, 2018) increasing the sample size of a study increase the power of the research. This became a significant obstacle in finding a trend and a meaningful relationship and the study could not extend into the FFV export but changed to look at only the local FFV supply chain. Finally, participants willing to grant interviews may have been restrained about offering broad information that could benefit the rival.

CHAPTER V

5.0 Conclusion, Recommendation, And Future Research

5.1 Conclusion

The Republic of Ghana is a transcendently agrarian nation with about 54% of its populace depending somewhat or completely on agriculture for their livelihoods. Horticulture is a significant sub-sector of Ghana's farming economy with extraordinary potential for development because of a solid export market as well as growing domestic demand. Fruits and vegetables play a basic capacity in the lives of peoples and horticulture production impacts the economy enormously. Purchasers in the Kumasi area get a large portion of their fresh fruits and vegetables they consume at the farmers market and nearby markets from market women, petty traders, and farmers themselves. Vegetables that are grown in the Kumasi area and its environs are sold significantly in the neighborhood markets and other direct marketing and showcasing outlets by farmers. While the Kumasi central market gets huge numbers of their fruits and vegetables from the transitional zones, the other market centers get their FFV's from close to the vicinity to the homesteads.

This study revealed two forms of FFV supply chains in the greater Kumasi area and its environs, the farmers' direct sale and marketing to the final consumer which was observed to be a short supply chain, and the modeled supply chain which was a longer supply chain illustrated as figures 7 and 8 respectively. Figure 7 was a short supply chain used mainly by farmers where they were observed to be transporting the yields and produce to the markets themselves and sell them directly to the final consumers. The second supply chain was a long one which involved intermediaries or market women and petty traders before the FFV's finally getting to the final consumers. Farmers either before or after harvesting their products either invites and sell all the produce to market women or intermediaries on the farm of which they are then transported to the various market centers where numerous petty traders are dependents on these market women to purchase these fruits and vegetables and ultimately sell them in smaller quantities to the final consumers.

The FFV supply chain logistics activities like; handling and sorting, packaging, storage, transportation, and lack of refrigeration in the study area were cited as contributing significantly to the food loss and waste in the greater Kumasi area and its environs in almost all the studied fruits and vegetables. The respondents cited these postharvest activities and the

major contributing factor for the loss of their yields and food items. The relevant literature reviewed suggests that this problem is seen across many developing countries and the number of losses is high in many of these countries. Given that post-harvest loss in cultivating crops is especially severe, coming back to PHL prevention and counteraction in horticulture is relied upon to be high in Ghana.

A firm proof base from which to survey food loss globally is missing, with no particular data on the effect of food lost in developing countries a significant concern, and with a great part of the loss estimates gathered more than 30 years prior. There is an increasing need for quantitative data covering developing countries and the quickly advancing urbanization of major cities and urban communities in these nations. The absence of infrastructure in many developing countries like Ghana and helpless harvesting/growing procedures are probably going to stay a significant component in the generation of food waste and loss.

5.2 Recommendation

In light of this study's findings and the literature review affirmed the presence and a sign of various causes and sources of food losses in the FFV supply chain. The researcher likewise recognized a decent number of opportunities for farmers and chain members in the FFV sector to settle on the correct choices and decide the accepted procedures and strategies to help mitigate the losses and waste in the supply chain. I, therefore, recommend the following intervention to help mitigate food losses in the fresh fruits and vegetable supply chain in Kumasi. Since fruits and vegetables are already highly perishable food items due to its short shelf life, to further reduce its losses, stakeholders and chain members need to take the following further action:

1. Local Investments; Investments into market infrastructures in the various designated markets centers in the Kumasi area will deal with the bad sanitary conditions within our market centers. Having a clean market environment prevents the spread of germs and bacteria's that cause food rot. Improving market facilities will food loss and waste greatly.

2. Education; Training farmers for example at the early stages of the supply chain will reduce food loss significantly. Most of the losses from the review literature suggest that food loss quantities are huge at the early stages of the supply chain. Hence, training into best practices and efficient ways of harvesting and handling, sorting and grading techniques will lead to a reduction of the FFV losses.
3. Cooling Chain when possible; All the participants in this study indicated that they have no cooling chain which they can use to store their food items to prolong its shelf life. Having a cooler at the market centers where possible will help increase the shelf life of the food items thereby reducing losses and waste significantly. But then this also raises the concern about the possibilities of achieving this especially in the rural communities where electrification is a problem. To successfully implement this, investments need to be made into providing electricity to the market centers where there is none first.
4. Improved Packaging; packaging was identified as one of the factors contributing to the FFV losses in the study. The current means of packaging the fruits and vegetables for sale and transport to the market were observed not to be the best. Food items are packaged in open wooden crates, baskets, and flat pans which are constantly exposed to the natural elements like the sun. This, in turn, decreases the shelf life of food items. Proper packing will protect and cushion the fruits and vegetables both in transport and on the shelf from direct sunshine and other elements that cause them to spoil and eventually go to waste.

5.3 Future Research

This study is subjective and descriptive in nature. A further quantitative and logical investigation may concentrate on inside and out examination concerning the evaluation of the measures of FFV food losses in Ghana or developing nations. A captivating exploration field identified in the above study is how supply chain development can be connected to the social turn of events. The most effective method to bring overflow impacts of chain development and advancement to small farmers, out-growers, and occasional workers is a significant point for additional investigation. The topic of who benefits most from the improvement of international supply chains originating in developing countries is a very intriguing one. One point which was not fully addressed is post-consumer food waste and loss and an overview of food processing and retailing losses.

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Appendix A: Interview Questions

Farmers

1. Are you into the production or cultivation of any of the studied food items?
2. Where is the location of your farm?
3. Who are the buyers of your yield?
4. How do you package your fruits or vegetables for sale?
5. Do you lose some of your yield due to any reason?
6. At what stage of the supply chain do you lose some of your yields?
7. What are some of the causes of these losses?

Middlemen/Market Women and Petty Traders

1. Which of fruits or Vegetables do you trade-in?
2. Where do you buy your food items?

All Participants

1. How do you transport your food items to your various market centers for sale?
2. What storage method do you use to store your fruits or vegetables?
3. Do you have a cooling chain where your items are stored?
4. How do you package your fruit of vegetables?
5. Do you have any additional information that you would like to add that I did not ask?

Appendix B: Interview Protocol

Introduction to the Interview

My name is Gyamfi Augustine, a student at Molde University College – Specialized University in Logistics in Molde- Norway pursuing a Master of Science degree in Logistics specializing in Advanced Supply Chain Management. Thank you for agreeing to participate in this investigation. I am conducting a qualitative (Subjective) single case study to comprehend the Fresh Fruit and Vegetables Logistics and its effect on food losses in Kumasi-Ghana. The length of the meeting ought to be about 25-30 minutes. The interview design is open-ended questions. It would be ideal if you do not hesitate to look for clearness on questions and include more detailed explanations and your perspective as you see proper.

Things to remember

- Have a protective Face mask or face shield on at all times.
- Let at least 2metres distance between you and the participant.
- Switch the mobile phone to airplane mode
- Seek consent to record the interview
- Assure participant that all responses will be confidential
- Begin the interview and audio recording simultaneously
- Observe the participant for non-verbal body language and gestures.
- Observe the settings and the infrastructure of the participant.
- Collect detailed response to the interview questions
- Ask follow-up probing questions to get more in-depth information.

After the Interview

Inform the participants they will receive a copy of the transcribed interpretation of the audio recording through Whats-App Messaging. Thank the participants for taking their time to of their busy schedules to participate in the study and give your contact details to them in case they have followed up questions and concerns.

Appendix C: Images from The Field Survey (2020)

Image 1; Mangoes in loaded in a truck



Image 2; Mango Petty Trader. Kumasi Central Market.



Image 3; Onion, Pepper and Tomato petty trader at the Market